



VERMONT JOURNAL
of ENVIRONMENTAL LAW

Volume 23 • Issue 2

VERMONT JOURNAL OF ENVIRONMENTAL LAW
VERMONT LAW SCHOOL

Volume 23, Issue 2

Winter 2022

ARTICLES

A Call to Stop Burning Trees in the Name of Climate Mitigation

*Laura Bloomer, Xiaopu Sun, Gabrielle Dreyfus, Tad Ferris, Durwood
Zaelke, Connor Schiff*.....93

Reframing Global Biodiversity Protection After COVID-19: Is
International Environmental Law up to the Task?

Maria Antonia Tigre, Natalia Urzola, Victoria Lichet.....124

STUDENT NOTES

Charging Forward: Accelerating Long-Term Energy Storage
Development

Collin Wilfong and Robert Bullington.....156

Groundwater Law, the San Luis Valley, and Climate Change

Rachel Grabenstein.....181

VERMONT JOURNAL OF ENVIRONMENTAL LAW

Vermont Law School
164 Chelsea Street | P.O. Box 96
South Royalton, Vermont 05068
(802) 831-1024
vjel@vermontlaw.edu

vjel.vermontlaw.edu

Cite to this *Journal* as: 23 VT. J. ENV'T L. ____ (2022).

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A CALL TO STOP BURNING TREES IN THE NAME OF CLIMATE MITIGATION

*Laura Bloomer, Xiaopu Sun, Gabrielle Dreyfus, Tad Ferris,
Durwood Zaelke, Connor Schiff**

Introduction	94
I. Explanation of Forest Bioenergy and Bioenergy with Carbon Capture and Storage (BECCS)	97
II. Ten Years or Less to Curb Warming	99
III. How Forest Bioenergy is Incompatible with Protecting the Climate, Biodiversity, and Communities	101
A. Burning Woody Biomass Accelerates Near-Term Warming	101
B. BECCS Will Take Decades to Remove Carbon and is Not Available at Scale	104
C. Forest Bioenergy and BECCS Threaten Biodiversity and Ecosystem Functioning	105
D. Increasing the Reliance on Energy from Woody Biomass Could Disproportionately Harm Vulnerable Communities	106
IV. Case Study: The European Union’s Treatment of Woody Biomass as a Carbon-Neutral Energy Source	108
A. History of Forest Biomass in the Renewable Energy Directive	108
B. Impacts of Classifying Forest Biomass as Renewable	109
C. 2021 Proposal to Amend the Renewable Energy Directive	110
V. Examination of Other Bioenergy Policies	111
A. The United States	112
B. China	116
VI. Calls to Action	118
A. Re-evaluate Policies to Ensure Correct Accounting of Forest Bioenergy’s Impacts	118

B. End Incentives for Forest Bioenergy and Invest in Forest Preservation, Low-emissions Energy, and Strategies to Reduce Energy Demand.....	120
C. Advance International Consensus on the Harms from Forest Bioenergy, Specifically the Impact on Climate and Biodiversity...	121
Conclusion.....	123

INTRODUCTION

Burning trees for energy delivers a one-two punch against climate change mitigation efforts. Harvesting woody biomass reduces the sequestration potential of forest carbon sinks, while the combustion of woody biomass releases large quantities of carbon into the air.¹ Forest regrowth may not offset these emissions for many decades²—well beyond the time the world has left to slow warming to avoid catastrophic impacts from climate change.

Further, harvesting forests for fuel harms ecosystems and contributes to environmental injustice. Destroying existing forests impairs biodiversity and ecosystems. Similarly, replacing natural forests with bioenergy plantations

* The authors are with the Institute for Governance & Sustainable Development (IGSD). IGSD's mission is to promote just and sustainable societies and to protect the environment by advancing the understanding, development, and implementation of effective and accountable systems of governance for sustainable development. As part of its work, IGSD pursues "fast-action" climate mitigation strategies that will result in significant reductions of climate emissions to limit temperature increase and other climate impacts in the near-term. The authors are grateful for the edits and contributions of Mary S. Booth, Director, Partnership for Policy Integrity.

1. *Forest Bioenergy, Carbon Capture & storage, & Carbon Dioxide Removal: An Update*, EUR. ACADS. SCI. ADVISORY COUNCIL 2 (2019), https://ecasac.eu/fileadmin/PDF_s/reports_statements/Negative_Carbon/EASAC_Commentary_Forest_Bioenergy_Feb_2019_FINAL.pdf; Timothy D. Searchinger et al., *Europe's Renewable Energy Directive Poised to Harm Global Forests*, 9 NATURE COMMUN 1, 2 (2018).

2. See Thomas Buchholz, John S. Gunn, & Benktesh Sharma, *When Biomass Electricity Demand Prompts Thinnings in Southern US Pine Plantations: A Forest Sector Greenhouse Gas Emissions Case Study*, FRONTIERS FORESTS & GLOB. CHANGE, May 10, 2021, at 1, 8 (finding that it takes more than 40 years for emissions from burning biomass derived from forest thinning to reach parity with emissions from fossil fuel-powered energy generation); Thomas Walker et al., *Carbon Accounting for Woody Biomass from Massachusetts (USA) Managed Forests: A Framework for Determining the Temporal Impacts of Wood Biomass Energy on Atmospheric Greenhouse Gas Levels*, 32 J. SUSTAINABLE ENERGY 130, 147–148 (2013) (discussing the greenhouse gas impact of switching from fossil fuels to woody biomass for energy generation); Holtsmark Bjart, *Harvesting in Boreal Forests and the Biofuel Carbon Debt*, 112 CLIMATIC CHANGE 415–428 (2011) (discussing the carbon debt incurred by harvesting boreal forests for energy).

degrades ecosystems.³ Increased reliance on bioenergy also threatens food and water security and could intensify social conflicts.⁴ In the United States, the wood pellet industry exacerbates environmental injustice.⁵

With little time left to achieve a sustainable and inclusive future, burning forests for energy contributes to warming in the near-term and is not a viable climate solution. Communities across the world are already suffering from the consequences of 1.2°C of warming.⁶ The Intergovernmental Panel on Climate Change (IPCC) and other experts warn that countries must make deep cuts to emissions within the next 10 years and continue reducing emissions through mid-century, including through carbon removal.⁷ Countries must make these deep cuts to meet the Paris Agreement's target of limiting warming to well below 2°C above pre-industrial levels.⁸ At the same

3. Thomas Walker et al., *Carbon Accounting for Woody Biomass from Massachusetts (USA) Managed Forests: A Framework for Determining the Temporal Impacts of Wood Biomass Energy on Atmospheric Greenhouse Gas Levels*, 32 J. SUSTAINABLE ENERGY 130, 145 (2013) (discussing the greenhouse gas impact of switching from fossil fuels to woody biomass for energy generation).

4. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, *Global Assessment Report XXII* (2019) [hereinafter IPBES].

5. See Stefan Koester & Sam Davis, *Siting of Wood Pellet Production in Environmental Justice Communities in the Southeastern United States*, 11 ENV'T JUST. 64, 64 (Apr. 2018), <https://www.liebertpub.com/doi/10.1089/env.2017.0025>; Patrick Anderson & Keri Powell, ENV'T INTEGRITY PROJECT, *DIRTY DECEPTION: HOW THE BIOMASS INDUSTRY SKIRTS THE CLEAN AIR ACT* 5 (April 26, 2018) [hereinafter ENV'T INTEGRITY PROJECT]; Michael Grunwald, *The 'Green Energy' That Might Be Ruining the Planet*, POLITICO MAG., Mar. 26, 2021; Danielle Purifoy, *How Europe's Wood Pellet Appetite Worsens Environmental Racism in the South*, SOUTHERLY (Oct. 5, 2020), https://southerlymag.org/2020/10/05/how-europes-wood-pellet-appetite-worsens-environmental-racism-in-the-south/?pico_new_user=true&pico_ui=login_link.

6. See *State of the Glob. Climate 2020: Provisional Rep.*, WORLD METEOROLOGICAL ORG., https://library.wmo.int/doc_num.php?explnum_id=10444 (noting that the global mean temperature for 2020 was 1.2 ± 0.1 °C above the 1850–1900 baseline).

7. See Katherine Calvin et al., *Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Dev.*, in *GLOBAL WARMING OF 1.5°C* 93, 112, 115–116 (Valérie Masson-Delmotte et al. eds., 2018) (describing pathways that stay within 1.5°C as requiring more significant near-term emissions reductions); Myles Allen et al., *Summary for Policymakers*, in *GLOB. WARMING OF 1.5°C* 3, 18 (Valérie Masson-Delmotte et al. eds., 2018) (“Pathways that limit global warming to 1.5°C with no or limited overshoot show clear emission reductions by 2030 (*high confidence*). All but one show a decline in global greenhouse gas emissions to below 35 GtCO₂eq yr⁻¹ in 2030, and half of available pathways fall within the 25–30 GtCO₂eq yr⁻¹ range (interquartile range), a 40–50% reduction from 2010 levels (*high confidence*).”).

8. Parties to the United Nations Framework Convention on Climate Change agreed to the Paris Agreement in 2015. U.N. Framework Convention on Climate Change Conference of the Parties, *Report of the Conference of the Parties on its twenty-first session*, U.N. Doc. FCCC/CP/2015/10/Add.1, Annex, at 3 (Jan. 29, 2016) [hereinafter *COP 21st Session Report*]. The Paris Agreement entered into force on

time, the biodiversity crisis is unprecedented and accelerating, demanding quick action to protect species and ecosystems.⁹

Yet, governments around the world categorize forest biomass as a carbon-neutral resource and promote harvesting and burning forest biomass as a strategy to meet net-zero carbon dioxide (CO₂) targets.¹⁰ Additionally, many climate models and country-specific plans include bioenergy with carbon capture and storage (BECCS) as a carbon removal strategy.¹¹ But the carbon capture and storage (CCS) technology is not ready for deployment at scale.¹² And in order to characterize forest-based BECCS as a carbon removal strategy, it is necessary to adopt the false premise that it is carbon neutral to harvest and burn forests to generate power.

Before it is too late, governments must stop cutting down forests to meet renewable energy targets. They must instead invest in strategies to deploy low-emission energy sources, decrease energy demand, and protect and enhance natural carbon sinks, while also reducing emissions of short-lived climate pollutants.

November 4, 2016. *Paris Agreement—Status of Ratification*, U.N. Framework Convention on Climate Change, <https://unfccc.int/process/the-paris-agreement/status-of-ratification> (last visited Jan. 15, 2022). Per Article 2, the Parties agree to “[hold] the increase in the global average temperature to well below 2°C above pre-industrial levels and [pursue] efforts to limit the temperature increase to 1.5°C above pre-industrial levels...” *COP 21st Session Report* at 4.

9. See IPBES, *supra* note 4, at 2 (“Human actions threaten more species with global extinction now than ever before. An average of around 25 per cent of species in assessed animal and plant groups are threatened, suggesting that around 1 million species already face extinction, many within decades, unless action is taken to reduce the intensity of drivers of biodiversity loss. Without such action, there will be a further acceleration in the global rate of species extinction, which is already at least tens to hundreds of times higher than it has averaged over the past 10 million years.”).

10. See, e.g., Council Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the Promotion of the Use of Energy from Renewable Sources, Annex VI, 2018 O.J. (L 328) 185 [hereinafter Council Directive 2018/2001] (showing that “Emissions of CO₂ from fuel in use, e_a, shall be taken to be zero for biomass fuels. Emissions of non-CO₂ greenhouse gases (CH₄ and N₂O) from the fuel in use shall be included in the e_a factor.”); Consolidated Appropriations Act, H.R. 133, 116th Cong. Div. G, Title IV, § 439 (2)(A) (2020) (stating that forest bioenergy policies should reflect forest bioenergy’s carbon neutrality); Zhōnghuá rénmin gònghéguó kě zàishēng néngyuán fǎ (中华人民共和国可再生能源法) [Renewable Energy Law of the People’s Republic of China] (promulgated by Standing Comm. Nat’l People’s Cong., Feb. 28, 2005, effective Jan. 1, 2006) art. 2, 32 (China) (defining biomass as renewable energy and encouraging its development to protect the environment).

11. See, e.g., DUNCAN BRACK & RICHARD KING, CHATHAM HOUSE, NET ZERO AND BEYOND: WHAT ROLE FOR BIOENERGY WITH CARBON CAPTURE AND STORAGE? 5 (2020) (stating that “The literature and models reviewed by SR1.5 exhibit huge variations in mitigation potential for BECCS, ranging from 1 GtCO₂/year to 85 GtCO₂/year by 2050.”).

12. *New Research: Carbon Capture and Storage is Ready but Rapid Deployment is Needed to Reach Net Zero*, SCOTTISH CARBON CAPTURE & STORAGE (Nov. 4, 2021), <https://www.sccs.org.uk/news-events/recent-news/669-new-research-carbon-capture-and-storage-is-ready-but-rapid-deployment-is-needed-to-reach-net-zero>.

This article begins with an overview of the scientific background of why harvesting and burning forests for energy is not a viable solution to climate change or related challenges. This background section includes an explanation of key terminology used in the article. The next section presents the European Union (EU)’s Renewable Energy Directive as a case study on the consequences of including bioenergy in renewable energy policies. Following the case study, the article examines bioenergy policies in the United States and China—the world’s two largest greenhouse gas emitters. The article concludes with policy recommendations to focus government action towards reducing reliance on energy from forest biomass. These recommendations are that governments: (1) re-evaluate their bioenergy policies and ensure lifecycle accounting of forest bioenergy’s climate emissions associated with harvesting and burning forest biomass; (2) end incentives for harvesting forests for fuel and invest in forest preservation, low-emission energy, and low energy demand pathways; and (3) advance international consensus on the harms from forest bioenergy, specifically the impact on climate and biodiversity.

I. EXPLANATION OF FOREST BIOENERGY AND BIOENERGY WITH CARBON CAPTURE AND STORAGE (BECCS)

The term “bioenergy” generally encompasses any form of energy derived from biomass.¹³ This article considers only forest biomass, such as trees logged for bioenergy and forestry residues from thinning or other harvesting activities. The article refers to these sources as “forest biomass” or “woody biomass” and the energy derived from these sources as “forest bioenergy.” Where the data is not specific to forest biomass, the article refers to “bioenergy” or “biomass” more generally.

Efforts to phase out fossil fuels are leading to a resurgence of forest bioenergy consumption in some countries.¹⁴ This resurgence is occurring partially through co-firing or conversion of coal-fired power plants to

13. Off. of Energy Efficiency & Renewable Energy, *Bioenergy Basics*, U.S. DEP’T ENERGY, <http://www.energy.gov/eere/bioenergy/bioenergy-basics> (last visited Jan. 15, 2022).

14. See CHARLES MOORE & MALGORZATA KASPRZAK, SANDBAG, *PLAYING WITH FIRE: AN ASSESSMENT OF PLANS TO BURN BIOMASS IN EU COAL POWER STATIONS* 7–8 fig. 2 (2019) (showing E.U. member states use of biomass as a fossil fuel substitute through an increase in biomass consumption for energy from 2010-2017).

biomass power plants.¹⁵ Converted or co-firing coal power plants generally run on wood pellets, which are manufactured at wood pellet facilities and shipped to power plants globally.¹⁶ The transition to generating electricity by burning wood is particularly concerning given the scale of potential demand and pressure on forests to meet renewable energy targets.¹⁷

Wood also fuels other energy and heat generation systems, including residential heating equipment, and industrial, commercial, and institutional boilers.¹⁸ These systems are problematic for public health and the climate. In 2017, biomass and wood combustion in residential and commercial buildings, industrial boilers, and other industry sources, had greater adverse health impacts in the United States than coal combustion for electricity generation.¹⁹

BECCS combines bioenergy with technology to capture and store the carbon emitted at combustion.²⁰ BECCS is considered a carbon-removal strategy.²¹ Although BECCS is not yet deployable at scale, scientific models of emission-reduction pathways that would stay within the Paris Agreement's temperature-limiting goals of 1.5°C or 2°C often rely on BECCS.²² The IPCC notes that 1.5°C-consistent pathways generally assume BECCS (including but not limited to BECCS associated with forest bioenergy and woody feedstocks) would remove 3–7 billion metric tons of CO₂ (GtCO₂) annually by 2050.²³ For reference, in 2019 the United States emitted over 5 billion tons of CO₂.²⁴ Despite these models, BECCS is not necessary to achieve the Paris Agreement's goals. The IPCC's 2018 *Special*

15. See *id.* at 16–17 figs. 6&7 (measuring E.U. member states' consumption of biomass at former coal power plants from 2010-2017).

16. *Id.* at 10.

17. See *id.* at 18-19 fig.8 (estimating EU's potential biomass consumption increases through coal-to-biomass substitutions).

18. Christopher D. Ahlers, *Wood Burning, Biomass, Air Pollution, and Climate Change*, 46 ENV'T L. J. 49, 51, (2016).

19. See Jonathan J. Buonocore, et al., *A Decade of the U.S. Energy Mix Transitioning Away from Coal: Historical Reconstruction of the Reductions in the Public Health Burden of Energy*, ENV'T RSCH. LETTERS, May 2021, at 1, 16–17 (discussing biomass' contributions through negative health impacts and mortality rates); See also Christopher D. Ahlers, *supra* note 18, at 51, 75-77 (outlining the ways that wood-burning emissions present health-related challenges).

20. See CHRISTOPHER CONSOLI, GLOBAL CCS INSTITUTE, BIOENERGY AND CARBON CAPTURE AND STORAGE 3–4 (2019) (illustrating the process of generating bioenergy and carbon capture and storage).

21. *Id.* at 3.

22. *Id.*

23. Joeri Rogelj et al., *Chapter 2: Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development*, in GLOB. WARMING OF 1.5°C 93, 129 tbl. 2.5 (Valérie Masson-Delmotte et al. eds., 2018).

24. *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, EPA, <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks> (last visited Nov. 19, 2021).

Report on 1.5°C highlights a 1.5°C-compatible mitigation scenario without BECCS deployment.²⁵ The policy scenario instead relies on low energy demand pathways, including energy efficiency measures and afforestation (planting new trees), among other strategies.²⁶

II. TEN YEARS OR LESS TO CURB WARMING

Effective climate change mitigation requires addressing both long-term climate stabilization and near-term risk reduction.²⁷ Deep cuts to greenhouse gas (GHG) emissions by 2030, on the way to net-zero CO₂ emissions, are necessary to stay within the 1.5°C threshold.²⁸ This includes reducing CO₂ and more potent short-lived climate pollutants: methane, black carbon, hydrofluorocarbons, and tropospheric ozone.²⁹ Parallel efforts to protect forests and other carbon sinks are designed to maximize carbon stored and minimize the release of carbon to the atmosphere.³⁰ Allowing existing forests to grow to their ecological potential, a strategy known as “proforestation,” would strengthen the Earth’s natural sink capacity in the next few decades.³¹

Staying within 1.5°C of warming will minimize the life-threatening impacts of climate change. Climate change disproportionately affects historically disadvantaged and vulnerable communities.³² Each increment of warming further impairs human health and increases the risk of heat-related

25. Allen et al., *supra* note 8, at 14.

26. See generally Arnulf Gruber et al., *A Low Energy Demand Scenario for Meeting the 1.5 °C Target and Sustainable Development Goals Without Negative Emission Technologies*, 3 NATURE ENERGY 515 (2018) (discussing scenarios and other strategies that could majorly transform energy supply).

27. Durwood Zaelke et al., INST. FOR GOVERNANCE & SUSTAINABLE DEV., CTR. FOR HUM. RTS. AND ENV’T., *THE NEED FOR FAST NEAR-TERM CLIMATE MITIGATION TO SLOW FEEDBACKS AND TIPPING POINTS* 1 (Sept. 27, 2021).

28. Allen et al., *supra* note 8, at 12.

29. Allen et al., *supra* note 8, at 12; See also Vaishali Naik & Sophie Szopa et al., *Chapter 6: Short-lived Climate Forcers*, in CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, 6–6 (Valérie Masson-Delmotte et al. eds., 2021) (discussing targeted SLCP policies and their role in climate change mitigation ranges).

30. Gensuo Jia & Elena Shevliakova, *Land-Climate Interactions*, in CLIMATE CHANGE AND LAND 136 (P.R. Shukla et al. eds., 2019); see also Monica L. Noon et al., *Mapping irrecoverable carbon in Earth’s ecosystems*, 5 NATURE SUSTAINABILITY 37, 37–38 (Jan. 2022) (identifying “irrecoverable carbon reserves that are manageable, are vulnerable to disturbance and could not be recovered by 2050 if lost today.”).

31. William R. Moomaw et al., *Intact Forests in the United States: Proforestation Mitigates Climate Change and Serves the Greatest Good*, FRONTIERS FORESTS & GLOB. CHANGE, June 2019, at 1, 2.

32. E.g., Allen et al., *supra* note 8, at 9 (stating that disadvantaged and vulnerable populations will disproportionately feel the effects of climate change).

deaths—especially for low-income communities and communities of color.³³ The IPCC estimates that limiting warming to 1.5°C rather than 2°C would protect hundreds of millions of people from climate-related risks and from being pushed into poverty.³⁴ Communities and ecosystems have a greater ability to adapt to 1.5°C of warming rather than 2°C.³⁵

Additionally, enhanced climate mitigation this decade will help slow self-amplifying climate feedback loops that accelerate warming and help avoid triggering irreversible climate tipping points.³⁶ For example, the Arctic sea ice extent is decreasing.³⁷ Warmer temperatures melt sea ice in the Arctic, increasing dark ocean surface exposure and decreasing the Earth's reflectivity.³⁸ This causes the Earth to absorb more incoming solar radiation, exacerbating warming and sea-ice melt (land-based snow and ice in the Arctic also is melting with the same consequences).³⁹ These feedback loops pull the Earth closer to passing tipping points that, if crossed, would irreversibly disrupt the climate system.⁴⁰ Examples of tipping points include: the melting of the Greenland and West Antarctic ice sheets, dieback of the Amazon rainforest, and large-scale thawing of permafrost.⁴¹ Scientists also warn that a cascade of tipping points could bring about runaway warming and a far less habitable “Hothouse Earth.”⁴² Avoiding these tipping points must be a priority as the world works towards climate stabilization.

The science is clear; the world must meet the Paris Agreement's 1.5°C goal. Meeting this target requires fast action this decade on the way to net-

33. *Id.*; See CLIMATE CHANGE AND SOCIAL VULNERABILITY IN THE UNITED STATES: A FOCUS ON SIX IMPACTS, EPA, 35 (Sept. 2021) (showing that minority populations and low-income communities will suffer higher rates of premature mortality due to climate-driven temperature changes).

34. See Allen et al., *supra* note 8, at 22 (warning that global warming between 2°C and 4°C will lead to thousands of premature deaths in the United States).

35. *Id.* at 10.

36. Timothy Lenton et al., Comment, *Climate Tipping Points—Too Risky to Bet Against*, NATURE 592, 594 (Nov. 27, 2019).

37. Matthew L. Druckenmiller et al., *The Arctic*, in STATE OF THE CLIMATE IN 2020, BULL. AM. METEOROLOGICAL SOC'Y S263, S269, S280 (Aug. 2021), <https://journals.ametsoc.org/view/journals/bams/102/8/BAMS-D-21-0086.1.xml>.

38. *Id.* at S283.

39. Rebecca Lindsey & Michon Scott, *Climate Change: Arctic Sea Ice*, CLIMATE.GOV (Sept. 28, 2021), <https://www.climate.gov/news-features/understanding-climate/climate-change-minimum-arctic-sea-ice-extent>; Peter Wadhams, A FAREWELL TO ICE 107–108 (2017) (“Warm air over an ice-free Arctic also causes the snowline to retreat. . . . This of the same magnitude as the sea ice negative anomaly [and] . . . means that snowline retreat and sea ice retreat are each adding about the same amount to global warming.”).

40. Lenton et al., *supra* note 36, at 594; See generally Sybren Drijfhout et al., *Catalogue of Abrupt Shifts in Intergovernmental Panel on Climate Change Climate Models*, 112 PROC. NAT'L. ACAD. SCI. E5777, E5777 (2015) (explaining “tipping elements” and their major climate effects).

41. Lenton et al., *supra* note 36, at 592.

42. Lenton et al., *supra* note 36, at 594; Will Steffen et al., *Trajectories of the Earth System in the Anthropocene*, 115 PROC. NAT'L. ACAD. SCI. 8252, 8254 (2018), <http://www.pnas.org/content/115/33/8252>.

zero. This action includes improving the carbon storage capacity of forests and other carbon sinks while reducing emissions of short-lived climate pollutants.

III. HOW FOREST BIOENERGY IS INCOMPATIBLE WITH PROTECTING THE CLIMATE, BIODIVERSITY, AND COMMUNITIES

Forest bioenergy moves the world in the wrong direction and immediately adds to warming. Replacing fossil fuels with woody biomass will not reduce emissions within the time left to curb warming, and expanding such bioenergy threatens biodiversity. Relying on large-scale deployment of BECCS distracts from the urgent need to cut emissions. Additionally, the wood pellet industry and forest biomass-fired power plants increase pollution—especially in environmental justice communities.⁴³

A. Burning Woody Biomass Accelerates Near-Term Warming

Burning woody biomass increases atmospheric CO₂ levels for decades.⁴⁴ Burning forest biomass for power generation emits more CO₂ per-unit of final energy than burning fossil fuels, including coal.⁴⁵ Carbon stored in woody biomass is released into the atmosphere immediately at combustion, but it takes significantly longer—generally decades—for trees to reabsorb the same amount of carbon through regrowth.⁴⁶ At the same time, removing biomass from forests decreases the carbon storage capacity of forests.⁴⁷

Harvesting forests for biomass can negatively impact the climate for over a century. A number of studies find that it takes many decades for tree regrowth to offset enough emissions from cutting and burning trees to make forest biomass a lower-emitting energy source than fossil fuels.⁴⁸ It would take even longer for tree regrowth to completely offset the emissions from

43. See Stefan Koester & Sam Davis, *supra* note 5, at 67.

44. *Id.* at 66.

45. See, e.g., Searchinger et al., *supra* note 1 (commenting on the increased carbon dioxide expected by 2050 if wood-burning replaces fossil-fuel-burning); Michael Norton, et al., Comment, *Serious Mismatches Continue Between Science and Policy in Forest Bioenergy*, 11 GLOB. CHANGE BIOLOGY BIOENERGY: POL'Y 1256, 1259 (2019).

46. Searchinger, *supra* note 1.

47. *Id.* at 3.

48. E.g. Thomas Buchholz, John S. Gunn, & Benktesh Sharma, *supra* note 2, at 8; Thomas Walker et al., *supra* note 2, at 147–148; Holtsmark Bjart, *Harvesting in Boreal Forests and the Biofuel Carbon Debt*, 112 CLIMATIC CHANGE 415–428 (2011).

burning woody biomass. One study found that it would take more than 40 years before emissions from generating electricity from forest thinning were less than emissions from a baseline electricity-generation scenario.⁴⁹ Another study of boreal forests estimates that it would take 190 years to make up for the combustion emissions and the forest sequestration lost from increased harvesting—even in a case where the harvested wood was converted to pellets to replace coal in a power plant.⁵⁰ Given these findings, harvesting for biomass will increase atmospheric GHG emissions and warming beyond the deadline the world has for rapidly reducing emissions and reaching net-zero.

Even bioenergy from forestry residues is not carbon neutral for many decades. Studies demonstrate that bioenergy from forest residues—residues that are leftover from other harvesting activities or thinning—results in decades-long net carbon emissions.⁵¹ Generally, net emissions from burning forestry residues are calculated by finding the difference between carbon released via combustion and carbon released via decomposition (if residues were left in the field).⁵² A study of power plants burning local forestry residue found that 41–95% of the cumulative direct emissions would count as additional carbon emissions added to the atmosphere after 10 years.⁵³

49. Thomas Buchholz, John S. Gunn, & Benktesh Sharma, *supra* note 2, at 8. The baseline scenario represented the U.K. electricity grid mix and excluded thinning of affected forests for wood pellet production.

50. Holtsmark, *supra* note 2, at 415.

51. *E.g.*, Thomas Buchholz et al., *supra* note 2, at 8 (“The GHG emission parity time for all three wood supply areas combined and individually was not reached within the 40- year model period when using a 2018 and 2025 target UK grid mix emission profile as a baseline. Based on the forest carbon stock loss from thinning in comparison to the baseline without thinning, the bioenergy scenario is unlikely to reach GHG emission parity until beyond 2,060 for both electricity GHG emission baselines.”); Philippe Leturcq, *GHG Displacement Factors of Harvested Wood Products: The Myth of Substitution*, SCI. REP., Nov. 27, 2020, at 1, 7, <https://doi.org/10.1038/s41598-020-77527-8> (discussing GHG displacement factors of harvested wood); Mary S. Booth, *Not Carbon Neutral: Assessing the Net Emissions Impact of Residues Burned for Bioenergy*, ENV’T RSCH. LETTERS, Feb. 21, 2018, at 1, 8, <https://iopscience.iop.org/article/10.1088/1748-9326/aaac88/pdf> (“The model finds that for plants burning locally sourced wood residues, from 41% (extremely rapid decomposition) to 95% (very slow decomposition) of cumulative direct emissions should be counted as contributing to atmospheric carbon loading by year 10. Even by year 50 and beyond, the model shows that net emissions are a significant proportion of direct emissions for many fuels.”); Holtsmark, *supra* note 2, at 415–417 (discussing the biofuel carbon debt); Jerome Langanier et al., *Range and Uncertainties in Estimating Delays in Greenhouse Gas Mitigation Potential of Forest Bioenergy Sourced from Canadian Forests*, 9 GCB BIOENERGY 358, 362–363, 365 (2017), <https://onlinelibrary.wiley.com/doi/epdf/10.1111/gcbb.12327.pdf> (discussing GHG mitigation potential of forest bioenergy); Grant M. Domke et al., *Carbon Emissions Associated with the Procurement and Utilization of Forest Harvest Residues for Energy*, *Northern Minnesota, USA*, 36 BIOMASS & BIOENERGY 141, 147 (2011), <https://www.sciencedirect.com/science/article/pii/S0961953411005502.pdf> (discussing carbon emissions associated with forest harvest residues for energy).

52. Booth, *supra* note 51, at 1, 8.

53. *Id.*

Some proponents of bioenergy argue that if the biomass is sourced from “sustainable harvests” (i.e., harvest levels that do not outpace the forest’s incremental growth), it should be considered carbon neutral.⁵⁴ But this argument essentially double-counts ongoing forest carbon uptake. As the IPCC’s 2014 mitigation report notes: “If bioenergy production is to generate a net reduction in emissions, it must do so by offsetting those emissions through increased net carbon uptake of biota and soils.”⁵⁵ In other words, because burning wood for energy creates a new and additional source of emissions, offsetting those emissions also requires a new and additional source of carbon sequestration.

Expanded bioenergy also would require significantly more managed tree plantations with low carbon-sink capacities.⁵⁶ Bioenergy plantations store far less carbon than natural forests, in part because young small trees sequester less carbon than mature forests.⁵⁷ Natural forests also tend to have greater carbon stocks overall, including in soils.⁵⁸ Further, considering factors that impact forest survival (such as temperature changes, pests, and fire), replanting trees may never fully offset emissions from forest bioenergy.⁵⁹

Regardless of the source, forest bioenergy emissions risk exceeding the Paris Agreement’s temperature targets in the coming decades. Policies that treat bioenergy as carbon neutral ignore timing—a crucial factor in climate mitigation.

54. See, e.g., CAMBRIDGE UNIVERSITY, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE [IPCC] (2014), CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE CONTRIBUTION WORKING GROUP III TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, at 879 (Ottmar Edenhofer et al., eds. 2014) (noting that biomass combustion is often considered climate neutral if the “bioenergy system is managed sustainably”).

55. *Id.* at 877.

56. Moomaw et al., *supra* note 31, at 2.

57. *Id.* at 5; Simon L. Lewis et al., Comment, *Regenerate Natural Forests to Store Carbon*, 568 NATURE 25, 27 (Apr. 4, 2019).

58. See generally L.B. Guo & R.M. Gifford, *Soil Carbon Stocks and Land Use Change: A Meta Analysis*, 8 GLOB. CHANGE BIOLOGY 345, 349 (2002) (explaining the different soil stocks for different land uses).

59. John D. Sterman et al., *Does Replacing Coal with Wood Lower CO₂ Emissions? Dynamic Lifecycle Analysis of Wood Bioenergy*, ENV’T RSCH. LETTERS, Jan. 18, 2018, at 1, 8.

B. BECCS Will Take Decades to Remove Carbon and is Not Available at Scale

Similarly, large-scale BECCS, especially when associated with forest biomass, is not a viable carbon-removal technique in the near- or mid-term. While CO₂ removal is necessary to stay within the 1.5°C limit on warming, BECCS will increase emissions long before reducing them.⁶⁰ Categorizing BECCS as a carbon-negative strategy likewise relies on the false assumption that bioenergy is carbon neutral, despite the slow tree regrowth and residue decomposition rates.⁶¹ Rather, tree regrowth exceeding the carbon impact from using forest biomass for fuel would need to occur before BECCS could be considered carbon negative.⁶² Thus, as the *Working Group I Contribution to the IPCC Sixth Assessment Report* confirmed, BECCS would increase carbon emissions in the initial decades of its operation.⁶³

The carbon-removal efficiency of BECCS varies and may be less than 50% due to leaks occurring before the carbon is stored in the ground.⁶⁴ If a BECCS facility burned wood pellets, a significant amount of carbon could be emitted along the supply chain and would not be captured by the CCS technology.⁶⁵ This means that tree regrowth would need to account for these inefficiencies before BECCS could be considered carbon negative.

Additionally, CCS technology is not yet deployable at scale.⁶⁶ One study estimated that the rate of carbon capture would need to increase 100 times from 2018 levels by 2050 to meet the 2°C target.⁶⁷ For BECCS specifically, there were only five BECCS facilities in operation in 2019, collectively

60. EUROPEAN ACADS. SCI. ADVISORY COUNCIL, *supra* note 1, at 6–7.

61. *Id.* at 7.

62. *See generally id.* at 2 (explaining that reabsorbed carbon through regrowth is not happening fast enough to meet the Paris Agreement’s timeline).

63. Marcos H. Costa et al., *Chapter 5: Global Carbon and Other Biogeochemical Cycles and Feedbacks*, in INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, ASSESSMENT REP. 6 CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS 5–108 (Valérie Masson-Delmotte et al. eds., 2021), <https://www.ipcc.ch/report/ar6/wg1/#FullReport>; *see also* EUROPEAN ACADS. SCI. ADVISORY COUNCIL, *supra* note 1, at 7 (forest bioenergy, carbon capture and storage, and carbon dioxide removal).

64. EUROPEAN ACADS. SCI. ADVISORY COUNCIL, *supra* note 1, at 6.

65. NAT. RES. DEF. COUNCIL, A BAD BIOMASS BET 3 (Oct. 2021).

66. *See e.g.*, R. Stuart Haszeldine et al., *Negative Emissions Technologies and Carbon Capture and Storage to Achieve the Paris Agreement Commitments*, PHIL. TRANSACTIONS OF THE ROYAL SOC’Y (Apr. 2, 2018) at 1, 14, 20 (discussing emissions technology and carbon capture and storage); CONSOLI, *supra* note 20, at 5 (discussing bioenergy and carbon capture and storage); *see also* Ragnhildur Sigurdardottir & Akshat Rathi, *Startups Climeworks and Carbfix are Working Together to Store Carbon Dioxide Removed from the Air Deep Underground*, BLOOMBERG, Sept. 8, 2021 (“The plant will capture 4,000 tons of CO₂ a year, making it the largest direct-air capture facility in the world. But that only makes up for the annual emissions of about 250 U.S. residents. It’s also a long way from Climeworks’ original goal of capturing 1% of annual global CO₂ emissions—more than 300 million tons—by 2025. It’s now targeting 500,000 tons by the end of the decade.”).

67. Haszeldine et al., *supra* note 66, at 1, 21.

capturing around 1.5 million metric tons of CO₂ per year.⁶⁸ All operating BECCS facilities are connected to ethanol-producing plants, and most of the facilities are in the United States.⁶⁹

BECCS' high price tag is part of the problem as well. The National Academies of Sciences, Engineering, and Medicine found that the capture and storage cost of BECCS is \$70/ton of CO₂, which is higher than the cost of CCS from fossil fuel-based power plants.⁷⁰ And the high costs required to avoid the negative effects of BECCS could sharply increase the total cost to \$100-200/ton of CO₂.⁷¹

C. Forest Bioenergy and BECCS Threaten Biodiversity and Ecosystem Functioning

Forest bioenergy, and especially large-scale deployment of BECCS, threatens biodiversity and ecosystem functioning. As the IPCC and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services noted: "Intensive bioenergy crop production can negatively affect biodiversity and ecosystem services, including in adjacent land, freshwater and marine ecosystems through fertilizer and pesticide use or by increasing agricultural water withdrawals, thus also impacting human capacity to adapt to climate change."⁷² Converting ecosystems such as natural forests to monocrops decreases local biodiversity,⁷³ and the invasion of non-native trees can decrease an area's carbon sequestration.⁷⁴ Even logging and thinning for bioenergy could negatively impact biodiversity and ecosystem services.⁷⁵ Removing forest residues can decrease future forest biomass

68. CONSOLI, *supra* note 20, at 2, 4.

69. *Id.*

70. NAT. ACAD. OF SCIS., ENG'G, AND MED., NEGATIVE EMISSIONS TECHS. AND RELIABLE SEQUESTRATION: A RSCH. AGENDA 11 (2019), <http://nap.edu/25259.pdf>.

71. EUROPEAN ACADS. SCI. ADVISORY COUNCIL, *supra* note 1, at 7.

72. *Id.*

73. M. J. Swift et al., *Biodiversity and Ecosystem Services in Agricultural Landscapes—Are We Asking the Right Questions*, 104 AGRIC., ECOSYSTEMS & ENV'T 113, 121 (2004).

74. Martin A. Nuñez et al., *Should Tree Invasions be Used in Treeless Ecosystems to Mitigate Climate Change?*, FRONTIERS IN ECOLOGY & ENV'T, 2021, at 334, 334–335.

75. Thomas Ranius et al., *The Effects of Logging Residue Extraction for Energy on Ecosystem Services and Biodiversity: A Synthesis*, 209 J. ENV'T'L MGMT. 409, 414 (2018); Johnny de Jong & Anders Dahlberg, *Impact on Species of Conservation Interest of Forest Harvesting for Bioenergy Purposes*, 383 FOREST ECOLOGY & MGMT. 37, 45–46 (2017).

growth and threaten a broad variety of species.⁷⁶ Many of the most threatened species depend on resources such as dead wood that are scarce in managed forests.⁷⁷

D. Increasing the Reliance on Energy from Woody Biomass Could Disproportionately Harm Vulnerable Communities

Demand for woody biomass presents a health threat to communities. Like burning coal, biomass releases pollutants that harm human health, including particulate matter.⁷⁸ Because of bioenergy's serious health impacts, the American Lung Association, the American Academy of Pediatrics, and other leading public health, medical, and nursing organizations oppose the expansion of bioenergy.⁷⁹

Although federal and state permitting processes in the U.S. require that biomass power plants stay within emissions thresholds, the regulations are not stringent or well enforced.⁸⁰ For example, in 2018, a wood-fired biomass power plant in Stockton, California, was by far the region's largest emitter of fine particulate matter.⁸¹ A 2014 study of 88 biomass power plants found that nearly half of the power plants characterized themselves in a way to avoid stringent federal regulations.⁸²

76. Thomas Ranius et al., *supra* note 75, at 414; Juha Siitonen, *Threatened Saproxyllic Species*, in BIODIVERSITY IN DEAD WOOD 356, 364 (Jogeir Stokland et al. eds., 2012).

77. Thomas Ranius et al., *supra* note 75, at 414; Johnny de Jong & Anders Dahlberg, *supra* note 75, at 45–46; Jürgen Bauhus et al., *How Does the Forest-based Bioeconomy Impact Forest Biodiversity?*, in WHAT CAN SCIENCE TELL US: TOWARDS A SUSTAINABLE EUROPEAN FOREST-BASED BIOECONOMY 67, 68 (Lauri Hetemäki et al. eds., 2017).

78. MARY S. BOOTH, PARTNERSHIP FOR POLICY INTEGRITY, TREES, TRASH, AND TOXICS: HOW BIOMASS ENERGY HAS BECOME THE NEW COAL 16–18 (Apr. 2, 2014); Christopher D. Ahlers, *supra* note 18, at 52, 64; See H. CAI & M.Q. WANG, ENERGY SYSTEMS DIVISION, ARGONNE NATIONAL LABORATORY, ESTIMATION OF EMISSION FACTORS OF PARTICULATE BLACK CARBON AND ORGANIC CARBON FROM STATIONARY, MOBILE, AND NON-POINT SOURCES IN THE UNITED STATES FOR INCORPORATION INTO GREET, U.S. DEPT. OF ENERGY 31, tbl.15 (May 2014) (listing mean black carbon emissions from biomass-fired boilers as emitting 0.273 g/kWh compared with 0.009 g/kWh from coal-fired boilers).

79. Letter from Allergy & Asthma Network et. al. to Senator/Representative (Sept. 13, 2016) (on file with author).

80. BOOTH, *supra* note 78, at 19–21.

81. See STOCKTON COMMUNITY EMISSIONS REDUCTION PROGRAM, SAN JOAQUIN VALLEY AIR POLLUTION CONTROL DIST., App. C-4 (Feb. 3, 2021), <https://community.valleyair.org/media/2688/appendix-c.pdf> (showing PM_{2.5} emissions from DTE Stockton, LLC of 13.84 tons per year; listing inspection history).

82. BOOTH, *supra* note 78, at 5.

Further, the wood pellet industry in the U.S. is perpetuating environmental injustice to support Europe's bioenergy industry.⁸³ Woody biomass harvest decreases biodiversity and ecosystem services in areas near wood pellet facilities.⁸⁴ The production processes release harmful air pollutants and increase noise pollution.⁸⁵ The burden of this pollution largely falls on low-income communities and communities of color.⁸⁶ According to one study, environmental justice communities (defined as low-income communities of color) are 50% more likely to have a wood pellet facility in their community than non-environmental justice communities.⁸⁷ The study also found that in North Carolina and South Carolina wood pellet facilities were sited exclusively in environmental justice communities.⁸⁸

Lastly, large-scale deployment of BECCS would impact food and water security, which could intensify social conflicts.⁸⁹ The IPCC *Special Report on Climate Change and Land* warns that high implementation of BECCS (11.3 GtCO₂ yr⁻¹ in 2050) could increase the population at risk of hunger by up to 150 million people.⁹⁰ The competition between food and bioenergy crops would hit low- and middle-income countries hardest, partially because of increased food prices.⁹¹ The IPCC also found that high BECCS deployment would use enough water to alter the water cycle at the regional scale.⁹²

83. ENV'T INTEGRITY PROJECT, *supra* note 5, at 9; Purifoy, *supra* note 5; Gruwnald, *supra* note 5; *see also* Press Release, NAACP et al., Release: Drax Facility Fined \$2.5M for Major Pollution Violation (Feb.18, 2021) (discussing major pollution violation and fine) <https://www.dogwoodalliance.org/2021/02/release-drax-facility-fined-2-5m-for-major-pollution-violations/>.

84. ENV'T INTEGRITY PROJECT, *supra* note 5, at 5–6; Purifoy, *supra* note 5; Gruwnald, *supra* note 5.

85. ENV'T INTEGRITY PROJECT, *supra* note 5, at 2; Press Release, NAACP et al., *supra* note 83; Purifoy, *supra* note 5.

86. Koester, *supra* note 5, at 64, 70; Purifoy, *supra* note 5; Gruwnald, *supra* note 5.

87. Koester, *supra* note 5, at 70.

88. *Id.* at 68.

89. IPBES, *supra* note 4, at 18.

90. Intergovernmental Panel on Climate Change [IPCC], The Climate Change and Land: Summary for Policymakers, at 27 (Valérie Masson-Delmotte et al. 2020).

91. Tomoko Hasegawa, *Food Security Under High Bioenergy Demand Toward Long-Term Climate Goals*, 163 CLIMATIC CHANGE 1587, 1598 (2020).

92. Marcos H. Costa et al., *Chapter 5: Global Carbon and Other Biogeochemical Cycles and Feedbacks*, in INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, ASSESSMENT REP. 6 CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS 5–30, Cross-Chapter Box 5.1 (Valérie Masson-Delmotte et al. eds., 2021), <https://www.ipcc.ch/report/ar6/wg1/#FullReport>.

IV. CASE STUDY: THE EUROPEAN UNION'S TREATMENT OF WOODY BIOMASS AS A CARBON-NEUTRAL ENERGY SOURCE

The European Union (EU) categorizes forest biomass as a renewable energy source in its Renewable Energy Directive (RED) and Emissions Trading System.⁹³ This classification makes bioenergy eligible for renewable energy subsidies, resulting in more than €17 billion in subsidies for bioenergy in 2019 alone.⁹⁴ This endorsement of bioenergy has occurred against the warnings of the EU's own scientists and at the expense of the EU's forests.⁹⁵ Understanding the shortcomings of the EU's policies can help other governments avoid subsidizing bioenergy instead of low-carbon energy sources and forest protection.

A. History of Forest Biomass in the Renewable Energy Directive

Since 2009, the EU has included forest biomass as a carbon-neutral energy source in the RED because the European Commission transposed international carbon reporting methods into energy policy. Under IPCC and United Nations Framework Convention on Climate Change (UNFCCC) guidelines for greenhouse gas inventories, countries report the forest carbon loss at the moment of harvest.⁹⁶ To avoid double counting, the carbon emissions are counted as zero in the energy sector when biomass is burned for energy.⁹⁷ From an accounting standpoint, the harvest and use of biomass for energy decreases the EU's land sink (if harvested in the EU), but it does not affect the EU's energy sector emissions.⁹⁸

Thus, the EU's accounting practice has encouraged treating forest bioenergy as if it actually is carbon-neutral despite its massive CO₂ footprint.⁹⁹ The RED assumes zero combustion emissions of CO₂ for forest biomass; it requires only that biomass-fired plants report the CO₂ from fossil

93. EUROPEAN COMMISSION, STUDY ON ENERGY SUBSIDIES AND OTHER GOVERNMENT INTERVENTIONS IN THE EUROPEAN UNION 35 (2021).

94. *Id.* (quantifying subsidies for all bioenergy, including biomass and biofuels).

95. Norton et al., *supra* note 45, at 1258.

96. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES, ch. 2, at 2.33 (Simon Eggleston et al., eds., 2006) ("Emissions of CO₂ from biomass fuels are estimated and reported in the AFOLU sector as part of the AFOLU methodology. In the reporting tables, emissions from combustion of biofuels are reported as information items but not included in the sectoral or national totals to avoid double counting."); *see also* Andrea Camia et al., Joint Rsch. Ctr., *JRC Science for Policy Report: The Use of Woody Biomass for Energy Production in the EU*, at 86, EUR 30548 EN (2021).

97. GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES, *supra* note 96, at 2.33; *see also* Camia et al., *supra* note 97, at 86.

98. Camia et al., *supra* note 96, at 86.

99. Norton et al., *supra* note 45, at 1257.

fuels burned during harvesting, processing, and transport of biomass, as well as non-CO₂ GHGs from biomass combustion.¹⁰⁰ With this policy, a power plant can switch from coal to woody biomass and claim that it has drastically reduced emissions while continuing to release similar amounts of CO₂.

B. Impacts of Classifying Forest Biomass as Renewable

Given this accounting trick, bioenergy use has increased since passage of the RED.¹⁰¹ Bioenergy accounts for around 60% of “renewable” energy in the EU.¹⁰² About half of woody biomass in the EU comes from primary biomass sources.¹⁰³ These sources include stemwood, treetops, and branches.¹⁰⁴ The result is an increase in emissions.¹⁰⁵ In 2015, the burning of forest biomass emitted 330–380 million metric tons of CO₂, which researchers estimate is around 100 million metric tons more than would have been emitted by the fossil fuels that bioenergy replaced.¹⁰⁶

Additionally, increased bioenergy use is likely escalating forest harvest levels.¹⁰⁷ Using satellite data, one study showed a significant increase in harvested areas in the EU between 2015 and 2018, as compared to the preceding years.¹⁰⁸ Although no longer a part of the EU, the U.K.’s demand for wood pellets is damaging forests in the Southeastern U.S. because most of the U.K.’s wood pellets are imported from the U.S.¹⁰⁹ A 2019 study of proposed coal-to-biomass power plants in the EU estimated that 270,000 hectares of forest in the U.S. South would need to be harvested each year if all of the converted power plants sourced wood pellets from that region.¹¹⁰

The EU’s own scientists oppose the RED’s treatment of biomass as a carbon-neutral energy source.¹¹¹ The European Academies’ Science

100. Council Directive 2018/2001, *supra* note 9, at 185.

101. Camia et al., *supra* note 96, at 44; Norton et al., *supra* note 45, at 1257.

102. Camia et al., *supra* note 96, at 40.

103. *Id.* at 6–7.

104. *Id.*

105. *Id.*

106. *Id.* at 88, Box 2.

107. *Id.* at 53.

108. Guido Ceccherini et al., *Matters Arising, Reply to Wernick, I.K. et al.; Palahi, M. et al.*, *NATURE*, Apr. 28, 2021, at E13, E18–E23; Guido Ceccherini et al., *Abrupt Increase in Harvested Forest Area Over Europe After 2015*, *NATURE*, July 2, 2020, at 72, 76.

109. NAT. RES. DEF. COUNCIL, *DOGWOOD ALL.*, and S. ENV’T L. CTR., *GLOBAL MARKETS FOR BIOMASS ENERGY ARE DEVASTATING U.S. FORESTS 3* (2019).

110. MOORE & KASPRZAK, *supra* note 14, at 27.

111. Norton et al., *supra* note 45, at 1258.

Advisory Council (EASAC) published a paper in 2019 concluding that the EU's bioenergy policies and subsidies risk "exacerbating rather than mitigating climate change."¹¹² EASAC recommended that biomass should not be considered renewable unless it can be proven that replacing fossil fuels with biomass will lead to net reductions in atmospheric CO₂ within a decade.¹¹³ In a separate commentary, EASAC warned against reliance on BECCS because of "substantial risks and uncertainties, both over its environmental impact and ability to achieve net removal of CO₂ from the atmosphere."¹¹⁴

C. 2021 Proposal to Amend the Renewable Energy Directive

Rather than heeding the advice of its scientists, the European Commission's 2021 proposal to amend the RED continues to classify forest biomass as a renewable energy source.¹¹⁵ While the proposal would end subsidies for electricity-only biomass power plants in 2027,¹¹⁶ critics note that this will have little impact.¹¹⁷ The provision would not apply to heat and power plants.¹¹⁸ It also includes a loophole that would exclude coal regions—target areas for subsidies for coal-to-biomass conversion projects.¹¹⁹

Furthermore, the proposal anticipates an increase in bioenergy. The Commission's Impact Assessment Report for the proposal anticipates that bioenergy demand will grow by 69% between 2030 and 2050.¹²⁰ This growth includes anticipated increased demand for electricity from biomass as electrification accelerates.¹²¹

112. *Id.*

113. *Id.* at 1260.

114. EUROPEAN ACADS. SCI. ADVISORY COUNCIL, *supra* note 1, at 2.

115. Commission Proposal for a Directive of the European Parliament and of the Council of 7 July 2021 on Amending Directive (EU) 2018/2001, at 30–31, COM (2021) 557 final (July 14, 2021) [hereinafter Commission Proposal].

116. *Id.* at 29–30.

117. See NGO Position Paper: *To Protect Nature and the Climate, We Must Reform how Bioenergy is Treated in the EU's Renewable Energy Directive 2* (Oct. 2021), https://www.fern.org/fileadmin/uploads/fern/Documents/2021/RED_-_NGO_Position_Paper_1_.pdf [hereinafter NGO Position Paper]; see also *What Does "Fit for 55" Mean for Forests*, FERN 2 (2021), https://www.fern.org/fileadmin/uploads/fern/Documents/2021/Fit_for_55_response.pdf (discussing how the phaseout of subsidies should not exclude coal regions).

118. Commission Proposal, *supra* note 115, at 29–30; see also NGO Position Paper, *supra* note 117.

119. Commission Proposal, *supra* note 115, at 29–30; see also NGO Position Paper, *supra* note 117.

120. European Commission Staff Working Document: Impact Assessment Report, at 141–42, SWD (2021) 621 final (July 14, 2021).

121. *Id.* at 142.

The RED's path dependence underscores the importance of excluding forest bioenergy from renewable energy policies at the outset. Categorizing biomass as a renewable source results in considerable stakeholder lock-in, making it difficult for the scientific arguments to prevail.¹²² Rather than fixing the misclassification, the EU continues to prop up a heavily polluting industry and make peripheral changes at the expense of the climate.¹²³ By the time the EU excludes bioenergy from its renewable energy programs, enormous resources that could go towards deployment of low-emissions energy will be lost.

V. EXAMINATION OF OTHER BIOENERGY POLICIES

Countries around the world are at a pivotal moment as they transition their energy systems away from fossil fuels. As the world's largest emitters, the United States' and China's choices for transitioning their energy systems play an outsized role in whether warming stays below 1.5°C.¹²⁴ While neither country relies on forest bioenergy to the same extent as the EU, both have taken steps to include forest biomass in their renewable energy policies.¹²⁵ Additionally, country-specific studies incorporate BECCS as a carbon removal strategy for achieving net-zero emissions by mid-century.¹²⁶ To

122. See Norton et al., *supra* note 45, at 1258 (arguing that the large investments made in biomass energy have influenced policy making by the European Parliament).

123. See generally MATTHEW SMITH, TYCHO SMIT, & ANN GARDINER, TRINOMICS, FINANCIAL SUPPORT FOR ELECTRICITY GENERATION & CHP FROM SOLID BIOMASS 15 (2019) (analyzing the scope of subsidies for biomass in EU countries) <http://trinomics.eu/wp-content/uploads/2019/11/Trinomics-EU-biomass-subsidies-final-report-28nov2019.pdf>; FERN, *supra* note 120, at 2.

124. See *Global Emissions*, CTR. FOR CLIMATE & ENERGY SOLUTIONS, <https://www.c2es.org/content/international-emissions/> (inferring the impacts of the three main GHG producers if each were to reduce GHG emissions with energy system transitions) (last visited Nov. 17, 2021); see also Brady Dennis et al., *U.S. and China Issue Joint Pledge to Slow Climate Change*, WASH. POST (Nov. 10, 2021), <https://www.washingtonpost.com/climate-environment/2021/11/10/us-china-declaration-climate/> (discussing pledge between United States and China to reduce GHGs by encouraging processes like clean energy).

125. EPA, Policy Statement, EPA'S TREATMENT OF BIOGENIC CARBON DIOXIDE (CO₂) EMISSIONS FROM STATIONARY SOURCES THAT USE FOREST BIOMASS FOR ENERGY PRODUCTION (2018); National People's Congress of China, *Outline of the 11th Five-Year Plan on National Economic and Social Development* (2006–2010) (2006).

126. E.g. Jay Fuhrman et al., *The Role of Negative Emissions in Meeting China's 2060 Carbon Neutral Goal*, OXFORD OPEN CLIMATE CHANGE, MAY 26, 2021, at 8 (contending that large-scale adoption of BECCS in China is necessary to meet the Paris Agreement's 1.5°C target); Ciaofan Xing et al., *Spatially*

meet the goals of the Paris Agreement, protect communities, and conserve biodiversity, China and the U.S. must not follow the example of the EU by fully embracing forest bioenergy as a renewable resource.

A. The United States

The U.S. Congress continues to promote forest bioenergy as a renewable energy source.¹²⁷ From 2017 to 2020, Congress passed annual budget riders that include identical provisions categorizing bioenergy as a carbon neutral energy source.¹²⁸ The riders direct executive agencies to develop policies that “reflect the carbon-neutrality of forest bioenergy and recognize biomass as a renewable energy source, provided the use of forest biomass for energy production does not cause conversion of forests to non-forest use.”¹²⁹

Proposed language for the fiscal year 2022 spending bill would change the language slightly. Rather than encouraging policies reflecting the “carbon-neutrality of forest bioenergy,” the bill would direct agencies to develop policies that “reflect the extent of the carbon benefits from forest bioenergy.”¹³⁰ The draft language retains the reference to forest bioenergy as renewable.¹³¹

In April 2018, in response to the budget rider, the Environmental Protection Agency (EPA) issued a policy statement classifying forest

Explicit Analysis Identifies Significant Potential for Bioenergy with Carbon Capture and Storage in China, NATURE COMM'NS (May 26, 2021), at 1, 7 (contending that BECCS is necessary to reach China's emissions reduction goal); U. S. DEP'T STATE & U. S. EXEC. OFF. PRESIDENT, THE LONG-TERM STRATEGY OF THE UNITED STATES: PATHWAYS TO NET-ZERO GREENHOUSE GAS EMISSIONS 47 (Nov. 2021) (contending that biomass is a key component of efforts to decarbonize the energy sector).

127. Consolidated Appropriations Act, H.R. 133, 116th Cong. § 439 (2020) (enacted).

128. Consolidated Appropriations Act, H.R. 133, 116th Cong. § 439 (2) (2020); Consolidated Appropriations Act, 2017, Pub. L. 115-31, 131 Stat. 501 § 428; Consolidated Appropriations Act, 2018, Pub. L. No. 115-141, 132 Stat. 348, § 431(2)(a); Consolidated Appropriations Act, 2019, Pub. L. No. 116-6, 133 Stat. 265, § 428; Further Consolidated Appropriations Act, 2020, Pub. L. 116-94, 133 Stat. 2752 § 440.

129. Further Consolidated Appropriations Act, 2020, Pub. L. 116-94, 133 Stat. 2752 § 440(2)(A).

130. S. COMM. ON APPROPRIATIONS, 117TH CONG., MAKING APPROPRIATIONS FOR THE DEPARTMENT OF THE INTERIOR, ENVIRONMENT, AND RELATED AGENCIES FOR FISCAL YEAR ENDING SEPTEMBER 30, 2022, AND FOR OTHER PURPOSES 173-174 (Comm. Print 2021); H. COMM. ON APPROPRIATIONS, 117TH CONG., MAKING APPROPRIATIONS FOR THE DEPARTMENT OF THE INTERIOR, ENVIRONMENT, AND RELATED AGENCIES FOR FISCAL YEAR ENDING SEPTEMBER 30, 2022, AND FOR OTHER PURPOSES 166 (Comm. Print 2021); Marc Heller, *Biomass Loses 'Carbon Neutral' Crown in Senate Spending Bill*, E&E News (Oct. 20, 2021).

131. S. COMM. ON APPROPRIATIONS, 117TH CONG., MAKING APPROPRIATIONS FOR THE DEPARTMENT OF THE INTERIOR, ENVIRONMENT, AND RELATED AGENCIES FOR FISCAL YEAR ENDING SEPTEMBER 30, 2022, AND FOR OTHER PURPOSES 173-174 (Comm. Print 2021); H. COMM. ON APPROPRIATIONS, 117TH CONG., MAKING APPROPRIATIONS FOR THE DEPARTMENT OF THE INTERIOR, ENVIRONMENT, AND RELATED AGENCIES FOR FISCAL YEAR ENDING SEPTEMBER 30, 2022, AND FOR OTHER PURPOSES 166-167 (Comm. Print 2021); see also Marc Heller, *supra* note 130.

biomass as carbon neutral.¹³² But the EPA has yet to include this statement in a formally promulgated regulation. The Biden administration withdrew a proposed rule, drafted by the Trump administration, before it was published in the Federal Register.¹³³ The Biden administration has not issued a statement regarding forest bioenergy's emissions.

In November 2021, Congress passed the Infrastructure Investment and Jobs Act (H.R. 3684), which promotes BECCS with woody biomass,¹³⁴ provides funding for biomass use,¹³⁵ and encourages agencies to use biomass to develop “clean hydrogen.”¹³⁶ The Act provides \$12 million in annual funding from 2022 to 2026 for the use of woody biomass from federal forests.¹³⁷ The Act also allocates \$400 million for wood product facilities that use byproducts from ecosystem restoration—funding that could ultimately go to wood pellet facilities.¹³⁸

Policy projections indicate that bioenergy use will increase if the U.S. stays on its current policy course.¹³⁹ In November 2021, the U.S. released its long-term strategy to reach net-zero GHG emissions.¹⁴⁰ The strategy refers to biomass as “carbon-beneficial”¹⁴¹ but includes language emphasizing the need to ensure that large-scale biomass use results in actual emission

132. EPA, EPA'S TREATMENT OF BIOGENIC CARBON DIOXIDE (CO₂) EMISSIONS FROM STATIONARY SOURCES THAT USE FOREST BIOMASS FOR ENERGY PRODUCTION 1 (2019), https://www.epa.gov/sites/production/files/2018-04/documents/biomass_policy_statement_2018_04_23.pdf.

133. Stephen Lee, *Scientists Fear Trump Wood-Burn Stance to Stay Under Regan EPA*, BLOOMBERG L. (Apr. 12, 2021) <https://news.bloomberglaw.com/environment-and-energy/scientists-fear-trump-wood-burn-stance-to-stay-under-regan-epa>.

134. Infrastructure Investment and Jobs Act, H.R. 3684, 117th Cong. § 80402 (2021) (enacted); *see also* Letter from William R. Moomaw, Emeritus Professor, The Fletcher School, et al. to President Biden and Members of Congress (Nov. 4, 2021), https://johnmuirproject.org/wp-content/uploads/2021/11/ScientistLetterOpposingLoggingProvisionsInBBB_BIF4Nov21.pdf.

135. Infrastructure Investment and Jobs Act, H.R. 3684, 117th Cong. Title VI § 614 (2021) (subsection on National Forest System) (enacted); *see also* Letter from William R. Moomaw, *supra* note 134.

136. Infrastructure Investment and Jobs Act, H.R. 3684, 117th Cong. § 814 (2021) (enacted).

137. Infrastructure Investment and Jobs Act, H.R. 3684, 117th Cong. Title VI § 614 (2021) (subsection on National Forest System) (enacted).

138. Infrastructure Investment and Jobs Act, H.R. 3684, 117th Cong. § 40804(b)(3) (2021) (enacted); *see also* Letter from William R. Moomaw, *supra* note 134.

139. U.S. DEP'T STATE & U. S. EXEC. OFF. PRESIDENT, THE LONG-TERM STRATEGY OF THE UNITED STATES: PATHWAYS TO NET-ZERO GREENHOUSE GAS EMISSIONS 47 (Nov. 2021).

140. *See generally* U.S. DEP'T STATE & U. S. EXEC. OFF. PRESIDENT, THE LONG-TERM STRATEGY OF THE UNITED STATES: PATHWAYS TO NET-ZERO GREENHOUSE GAS EMISSIONS (Nov. 2021).

141. *Id.* at 46.

reductions and reflects consideration of non-carbon consequences.¹⁴² Still, the strategy states that “biomass is a key component of efforts to decarbonize the energy sector.”¹⁴³ The strategy projects that biomass use, both with and without CCS, will increase in electricity generation¹⁴⁴ and the industrial sector¹⁴⁵ through 2050. Additionally, in the 2021 Annual Energy Outlook, the U.S. Energy Information Administration projected biomass energy production would increase to 5.39 quadrillion British thermal unit (Btu) by 2050 from 4.47 quadrillion Btu in 2020.

At the state level, bioenergy accounts for a significant share of some states’ energy portfolios. According to an industry trade publication, in January 2022, California alone had 530 megawatts (MW) of capacity from wood and wood-derived biomass power plants.¹⁴⁶ This compares to the combined capacity of New England and New York at 491 MW.¹⁴⁷ In Maine, biomass generates 20% of the State’s total net generation, the largest share of any state.¹⁴⁸ In Vermont, where nearly all in-state electricity generation comes from “renewable” resources, biomass accounts for 17% of the total net generation.¹⁴⁹ In New Hampshire, biomass supplied about 6% of the total net generation in 2020.¹⁵⁰

State renewable energy policies generally treat forest biomass as renewable and incentivize its use. Nearly all of the states that have renewable portfolio standards (RPS) or renewable energy standards include forest bioenergy under their definition of “renewable energy resource.”¹⁵¹

142. *Id.* at 47.

143. *Id.* (contending that biomass is a key component of efforts to decarbonize the energy sector).

144. *Id.* at 26 (Figure 5).

145. *Id.* at 34 (Figure 10).

146. *U.S. Biomass Power Plants*, BIOMASS MAGAZINE (Jan. 18, 2022), <http://biomassmagazine.com/plants/listplants/biomass/US/> (calculating biomass power by adding capacities with feedstocks of woody biomass, logging, mill residue, wood residuals, urban wood waste, orchard removal trees, forest thinning, and wood waste).

147. *Id.* (classifying Vermont, New Hampshire, Maine, Massachusetts, Rhode Island and Connecticut as New England states).

148. *Maine: State Profile and Energy Estimates*, U.S. ENERGY INFO. ADMIN. (Aug. 19, 2021), <https://www.eia.gov/state/analysis.php?sid=ME>.

149. *Vermont: State Profile and Energy Estimates*, U.S. ENERGY INFO. ADMIN., (Sept. 16, 2021), <https://www.eia.gov/state/analysis.php?sid=VT>.

150. *New Hampshire: State Profile and Energy Estimates*, U.S. ENERGY INFO. ADMIN., (Aug. 19, 2021), <https://www.eia.gov/state/analysis.php?sid=NH>.

151. *See generally, State Renewable Portfolio Standards and Goals*, NAT’L CONF. OF STATE LEGISLATURES (Aug. 31, 2021), <https://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx> (listing states with renewable portfolio standards), *see also.*, MICH. COMP. LAWS ANN. § 460.1011(g)(i) (West 2017); OR. REV. STAT. ANN. § 469A.025(2) (West 2021); WASH. REV. CODE § 19.285.030(12)(d) (2019) (providing examples of states with renewable portfolio standards).

However, some states exclude old-growth timber from qualifying¹⁵² or have limits on forest resources available for use.¹⁵³

Only a few states exclude most woody biomass. Colorado passed a law in 2021 requiring that biomass must be “GHG neutral” within five years to be eligible as a renewable resource.¹⁵⁴ In March 2020, Virginia passed the Clean Economy Act, which requires Virginia’s power producers to reduce their emissions to zero by 2050 and transition to clean energy.¹⁵⁵ The Act excludes woody biomass from its definition of eligible sources for Virginia’s RPS and defines “zero-carbon electricity” as “electricity generated by any generating unit that does not emit carbon dioxide as a by-product of combusting fuel to generate electricity.”¹⁵⁶ The Act includes one exception for biomass facilities that provide less than 10% of their electrical generation to the grid, but the Act caps the number of credits that may be sold for those facilities.¹⁵⁷ The Act also requires that all existing stand-alone biomass plants permanently retire by 2028 and that all carbon-emitting power plants close by 2045 (which includes coal and biomass co-firing plants).¹⁵⁸

Other states have been struggling with how to treat biomass. In its 2018 Clean Energy Plan, North Carolina emphasized the harmful climate impacts of the wood pellet industry in North Carolina.¹⁵⁹ At the same time, electricity generation from biomass is eligible for renewable energy credits in North Carolina.¹⁶⁰ And in 2019, North Carolina approved a permit for the expansion of the Enviva wood pellet plant.¹⁶¹ In Massachusetts, the government enacted regulations in 2012 that took large-scale, low-efficiency

152. See MD. CODE ANN., PUB. UTIL. § 7-701(h), (l)(1)(i) (West 2021) (excluding old-growth forests from qualifying as biomass); WASH. REV. CODE §19.285.30(3)(b), (12)(d) (2019) (limiting the definition of biomass energy as it relates to eligible renewable resources).

153. E.g., N.M. STAT. § 62-16-3(H)(3) (2019) (limiting the resources that qualify as biomass).

154. COLO. REV. STAT. ANN. § 40-2-124(1)(a)(IV).

155. S.B. 851, 2020 General Assemb. (Va. 2020).

156. *Id.*

157. *Id.*

158. *Id.*

160. N. C. DEP’T ENV’T QUALITY, CLEAN ENERGY PLAN: TRANSITIONING TO A 21ST CENTURY ELECTRICITY SYSTEM 25–26 (Oct. 2019).

161. N.C. General Statute § 62-133.8(a)(8); Lisa Sorg, *North Carolina Sends Conflicting Messages on Burning Wood as Fuel*, NC POL’Y WATCH (Oct. 2, 2019), <http://www.ncpolicywatch.com/2019/10/02/north-carolina-sends-conflicting-messages-on-burning-wood-as-fuel/>.

biomass plants out of the state's renewable energy portfolio.¹⁶² This rule change is now under threat, however, as the current administration in Massachusetts has proposed significant rollbacks of environmental protections.¹⁶³

B. China

Multiple statutes in China address bioenergy. China's Renewable Energy Law includes bioenergy within the broader category of renewable energy (also referred to as non-fossil fuel energy).¹⁶⁴ The Renewable Energy Law establishes the national legislative framework to promote the development and deployment of bioenergy.¹⁶⁵ China's Energy Conservation Law also reiterates support for bioenergy.¹⁶⁶

Additionally, China's Five-Year planning system has set increasingly ambitious targets for non-fossil fuel energy, including bioenergy. Such targets have significant implications for China's social and economic development policies. Starting in the 11th Five-Year period (2006–2010), the Five-Year plans have included the development and deployment of bioenergy.¹⁶⁷ China's current targets include an aim to increase the

162. 225 MASS. CODE REGS. 14.00 (2021); *see also* Mary S. Booth and Margaret Sheehan, *Closing the Biomass Carbon Loophole*, COMMONWEALTH MAG. (Oct. 11, 2012).

163. *See* Mary S. Booth, *Get Ready for Another Biomass Battle*, COMMONWEALTH MAG. (May 14, 2019).

164. Kezaisheng Nengyuan Fa (可再生能源法) [Renewable Energy Law] (promulgated by the Standing Comm. Nat'l People's Cong., Feb. 28, 2005, amended by the Standing Comm. Nat'l People's Cong., Dec. 26, 2009, effective Jan. 1, 2006), art. 2, (China) http://www.npc.gov.cn/zgrdw/huiyi/cwh/1112/2009-12/26/content_1533216.htm.

165. *Id.*

166. Jieyue Nengyuan Fa (节约能源法) [Energy Conservation Law] (promulgated by the Standing Comm. Nat'l People's Cong., Nov. 1, 1997, amended by the Standing Comm. Nat'l People's Cong., Oct. 28, 2007, July 2, 2016 & Oct. 26, 2018, effective Apr. 1, 2008), art. 58, (China) http://www.npc.gov.cn/zgrdw/npc/xinwen/2018-11/05/content_2065665.htm.

167. *Outline of the 11th Five-Year Plan on National Economic and Social Development of the People's Republic of China*, TENTH NAT'L PEOPLE'S CONG., CHINA (2006), http://www.gov.cn/gongbao/content/2006/content_268766.htm.

percentage of non- fossil fuels to around 20% of total energy consumption by 2025,¹⁶⁸ 25% by 2030,¹⁶⁹ and eventually to over 80% by 2060.¹⁷⁰

A recently released national policy document further elaborates on China's actions to promote renewable energy.¹⁷¹ This includes a policy that renewable energy consumption will not count towards the total energy consumption limits for localities.¹⁷² Such policies link closely to China's strategic priorities for achieving its climate goals of reaching carbon peaking before 2030 and carbon neutrality before 2060.¹⁷³ Although the current scale of bioenergy deployment in China is limited, the Chinese government has issued numerous policies providing financial incentives, including subsidies, for biomass power generation.¹⁷⁴ For 2021, China's national government allocated 2.5 billion RMB (approximately 390 million USD) to subsidize the

168. *Outline of the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035*, THIRTEENTH NAT'L PEOPLE'S CONG. CHINA (2021), https://www.ndrc.gov.cn/xxgk/zcfb/ghwb/202103/t20210323_1270124.html?code=&state=123.

169. H.E. Xi Jinping, President of the People's Republic of China, Remarks by Chinese President Xi Jinping at Climate Ambition Summit (Dec. 12, 2020), http://www.xinhuanet.com/english/2020-12/12/c_139584803.htm.

170. *China's Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy*, CHINA, 8–9 (Oct. 28, 2021), <https://unfccc.int/sites/default/files/resource/China%E2%80%99s%20Mid-Century%20Long-Term%20Low%20Greenhouse%20Gas%20Emission%20Development%20Strategy.pdf>; *See also Ahead of COP 26, China Submits Update to NDC and Mid-Century Development Strategy*, INST. FOR GOVERNANCE & SUSTAINABLE DEV. (Oct. 28, 2021), <https://www.igsd.org/ahead-of-cop-26-china-submits-update-to-ndc-and-mid-century-development-strategy/> (explaining China's new NDC).

171. Wanshan Nengyuan Xiaofei Qiangdu He Zongliang Shuangkong Zhidu Fang'an (完善能源消费强度和总量双控制度方案) [Systematic Plan for Improving the Dual-Control on the Intensity and Total Amount of Energy Consumption] (promulgated by China National Development and Reform Commission, Sept. 11, 2021, effective Sept. 11, 2021)(China), http://www.gov.cn/zhengce/zhengceku/2021-09/17/content_5637960.htm.

172. *Id.*

173. H.E. Xi Jinping, *supra* note 169.

174. *See, e.g.*, Guanyu Fazhan Shengwu Nengyuan He Shengwu Huagong Caishui Fuchi Zhengce De Shishi Yijian (关于发展生物能源和生物化工财税扶持政策的实施意见) [Implementation Opinions on the Financial and Tax Policies for Supporting the Development of Bioenergy and Biochemistry] (promulgated by China Ministry of Finance, National Development and Reform Commission, Ministry of Agriculture, State Taxation Administration and National Forestry Administration, Sept. 30, 2006, effective Sept. 30, 2006), <http://www.chinatax.gov.cn/chinatax/n810341/n810765/n812183/200611/c1196178/content.html>.

operation of biomass power stations.¹⁷⁵ The 2021 policy differentiates between regions and ultimately could provide more financial incentives for certain less-developed and environmentally sensitive regions to undertake forest bioenergy projects.¹⁷⁶

Additionally, the Chinese government intended to expand bioenergy plantations to support its renewable energy push. The government announced the goal of developing 16.78 million hectares of energy forests (an area about the size of Belgium) by 2020.¹⁷⁷ This goal included 10.1 million hectares of new forests and 6.77 million hectares to be converted from existing forests.¹⁷⁸

VI. CALLS TO ACTION

Before it is too late, governments must stop burning forests and instead promote solutions that reduce near-term risks and protect the climate, biodiversity, and communities. Investing in forest biomass and BECCS takes resources away from the urgent mitigation efforts needed to achieve countries' carbon neutrality goals, including greater protection of forests. The following is a list of policy recommendations for governments to adopt at the international, national, and subnational levels.

A. Re-evaluate Policies to Ensure Correct Accounting of Forest Bioenergy's Impacts

Governments should advance science-based renewable energy policies that reflect both accurate lifecycle accounting of energy sources' GHG emissions and the urgency of the climate crisis. First, policies and programs that incentivize renewable energy should include only those sources that have very low lifecycle emissions. Governments should not rely on nonscience-based policy assumptions regarding any source's emissions. Second, timing must be an integral part of calculating a source's net

175. 2021 Nian Shengwuzhi Fadian Xiangmu Jianshe Gongzuo Fangan (2021 年生物质发电项目建设工作方案) [Workplan on Construction of Biomass Power Generation Projects in 2021] (promulgated by China National Development and Reform Commission, Ministry of Finance and National Energy Administration, Aug. 11, 2021, effective date Aug. 11, 2021), https://sme.miit.gov.cn/zcfg/art/2021/art_322ae7c954f8478c822bdb46fc510588.html.

176. *Id.*

177. National Forestry Administration (now "National Forestry and Grassland Administration"), *National Forest Bioenergy Development Plan (2011-2020)* (May 28, 2013) <http://www.ccchina.org.cn/nDetail.aspx?newsId=40427&TId=60> ("By 2020, [China will] develop 16.78 million hectares of energy forests, including 10.1 million hectares of new forests and 6.77 million hectares to be converted from existing forests") (quotes were translated by authors).

178. *Id.*

emissions. Any source that does not have very low lifecycle emissions within a decade should not qualify as renewable energy. Thus, a source that assumes negative emissions more than a decade in the future would not be considered very low emitting in the near-term.

Regarding forest bioenergy specifically, the full lifecycle emissions from harvest to combustion should be counted for each facility.¹⁷⁹ Regardless of other carbon accounting schemes, governments must not ignore forest bioenergy's combustion emissions, nor the other land-sector emissions associated with bioenergy use, including from soil carbon loss and biomass burned during pellet manufacturing. Because forest bioenergy increases net GHG emissions for decades to centuries, it should be excluded from renewable energy and non-fossil fuel energy programs.

For greatest impact, national and subnational governments both should take these actions. For example, if the U.S. Congress were to pass clean energy legislation that excluded forest bioenergy, the law would be an important step in curbing forest bioenergy's growth. But each state's renewable energy policies and subsidies might limit the impact of federal legislation. To phase out forest bioenergy, governments at both levels need to act.

In terms of BECCS, countries' emissions-reduction plans should not rely on deployment of BECCS to reach net-zero emissions. More needs to be done to ensure that timing is a central consideration of countries' mid-century strategies so that governments do not exceed their emissions goals because of reliance on CCS. Instead, countries should commit to enhancing carbon sinks and reducing CO₂ and non-CO₂ climate pollutants, including methane, hydrofluorocarbons, tropospheric ozone, and black carbon. Governments must also promote methods to reduce energy demand. By taking these steps, governments will align their renewable energy policies and non-fossil energy targets with their carbon reduction goals.

179. P'SHIP FOR POL'Y INTEGRITY, MARY S. BOOTH & BEN MITCHELL, *Paper Tiger: Why the EU's RED II Biomass Sustainability Criteria Fail Forests and the Climate* (Jul. 6, 2020) ("Implement full life-cycle GHG accounting: Full accounting for forest biomass includes all the GHG emitted by growing, harvesting, processing, transporting, and burning the fuel."), <http://eubiomasscase.org/wp-content/uploads/2020/07/RED-II-biomass-Paper-Tiger-July-6-2020.pdf>.

*B. End Incentives for Forest Bioenergy and Invest in Forest Preservation,
Low-emissions Energy, and Strategies to Reduce Energy Demand*

Countries that subsidize or otherwise incentivize facilities that burn woody biomass must redirect those subsidies. Without these subsidies, forest bioenergy likely would not be economically feasible.¹⁸⁰ A study of 15 European countries found that on average 9% of all renewable energy subsidies went to solid biomass in 2015 and 2016.¹⁸¹ And across these 15 countries, biomass subsidies increased from 2015 to 2017.¹⁸² Finland allocated one-third of its total renewable energy subsidies to bioenergy in 2015.¹⁸³ Countries, including those within the EU, can immediately end subsidies for bioenergy plants. The Netherlands voted to end subsidies for new bioenergy plants in 2021 (though the existing subsidies remain in place).¹⁸⁴ At a time when investment in climate mitigation falls far below what is necessary,¹⁸⁵ these subsidies should be redirected toward low-emissions energy sources or strategies for reducing energy demand. Such incentives would be aligned with the IPCC pathway that does not rely on BECCS to stay within the 1.5°C limit of warming.¹⁸⁶

National and subnational governments also should increase investment in forest preservation and increase the percentage of forests protected from development. Proforestation—protection and enhancement of existing forests—will have a larger near-term impact on carbon sequestration than planting new trees.¹⁸⁷ Because of their higher growth rate, older trees can store significantly more carbon each year than younger trees.¹⁸⁸ Proforestation calls for governments to manage more forests as “intact”—reserved from logging and other development. This allows trees to grow to

180. SETH WALKER ET AL., RISI, AN ANALYSIS OF UK BIOMASS POWER POLICY, US SOUTH PELLET PRODUCTION, AND IMPACTS ON WOOD FIBER MARKET 16 (2015), <https://docplayer.net/25281897-An-analysis-of-uk-biomass-power-policy-us-south-pellet-production-and-impacts-on-wood-fiber-markets-prepared-for-the-american-forest-paper.html>.

181. MATTHEW SMITH, TYCHO SMIT, & ANN GARDINER, TRINOMICS B.V., FINANCIAL SUPPORT FOR ELECTRICITY GENERATION & CHP FROM SOLID BIOMASS 19–20 (2019), <http://trinomics.eu/wp-content/uploads/2019/11/Trinomics-EU-biomass-subsidies-final-report-28nov2019.pdf>.

182. *Id.* at 20, tbl. 3-1.

183. *Id.* at 15.

184. Justin Catanoso, *Dutch to Limit Forest Biomass Subsidies, Possibly Signaling EU Sea Change*, MONGABAY (March 9, 2021), <https://news.mongabay.com/2021/03/dutch-to-limit-forest-biomass-subsidies-possibly-signaling-eu-sea-change/>.

185. Sophie Yeo, *Where Climate Cash is Flowing and Why it's not Enough*, NATURE NEWS FEATURE (Sept. 17, 2019), <https://www.nature.com/articles/d41586-019-02712-3>.

186. Allen et al., *supra* note 8, Fig. SPM.3b; *see generally* Arnulf Gruber et al., *supra* note 26 (describing a low energy demand pathway).

187. Moomaw et al., *supra* note 31, at 2.

188. N. L. Stephenson et al., *Rate of Tree Carbon Accumulation Increases Continuously with Tree Size*, NATURE, Jan. 2014, at 90, 93; Moomaw et al., *supra* note 31, at 2.

their ecological potential.¹⁸⁹ But less than 20% of the world's forests, and only 7% of U.S. forests, are intact.¹⁹⁰ In the U.S., eastern forests have especially high carbon sequestration potential and could store significantly more carbon if protected from development.¹⁹¹ Designating more existing forests as reserves, especially those with large potentials to sequester carbon, will assist near-term mitigation efforts by strengthening forests' carbon sinks.

C. Advance International Consensus on the Harms from Forest Bioenergy, Specifically the Impact on Climate and Biodiversity

At the international level, countries could commit to protect forests and end subsidies for woody biomass power plants. By signing the Glasgow Leaders' Declaration on Forests and Land Use, over 140 countries pledged to conserve forests, accelerate forest restoration, and reverse forest loss by 2030.¹⁹² World leaders announced the Declaration at the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC).¹⁹³ The signatories, including China, the E.U., and the U.S., pledged to protect over 90% of global forests.¹⁹⁴ The Declaration includes a commitment to "facilitate the alignment of financial flows with international goals to reverse forest loss and degradation while ensuring robust policies and systems are in place to accelerate the transition to an economy that is resilient and advances forest, sustainable land use, biodiversity and climate goals."¹⁹⁵

That said, while the Declaration is an important step, it does not count logging as a deforestation activity.¹⁹⁶ This could leave room for countries to approve high levels of harvest in pursuit of increasing bioenergy.¹⁹⁷ In effect,

189. Moomaw et al., *supra* note 31, at 1.

190. *Id.* at 2.

191. *See id.* at 4–5 (discussing studies that suggest letting forests grow is the best way to sequester carbon).

192. *Glasgow Leaders' Declaration on Forests and Land Use*, U.N. CLIMATE CHANGE CONF. U.K. 2021 (Nov. 12, 2021), <https://ukcop26.org/glasgow-leaders-declaration-on-forests-and-land-use/>.

193. *Id.*

194. *Id.*

195. *Id.*

196. *See The Glasgow Declaration on Forests Doesn't Go Far Enough*, FOREST DEFS. ALL. (Nov. 2, 2021), <https://forestdefenders.eu/the-glasgow-declaration-on-forests-doesnt-go-far-enough/> (discussing that permanent forest loss happens when one use for land is converted into another use, which is not ultimately counted as traditional forest degradation).

197. *Id.*

countries will contradict their commitment to the declaration by continuing to incentivize energy from woody biomass.¹⁹⁸ Countries should go further than the minimum required by the Declaration and preserve forests by ending reliance on, and redirecting, incentives for forest bioenergy.

Additionally, under the UNFCCC Paris Agreement, countries should commit to forest preservation, especially of existing forests with large carbon-storage potential, in their nationally determined contributions for GHG emission reductions.¹⁹⁹ Parties with forest bioenergy in their energy mix should ensure proper accounting of the emissions while also rapidly reducing forest bioenergy's share of energy generation. Countries should not rely on BECCS to reach their Paris Agreement commitments.

Furthermore, countries should address forest bioenergy through the Convention on Biological Diversity (CBD). Parties to the CBD adopted the Kunming Declaration at the 15th Conference of the Parties hosted by China in October 2021.²⁰⁰ The Declaration includes a commitment to "reform incentive structures, eliminating, phasing out or reforming subsidies and other incentives harmful to biodiversity"²⁰¹ This commitment must encompass the elimination of incentives for forest bioenergy.

Parties to the CBD continue to negotiate the *Post-2020 Global Biodiversity Framework* and plan to meet again in China in May 2022.²⁰² Parties should include language in the post-2020 framework recognizing that burning woody biomass undermines biodiversity and must be phased down. The first draft of the framework includes language to redirect or eliminate incentives that are harmful to biodiversity.²⁰³ Implementing such a commitment must encompass redirecting incentives for forest bioenergy. Additionally, rejecting woody biomass as a clean energy source fits into the draft post-2020 framework's call to better coordinate climate change targets and biodiversity conservation.²⁰⁴

198. See Justin Catanoso, *COP26: E.U. is Committed to Forest Biomass Burning to Cut Fossil Fuel Use*, MONGABAY (Nov. 10, 2021), <https://news.mongabay.com/2021/11/cop26-e-u-is-committed-to-forest-biomass-burning-to-cut-fossil-fuel-use/> (explaining the contradiction between signing the Declaration and continuing to use biomass).

199. Under the Paris Agreement, Parties are required to submit nationally determined contributions (NDCs) that explain their plans to mitigate and adapt to climate change. See *All About the NDCs*, U.N., <https://www.un.org/en/climatechange/all-about-ndcs> (last visited Nov. 17, 2021) (explaining the purpose of NDCs).

200. Convention on Biological Diversity, *Kunming Declaration "Ecological Civilization: Building a Shared Future for All Life on Earth"*, U.N. Doc. CBD/COP/15/5/Add.1 (Oct. 13, 2021).

201. *Id.* at ¶13.

202. *Preparations for the Post-2020 Biodiversity Framework*, CONVENTION ON BIOLOGICAL DIVERSITY, <https://www.cbd.int/conferences/post2020> (last visited Nov. 17, 2021).

203. Open Ended Working Group on the Post-2020 Global Biodiversity Framework, First Draft of the Post-2020 Global Biodiversity Framework, CBD/WG2020/3/3, *Annex* ¶12 (July 5, 2021) (Target 18).

204. *Id.* at ¶12.

Finally, over 75 countries have united as the High Ambition Coalition for Nature and People.²⁰⁵ Countries in the Coalition are committed to enhancing protections for nature, including by promoting commitments to conserve 30% of lands and ocean by 2030 (30x30 pledge).²⁰⁶ The Coalition works to advance its goals through myriad international channels, including both the UNFCCC and the CBD.²⁰⁷ Coalition members could prioritize scaling up the areas protected as intact forests through the 30x30 pledge.

CONCLUSION

Time is running out for countries to act on climate change to avert near-term emergencies and secure long-term climate stability. The world cannot afford to burn forests in the name of climate mitigation. Governments must act now to protect communities and ecosystems by conserving forests and reducing GHG emissions.

205. *HAC Member Countries*, HIGH AMBITION COAL. FOR NATURE AND PEOPLE, <https://www.hacfornatureandpeople.org/hac-members> (last visited Nov. 17, 2021).

206. *Launch at the One Planet Summit*, HIGH AMBITION COAL. FOR NATURE AND PEOPLE, <https://www.hacfornatureandpeople.org/hac-launch-hub-page> (last visited Nov. 17, 2021).

207. *See Roadmap to 30x30*, HIGH AMBITION COAL. FOR NATURE AND PEOPLE, <https://www.hacfornatureandpeople.org/roadmap> (last visited Nov. 17, 2021) (highlighting the many meetings various Coalition countries had to advance their goals along different channels).

REFRAMING GLOBAL BIODIVERSITY PROTECTION AFTER COVID-19: IS INTERNATIONAL ENVIRONMENTAL LAW UP TO THE TASK?

Maria Antonia Tigre, Natalia Urzola**, Victoria Lichet****

Introduction	125
I. Regulation of Wildlife Trade and Deforestation: A Pathway to Reduce Biodiversity Loss?	126
A. Deforestation and Land-Use Changes as Primary Drivers of Biodiversity Loss	128
B. Wildlife Trade and Zoonotic Diseases	130
C. Possible Responses to Biodiversity Loss: Protected Areas and Wildlife Trade International Regulation	132
1. Protected Areas as a way to Minimize Deforestation and Land-Use Change	133
2. Wildlife Trade Regulation as a way to Reduce the Spread of Covid-19 and Prevent New Zoonotic Diseases	134
II. Environmental Protection Theories: Would Setting Aside Half of Earth for Conservation Purposes Ensure Biodiversity Protection in a Post-Pandemic Context?	136
A. Half-Earth Theory: What is it?	137
B. Critiques to Half-Earth Theory	139
1. Lack of Effectiveness in Protecting Biodiversity	139
2. Impacts on Marginalized Populations	141
C. The Future of Half-Earth Theory: An Answer to Biodiversity Loss or a Burden in Building Back Better?	143
III. International Cooperation: Could International Law Better Protect Biodiversity?	146
A. International Cooperation for Biodiversity Protection	147
1. CITES: Benefits and Shortcomings in Biodiversity Protection	147

2. Lack of Solid Cooperation on Biodiversity Protection	150
B. Envisioning a Post-Pandemic Scenario	151
Conclusion.....	154

INTRODUCTION

In an increasingly interdependent world, the climate and biodiversity crises are, more than ever, inextricably tied to human health and the transmission of infectious diseases. The 2020 Covid-19 pandemic has irrevocably shown us that the exploitation of wild species and deforestation increases and modifies the interface between people and wildlife, leading to a spillover of diseases from wildlife to people.¹ From a legal perspective, the gaps in international environmental law have contributed to the lack of an effective international biodiversity policy. In light of the challenges brought by the pandemic, there is now an opportunity to rethink our existing legal framework: How could international environmental law better protect biodiversity to avert future pandemics?

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) recognized that pandemics' underlying causes are the same global environmental changes that drive biodiversity loss and climate change, including land-use change, agricultural expansion and intensification, and wildlife trade and consumption.² These drivers bring wildlife closer to humans, allowing microbes and outbreaks to move into people and lead to infections. The rise in consumption, trade, and demographic pressure has led to many emerging diseases in biodiversity-rich countries. Therefore, pandemics underscore the interconnectedness of the

* Global climate litigation fellow at the Sabin Center for Climate Change Law at Columbia Law School; S.J.D. at Elisabeth Haub School of Law, Pace University, New York, USA; Deputy Director, Global Network for Human Rights and the Environment (GNHRE); Coordinator of the Ecological Rights Subgroup of the Global Pandemic Network (GPN). Corresponding author. E-mail mb4913@columbia.edu. Physical address: 435 West 116th Street, New York, NY 10027.

** Co-chief Operating Officer, Global Network for the Study of Human Rights and the Environment (GNHRE) and member, Ecological Rights Subgroup of the Global Pandemic Network (GPN). E-mail: natalia.urzola.g@gmail.com.

*** U.S. Coordinator, Global Pact for the Environment Coalition; Co-Chief Operating Officer, Global Network for the Study of Human Rights and the Environment (GNHRE). E-mail victoria.licht@gmail.com.

1. Raina K. Plowright et al., *Pathways to Zoonotic Spillover*, 15 NATURE REV. MICROBIOLOGY, 502 (2017); Christina L. Faust et al., *Pathogen Spillover During Land Conversion*, 21 ECOLOGY LETTERS, 471 (2018).

2. P. DASZAK ET AL., IPBES WORKSHOP REPORT ON BIODIVERSITY AND PANDEMICS: EXECUTIVE SUMMARY 5 (IPBES 2020).

world community and the threat posed by global inequality to people's health, well-being, and security.

The article is structured as follows. Section I addresses the international regulation of deforestation and wildlife trade as pathways to reduce biodiversity loss. On the one hand, deforestation and land-use changes reduce animal habitat, pushing wildlife to urban areas. On the other hand, the wildlife trade heightens human-animal contact. Taken together, these activities further risk intensifying zoonotic "spillover." International regulation is essential to providing a global response to the root causes of zoonotic spillover. Section II analyzes the Half-Earth theory as a potential avenue to ensure biodiversity protection and Building Back Better after Covid-19. As one of the emerging legal theories in biodiversity conservation, we question Half-Earth's effectiveness, its potential impact on marginalized groups, and its feasibility in a post-pandemic context. Section III describes the current state of international cooperation on biodiversity protection and whether existing norms could provide a pathway for Building Back Better in a way that protects both nature and marginalized sections of the population. Then the article concludes that international cooperation is key in Building Back Better and understanding the frameworks' current limitations will necessarily facilitate a better response and collaboration.

I. REGULATION OF WILDLIFE TRADE AND DEFORESTATION: A PATHWAY TO REDUCE BIODIVERSITY LOSS?

With the disastrous impact of human activities on the planet, a new era in the Earth's geological history has begun: the Anthropocene.³ In particular, human-driven biodiversity loss could lead to the sixth mass extinction.⁴ The biodiversity crisis is so alarming that scientists from 184 countries alerted in *Warning to Humanity: A Second Notice*⁵ about the collision course between humanity and the natural world "as ecosystems are being pushed beyond their

3. Simon L. Lewis & Mark A. Maslin, *Defining the Anthropocene*, 519 NATURE 171, 171 (2015); Jan Zalasiewicz et al., *The Working Group on the Anthropocene: Summary of Evidence and Interim Recommendations*, 19 ANTHROPOCENE 55, 56 (2017).

4. Nicholas De Sadeleer & J. Godfroid, *The Story Behind COVID-19: Animal Diseases at the Crossroads of Wildlife, Livestock and Human Health*, 11 EUR. J. OF REGUL., 212, 212 (2020), <https://munin.uit.no/bitstream/handle/10037/20303/article.pdf?sequence=3&isAllowed=y> (citing Richard Leakey & R. Lewin, *The Sixth Extinction: Patterns of Life and the Future of Humankind*, ANCHOR (1995)).

5. In 2017, 25 years later, scientists signed *World Scientists Warning to Humanity: A Second Notice*, written by William J. Ripple and seven co-authors. See William J. Ripple et al., *World Scientists' Warning to Humanity: A Second Notice*, 67 BIOSCIENCE 12, 1026 (Dec. 2017), <https://academic.oup.com/bioscience/article/67/12/1026/4605229>.

capacities to support the web of life on this planet.”⁶ The Covid-19 crisis further highlighted the crucial need to effectively reduce damaging human activities, including wildlife trade and deforestation as drivers of disease transmission and species extinction.⁷

Zoonotic “spillovers” at the wildlife–human interface, a core cause of the Covid-19 pandemic, are neither one-off events nor only found in distant lands.⁸ Spillover, also known as “evolutionary jump,” refers to the “transmission of a pathogen from a natural animal host to a novel host leading to infection in the new host.”⁹ It has been recognized that some viruses, such as the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV-1 and the novel SARS-CoV-2) and the Middle East Respiratory Syndrome (MERS-CoV), may have emerged in wildlife and crossed over to humans.¹⁰ The Coronavirus likely originated from bats before transmission to humans due to illegal trapping and sale of live animals in Asia.¹¹ United Nations Environment Programme (UNEP) recently underlined that the emergence of zoonotic diseases derives from seven major anthropogenic drivers to zoonotic disease, including: (1) the increasing demand for animal protein; (2) unsustainable agricultural intensification; (3) increased use and exploitation of wildlife; (4) unsustainable utilization of natural resources increased by urbanization, land use, and extractive industries; (5) travel and transportation; (6) changes in food supply chains;¹²

6. De Sadeleer, *supra* note 4, at 212.

7. *Id.* at 222.

8. Nicholas Robinson and Christian Walzer, *How Do We Prevent the Next Outbreak?*, SCI. AM. (Mar. 25, 2020), <https://blogs.scientificamerican.com/observations/how-do-we-prevent-the-next-outbreak/>.

9. Najmul Haider et al., *COVID-19—Zoonosis or Emerging Infectious Disease?*, 8 FRONTIERS PUB. HEALTH 596944, 596944 (Nov. 26, 2020), <https://www.frontiersin.org/articles/10.3389/fpubh.2020.596944/full>; See also Kevin J. Olival et al., *Possibility for Reverse Zoonotic Transmission of SARS-CoV-2 to Free-Ranging Wildlife: A Case Study of Bats*, 16 PLOS PATHOGENS 9, 9 (Sept. 3, 2020), <https://journals.plos.org/plospathogens/article?id=10.1371/journal.ppat.1008758>.

10. Frédéric Baudron & Florian Liégeois, *Fixing Our Global Agricultural System to Prevent the Next COVID-19*, 49(2) OUTLOOK ON AGRIC. 111, 111 (2020).

11. Manfredo A. Turcios-Casco & Roberto Cazzolla Gatti, *Do not Blame Bats and Pangolins! Global Consequences for Wildlife Conservation After the SARS-CoV-2 Pandemic*, 29 BIODIVERSITY & CONSERVATION 3829, 3830 (Sept. 19, 2020), <https://doi.org/10.1007/s10531-020-02053-y> (citing Andersen et al., *The Proximal Origin of SARS-CoV-2*, 26 NAT'L MED. 450, 452 (2020); Lau et al., *Possible Bat Origin of Severe Acute Respiratory Syndrome Coronavirus*, 2 EMERGING INFECTIOUS DISEASES (2020), https://wwwnc.cdc.gov/eid/article/26/7/20-0092_article).

12. Delia Grace Randolph et al., *Preventing the Next Pandemic: Zoonotic Diseases and how to Break the Chain of Transmission*, UNEP, 7 (July 6, 2020), <https://www.unep.org/resources/report/preventing-future-zoonotic-disease-outbreaks-protecting-environment-animals-and>; Josef Settle et al., *COVID-19 Stimulus Measures Must Save Lives, Protect*

Environmental degradation is critical in the emergence of zoonosis. Forests specifically contain a vast number of animal species and associated pathogens that could potentially be transferred to humans.¹³ Biodiversity loss caused by anthropogenic activities, such as deforestation and the wildlife trade, has allowed the coronavirus to jump from animals to humans by bringing them together in previously inaccessible spaces.¹⁴ This section analyzes how deforestation and the wildlife trade contribute to biodiversity loss, a critical cause of emerging zoonotic diseases, and assesses how to cope with the current and future viruses while ensuring biodiversity protection.

A. Deforestation and Land-Use Changes as Primary Drivers of Biodiversity Loss

The emergence of zoonoses is strongly linked to deforestation and other land-use changes that increase human–wildlife contact, allowing a higher risk of human infection from zoonotic diseases.¹⁵ Approximately 22% of the land area represented by biodiversity hotspots, which overlap with emerging disease hotspots, is currently threatened by agricultural expansion and deforestation.¹⁶ With increased deforestation rates and habitat fragmentation, animal species are drawn to urban areas, underscoring its direct consequences on a healthy environment.¹⁷ The closer proximity of animals and humans deriving from socio-economic processes allows for the invasion of host communities.¹⁸ In November 2019, scientists sounded the alarm on

Livelihoods, and Safeguard Nature to Reduce the Risk of Future Pandemics, IPS (April 27, 2020), <http://www.ipsnews.net/2020/04/covid-19-stimulus-measures-must-save-lives-protect-livelihoods-safeguard-nature-reduce-risk-future-pandemics/>.

13. Delia Grace Randolph et al., *supra* note 12, at 14.

14. Josef Settle et al., *supra* note 12.

15. Felicia Keesing et al., *Impacts on Biodiversity on the Emergence and Transmission of Infectious Diseases*, 468 NATURE 647, 647 (Dec. 2, 2010); Philip M. Fearnside, *Will the Next Coronavirus Come from Amazonia? Deforestation and the Risk of Infectious Diseases (Commentary)*, MONGABAY (April 8, 2020), <https://news.mongabay.com/2020/04/will-the-next-coronavirus-come-from-amazonia-deforestation-and-the-risk-of-infectious-diseases-commentary/>.

16. Baurdon & Liégeois, *supra* note 10, at 112–113.

17. For example, it has been reported that the disruption of bat ecosystems and habitats has driven increasing numbers of fruit bats seeking food in suburban and urban areas, increasing human and livestock contact. See Gabriele Volpato et al., *Baby Pangolins on My Plate: Possible Lessons to Learn from the COVID-19 Pandemic*, J. ETHNOBIOLOGY & ETHNOMEDICINE, 2020, at 3, 12 (explaining the connection between deforestation and viruses); See also Empire Hechime Nyekwere, *The Impacts of the Covid-19 Coronavirus Pandemic on International Environmental Protection*, 101 J. L., POL'Y, & GLOBALIZATION 96, 101 (2020), (discussing habitat fragmentation and its consequences).

18. Rory Gibb et al., *Ecosystem Perspectives are Needed to Manage Zoonotic Risks in a Changing Climate*, BMJ, 2020, at 1, doi: <https://doi.org/10.1136/bmj.m3389>.

increasing deforestation as a possible catalyst for disease outbreaks.¹⁹ If we disrupt natural habitats, we dislodge pathogens, which, in turn, seek new homes in cities and other populated areas.²⁰ Similarly, land-use changes from cattle ranching can drive zoonotic diseases, as cattle are intermediary carriers of disease to humans.²¹

The interplay between deforestation, land-use change, and habitat loss is the “perfect storm” for the emergence of infectious diseases.²² In places like the Amazon region, deforestation alters vital natural cycles that help reduce the effects of global warming and recycling water essential for other non-Amazonian areas.²³ Ecosystems like Amazonia are critical to controlling zoonotic diseases and vector-borne infections.²⁴ Yet, these ecosystems are increasingly threatened. During the first month of quarantine, the Amazonian Institute for Scientific Research SINCHI (SINCHI) registered widespread forest fires in Colombia: a 276% increase from the previous year.²⁵ By April 2020, the Colombian Amazon had lost 75,000 hectares (from January to April).²⁶ Environmental degradation is exacerbated where governmental institutions are almost non-existent and illegal, armed groups are present, which impedes an adequate implementation of environmental policies.²⁷

19. Sarah Gibbens, *Protecting Land and Animals Will Mitigate Future Pandemics*, NAT'L GEOGRAPHIC (Oct. 19, 2020), https://www.nationalgeographic.com/environment/2020/10/protecting-land-animals-will-mitigate-future-pandemics-report-says/?cmpid=org=ngp::mc=crm-email::src=ngp::cmp=editorial::add=SpecialEdition_20201030&rid=BB3192A42DA2949024ADDA6B9261012C.

20. Nicholas A. Robinson, *Global Health as a Foundation for World Peace: Preventing the “Next” Pandemic*, NCP BLOG (Apr. 15, 2020), <https://chairpeace.hypotheses.org/1365>.

21. *Id.*

22. Joel Henrique Ellwanger et al., *Beyond Diversity Loss and Climate Change: Impacts of Amazon Deforestation on Infectious Diseases and Public Health*, ANAIS DA ACADEMIA BRASILEIRA DE CIÊNCIAS, 2020, at 2.

23. Maria Antonia Tigre, COOPERATION FOR CLIMATE MITIGATION IN AMAZONIA: BRAZIL'S EMERGING ROLE AS A REGIONAL LEADER, 5 TRANSNAT'L ENV'T L. 2, 416, 425 (2016) (explaining the Report of the Intergovernmental Panel on Climate Change findings on the Amazonia); *See generally* MARIA ANTONIA TIGRE, REGIONAL COOPERATION IN AMAZONIA: A COMPARATIVE ENVIRONMENTAL LAW ANALYSIS VOL. 13 66 (2017) (discussing the link between the Amazon and climate change) [hereinafter REGIONAL COOPERATION IN AMAZONIA].

24. Ellwanger et al., *supra* note 22, at 2.

25. “*Están Aprovechando la Cuarentena para Quemar la Selva*”: *Corpoamazonia*, SEMANA (Apr. 1, 2020), <https://www.semana.com/impacto/articulo/estan-aprovechando-la-cuarentena-para-quemar-la-selva-corpoamazonia/49489/>.

26. Oliver Griffin, *Columbia Lost more than 158,000 Hectares to Deforestation in 2019*, THOMSON REUTERS (July 9, 2020), <https://news.trust.org/item/20200709184816-80ir7>.

27. James Fair, *COVID-19 Lockdown Precipitates Deforestation Across Asia and South America*, MONGABAY (Jul. 3, 2020), <https://news.mongabay.com/2020/07/covid-19-lockdown-precipitates-deforestation-across-asia-and-south-america/>; *See also*, Amador-Jiménez et al., *The Unintended Impact of Colombia's Covid-19 Lockdown on Forest Fires*, 76 ENV'T RES. ECON., 1081–1105 (2020), <https://doi.org/10.1007/s10640-020-00501-5>.

In Brazil, Amazonian deforestation is at a nine-year high.²⁸ During the first and second trimester of 2020, deforestation rates were already 51% higher than the previous year.²⁹ By April, the total deforested area was the highest of the decade and by the end of August 2020, Brazil had experienced deforestation of approximately 3,070 km² (from January to July).³⁰ A recent study found a significant correlation between rising deforestation and the transmission of Covid-19 in Indigenous communities in Brazil, especially as human encroachment in Indigenous lands sparks conflicts that results from deforestation-inducing activities, such as illegal mining, furthering virus transmission in already vulnerable populations.³¹ To avoid more zoonotic spillovers, we need to rethink and reshape the human–nature relationship and its consequences on biodiversity loss. The first step is addressing deforestation and land-use changes so that ecosystems like Amazonia do not become the birthplace of the next pandemic.

B. Wildlife Trade and Zoonotic Diseases

Wildlife trade also plays a significant role in the emergence of zoonotic diseases. The U.S. National Academy of Medicine considers international trade one of the six contributing factors to emerging infectious disease risk.³² Many wild, captive-bred, and farmed animal species are transported and traded together in markets, which facilitates disease transmission.³³ The proximity of humans with different species further enables “animal-to-human spillover” of new viruses that are more likely to amplify the human-to-human transmission.³⁴

A recent study shows that the number of bamboo rats infected by coronaviruses increased through the wildlife trade value chain in Vietnam, from 6% in rat farms to 21% in large live animal markets, to 56% in

28. Simone Iglesias, *Brazil to Boost Amazon Forest Oversight as Deforestation Jumps*, YAHOO FIN. (Apr. 14, 2020), <https://finance.yahoo.com/news/brazil-boost-amazon-forest-oversight-152259352.html>.

29. Patricia Vieira, *Brazilian Amazon at a Crossroads*, REVISTA (July 7, 2020), <https://revista.drclas.harvard.edu/brazilian-amazon-at-a-crossroads/>.

30. Humberto Laudaes & Pedro Gagliardi, *Is Deforestation Spreading COVID-19 to the Indigenous Peoples?*, 2 (IEPS, Working Paper No. 8, 2020).

31. *Id.* at 16, 22.

32. Stefan Borsky et al., *CITES and the Zoonotic Disease Content in International Wildlife Trade*,

76 ENV'T & RES. ECON. 1001, 1002 (2020), <https://doi.org/10.1007/s10640-020-00456-7>.

33. Randolph et al., *supra* note 12, at 33.

34. *Id.*

restaurants before being killed.³⁵ Recent data also shows that the international legal wildlife trade might have increased by 500% in value since 2005 and by 2000% since the 1980s, partly due to enhanced sustainable captive breeding.³⁶ Approximately 24% of all wild terrestrial vertebrate species on Earth are traded globally,³⁷ either legally (estimated to be worth \$107 billion in 2019) or illegally (estimated to be worth between \$7–23 billion per year).³⁸

This unprecedented rise in scale and speed of wildlife trade increases the contact between animals and humans.³⁹ The wildlife trades include: harvesting of wild animals as a source of protein and money; the recreational hunting and consumption of wildlife as a symbol of status or tradition; the trade of wildlife for recreational use (e.g., pets and zoos); and the use of animal parts for decorative, medicinal, and other commercial products (e.g., furs, as trophies or traditional medicine).⁴⁰ Pathogen transmission from wild animals to humans can come from hunters and farmers, ranching, subsistence, and recreational hunting, as well as traders, transporters, middle-marketers, handlers, buyers, and meat-eaters.⁴¹ Researchers have estimated over one billion contacts per year, with an approximate 650,000 to 840,000 existing zoonotic pathogens that could cross over the species barrier.⁴²

While wildlife farming led to a decrease in wildlife meat consumption, surveys show that wildlife farms are sometimes stocked with wild-caught animals. The impossibility of distinguishing between both increases the risk of disease transmission.⁴³ Furthermore, epidemiologists have warned of the

35. DASZAK ET AL., *supra* note 2, at 32 (citing N. Q. Huong et al., *Coronavirus Testing Indicates Transmission Risk Increases Along Wildlife Supply Chains for Human Consumption in Vietnam 2013–2014*, PLOS ONE, 2020, at 27, doi:10.1371/journal.pone.0237129).

36. *Id.* (citing DILYS ROE, *TRADING NATURE: A REPORT, WITH CASE STUDIES, ON THE CONTRIBUTION OF WILDLIFE TRADE MANAGEMENT TO SUSTAINABLE LIVELIHOODS AND THE MILLENNIUM DEVELOPMENT GOALS 24* (2008); *UN Comtrade Database - Merchandise Trade Data Availability*, UNITED NATIONS, <https://comtrade.un.org/data/da> (last visited Jan. 22, 2022); *See generally* Janine Robinson et al. *Dynamics of the Global Trade in Live Reptiles: Shifting Trends in Production and Consequences for Sustainability*, 184 BIOLOGICAL CONSERVATION 42 (2015) <https://doi.org/10.1016/j.biocon.2014.12.019>).

37. *Id.* at 28 (citing Brett R. Scheffers et al., *Global Wildlife Trade Across the Tree of Life*, 366 SCIENCE 71 (Oct. 4, 2019), doi:10.1126/science.aav5327).

38. *Id.* at 29 (citing DAAN P. VAN UHM, *THE ILLEGAL WILDLIFE TRADE: INSIDE THE WORLD OF POACHERS, SMUGGLERS AND TRADERS* 15 (2016)).

39. Borsky et al., *supra* note 32, at 1002.

40. Randolph et al., *supra* note 12, at 15.

41. *Id.* at 32; *See also* Borsky et al., *supra* note 32, at 1003.

42. Borsky et al., *supra* note 32, at 1003.

43. DASZAK ET AL., *supra* note 2, at 30 (citing Laura Tensen, *Under What Circumstances can Wildlife Farming Benefit Species Conservation?*, 6 GLOB. ECOLOGY & CONSERVATION 286–298 (2016)).

likelihood that Covid-19 could become endemic if established in a wild animal population.⁴⁴ Animal reservoirs provide viruses with new hosts, potentially allowing for viruses to spill back into people after being under control. Yellow fever, Ebola, and Chikungunya have experienced such a spill back.⁴⁵ Since Covid-19 is thought to have originated in bats but passed to people through an intermediate host, chances are that it will also become endemic, which is why strategies to reduce the spread and control of the virus are essential to overcoming this pandemic.⁴⁶ Wildlife trade regulation is crucial in preventing the further spread of the virus.

C. Possible Responses to Biodiversity Loss: Protected Areas and Wildlife Trade International Regulation

With globalization, the effects of biodiversity loss are no longer confined to physical borders. An increasing number of people travel to and from risk regions, contributing to the dissemination of pathogen agents.⁴⁷ Safeguarding biodiversity is essential to preventing future pandemics given the connection between human disease and habitat destruction.⁴⁸ International regulation of activities that induce wildlife-human contact could decrease the risk of zoonotic spillover. However, most governmental initiatives reactively respond to diseases ex-post facto, worsening the government's ability to control the threat of future zoonoses. To avoid the next pandemic, international cooperation is essential. One pathway to address the root causes of zoonotic spillover lies in protected areas.

<http://dx.doi.org/10.1016/j.gecco.2016.03.007>; E. G. E. Brooks, S.I. Robertson & D.J. Bell, *The Conservation Impact of Commercial Wildlife Farming of Porcupines in Vietnam*, 143 BIOLOGICAL CONSERVATION 2808–2814 (2010) <https://doi.org/10.1016/j.biocon.2010.07.030>).

44. Nicky Phillips, *The Coronavirus Is Here to Stay—Here's What That Means*, NATURE (Feb. 16, 2021), https://www.nature.com/articles/d41586-021-00396-2?campaign_id=9&emc=edit_nn_20210223&instance_id=27427&nl=the-morning®i_id=64750540&segment_id=52225&te=1&user_id=17e04417a4944065756c5772e26dcecd.

45. *Id.*

46. *Id.*

47. Gustavo Ortiz Millán, *Pandemias, Zoonosis y Comercio de Animales Silvestres*, REVISTA DE BIOÉTICA Y DERECHO, Nov. 2020, at 21, https://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1886-58872020000300003.

48. Baurdon & Liégeois, *supra* note 10, at 112.

1. Protected Areas as a way to Minimize Deforestation and Land-Use Change

Protected areas can support reducing deforestation by confronting biodiversity loss in tandem with other pressing issues such as climate change. Conserving biodiversity through protected areas is fundamental for implementing an effective public health policy to prevent or reduce the transfer of infectious diseases to human populations.⁴⁹ Humans and animals can coexist better if biodiversity is protected and conservation efforts are advanced.

For example, the Emerald Network is made up of protected areas or “Areas of Special Conservation Interest,” by the Council of Europe after adopting the European Convention on Conservation of European Wildlife and Natural Habitats (also known as the Bern Convention).⁵⁰ The Natura 2000 network started as the European Union’s (E.U.) contribution to the Emerald Network.⁵¹ As a network of more than 1.15 million km² of privately-owned protected nature reserves across the E.U. Member States that were established to protect rare and threatened species and rare natural habitat,⁵² it provides an example of the selection-process of protected areas, identification of significant threats to habitats, and implementation of conservation measures.⁵³

A similar network could be built in other regions in a post-pandemic scenario. To Build Back Better, it is necessary to strengthen biodiversity and forest protection through existing and new legal mechanisms at different levels of governance. It is predictable that once the lockdown measures are lifted, an increase in industrial activity and, particularly, extractivism is expected, especially given the challenging economic conditions that have emerged during the pandemic.⁵⁴ Covid-19’s more lasting impacts will

49. Keesing et al., *supra* note 15, at 647–652.

50. Olena Bevez, *Legal Regulation of the Emerald Network: National and Global Aspects*, 5 J. VASYL STEFANYK PRECARPATHIAN NAT’L UNIV. 91, 93 (2018), doi: 10.15330/jpnu.5.2.91-98; See Convention on the Conservation of European Wildlife and Natural Habitats, Alb.-Tunis., Sept. 09, 1979, E.T.S. No. 104 (entered into force June 01, 1982).

51. Eur. Consult. Ass., *Revised Criteria for Assessing the National Lists of Proposed Areas of Special Conservation Interest (ASCIs) at Biogeographical Level and Procedure for Examining and Approving Emerald Candidate Sites*, 33rd Standing Comm. Meeting, Doc. 13 T-PVS/PA 6, 2-3 (2013) <https://rm.coe.int/1680746a34>.

52. *Natura 2000*, EUR. COMM’N, https://ec.europa.eu/environment/nature/natura2000/index_en.htm (last visited Jan. 22, 2022).

53. Thomas Campagnaro et al., *Half Earth or Whole Earth: What Can Natura 2000 Teach Us?*, 69-2 BIOSCIENCE 117, 122 (2019).

54. Turcios-Casco & Cazzolla Gatti, *supra* note 11, at 5.

probably be financial, affecting restoration and reforestation efforts.⁵⁵ Reduced government spending, rollback of environmental regulations, forest clearing and hunting, demand for agricultural products, and increased rural poverty and population density all amount to a more complex implementation of environmental protection policies and laws.⁵⁶ That is why biodiversity conservation and restoration are more important than ever, both to help cope with the pandemic's consequences and prevent future ones.

2. Wildlife Trade Regulation as a way to Reduce the Spread of Covid-19 and Prevent New Zoonotic Diseases

While animal exploitation from wildlife trade has grown in recent years,⁵⁷ international regulation remains scarce. Animals are kept in overcrowded spaces for production and commercialization,⁵⁸ increasing the possibility of emerging zoonotic diseases.⁵⁹ This has prompted the question: Should the international community prohibit wildlife commerce?

There are a lot of reasons to prohibit the sale of animals in public markets, including the hygiene and sanitary conditions in which animals are kept, the amount of damage and suffering in individual animals and social groups, the imbalance created in ecosystems when animals are removed, and the risk of extinction.⁶⁰ However, prohibiting wild animal commerce can be counterproductive. Animal markets are not isolated; instead, they are part of a larger supply chain.⁶¹ Applying a blanket ban to wildlife commerce ignores the underlying drivers of the emergence and spread of zoonoses.⁶² It obscures the social context of the extraction, breeding, hoarding, commercialization, and supply, which may risk sending animal trafficking to the illegal world's deep, clandestine spaces, where sanitary measures are even worse.⁶³

Most of the dire conditions that favor spillovers could be addressed with stricter regulation and monitoring of market conditions rather than a blanket

55. Rakan A. Zahawi et al., *Potential Impacts of COVID-19 on Tropical Forest Recovery*, 52 BIOTROPICA 803, 804 (2020).

56. *Id.* at 804, 805.

57. Yadav Upriety et al., *Illegal Wildlife Trade Is Threatening Conservation in the Transboundary Landscape of Western Himalaya*, 59 J. FOR NATURE CONSERVATION 1, 1 (2021).

58. Millán, *supra* note 47, at 21.

59. *Id.*

60. *Id.*; See also Dilys Roe & Tien Ming Lee, *Possible Negative Consequences of a Wildlife Trade Ban*, NATURE SUSTAINABILITY (Jan. 19, 2021), <https://www.nature.com/articles/s41893-020-00676-1>.

61. Millán, *supra* note 47, at 24.

62. *Id.* at 5.

63. *Id.* at 22.

ban. Suppose governments strengthen legislation and regulations to control and monitor import and export, sale, and consumption of wild animals and their derivatives, as well as to ensure animal well-being throughout the whole supply chain. In that case, a positive effect is most likely to happen.⁶⁴ Periodic reviews may positively affect commercial breeding and production on farms and generally set higher standards for those animals.⁶⁵

Additionally, the wildlife trade supports millions of families and individuals, contributing to income generation among the world's most impoverished population.⁶⁶ It is crucial to assess comprehensively the social aspects of wildlife trade in any international cooperation initiative, especially in a post-pandemic scenario. About six million tons of wild meat is harvested yearly in Africa and Latin America.⁶⁷ Thirty-nine percent of households in Africa, Asia, and Latin America declared that they harvested and consumed wild meat last year.⁶⁸ The pandemic has already hit marginalized populations hard, and a blanket ban would only add to that.⁶⁹ Furthermore, this ban would affect those who produce and consume meat for cultural, health, and livelihood security reasons.⁷⁰ Moreover, wild meat consumption is critical to ensuring the food security of Indigenous peoples and local communities worldwide.⁷¹

In sum, deforestation and the wildlife trade need to be better regulated.⁷² It is necessary to address changes in land use and exploitation of wildlife to strengthen environmental protection.⁷³ UNEP has called for advancing a global biodiversity agenda that promotes human–wildlife coexistence while expanding innovative financing for restoration and ecosystem-based approaches.⁷⁴ To deliver transformational change in the post-pandemic scenario, UNEP urges collective action and firm commitments from non-

64. *Id.*

65. *Id.*

66. Uprety et al., *supra* note 57, at 1.

67. Jani Hall, *Bushmeat—Explained*, NAT'L GEOGRAPHIC (June 19, 2019), <https://www.nationalgeographic.com/animals/article/bushmeat-explained>.

68. Randolph et al., *supra* note 12, at 31 (citing Robert Nasi et al., *Empty Forests, Empty Stomachs? Bushmeat and Livelihoods in the Congo and Amazon Basins*, 13 INT'L FORESTRY REV. 3, 355–368 (2011); Martin Nielsen et al., *The Importance of Wild Meat in the Global South*, 146 ECOLOGICAL ECON., 696, 699 (2018)).

69. Amaël Borzée et al., *COVID-19 Highlights the Need for More Effective Wildlife Trade Legislation*, 35 TRENDS ECOLOGY & EVOLUTION 12, 1054 (2020).

70. Roe & Lee, *supra* note 60.

71. *Id.*

72. Borzée et al., *supra* note 69, at 1054.

73. Jiajia Liu et al., *Pandemics and Biodiversity: Applying Lessons Learned to Conservation in the Post-COVID-19 era*, ECOEVOXIV (2020) (Pre-print) doi:10.32942/osf.io/4det8.

74. U.N. Executive Director, *Progress in the Implementation of Resolution*, ¶ 11, U.N. Doc. K2002605 291220 (Nov. 16, 2020).

traditional players, like financial institutions, to meet international obligations.⁷⁵ To achieve this, it is necessary to address the structural and systemic causes of biodiversity loss.

Unveiling the underlying drivers of the emergence and spread of zoonotic diseases like Covid-19 would mean examining processes that massively increase interaction between animals and humans and facilitate disease transmission.⁷⁶ But this requires radical changes to our way of life. It may mean a shift away from industrialized agriculture and commodity supply chains that encourage deforestation, as well as dietary shifts.⁷⁷ Environmentalists have urged governments to take advantage of this disruption and make vital, radical changes to business as usual—towards more sustainable and nature-friendly practices.⁷⁸ However, governments seem to be doing the exact opposite and supporting harmful practices such as fossil fuel production and extractive activities.⁷⁹

There is an apparent conflict between some conservation proposals and the world's economic development model. However, economic balance and environmental protection need to go hand-in-hand to truly overcome this pandemic and prevent future ones. Environmental protection theories that aim at setting aside large portions of the world for conservation purposes have started to gain traction, especially given the relationship between Covid-19 and biodiversity loss.⁸⁰ This begs the question: Are these theories truly effective in ensuring biodiversity protection? And more importantly, how do they interplay with an economic crisis in a post-pandemic scenario?

II. ENVIRONMENTAL PROTECTION THEORIES: WOULD SETTING ASIDE HALF OF EARTH FOR CONSERVATION PURPOSES ENSURE BIODIVERSITY PROTECTION IN A POST-PANDEMIC CONTEXT?

Environmental protection theories come in all shapes and sizes. They can push for strict and conservative measures or adopt a more nuanced approach. They can understand the human–nature relationship as one of interconnectedness or as one of exploitation. This section analyzes the benefits and pitfalls of one such theory gaining attention at the international

75. *Id.*

76. Roe & Lee, *supra* note 60, at 5.

77. *Id.*

78. Daniel Cross, *Post-pandemic Recovery Plans Fail to Address Biodiversity Loss*, SUSTAINABILITY TIMES (Oct. 13, 2020), <https://www.sustainability-times.com/environmental-protection/post-pandemic-economic-plans-are-failing-to-address-biodiversity-loss/>.

79. *Id.*

80. Roe & Lee, *supra* note 60, at 5.

level: the Half-Earth theory. It specifically assesses whether the Half-Earth approach responds to the world's needs in biodiversity protection and Building Back Better after Covid-19.

A. Half-Earth Theory: What is it?

Currently, close to 15% of Earth's land and 10% of waters are under some kind of environmental protection, whether as natural parks or protected areas in general.⁸¹ It is estimated that every 30 seconds, the U.S. loses a football field's worth of nature.⁸² In contrast, the Brazilian Amazon loses more than 10 square miles of rainforest due to fires and clearings daily (approximately three football fields of rainforest every minute).⁸³ To respond to this rapid loss of biodiversity, a radical conservation theory has gained significant attention among conservationists: the Half-Earth Theory. This approach aims at setting aside half of Earth's surface as one global conservation reserve through a series of interconnected protected areas.⁸⁴ Additionally, it aims at protecting 85% of the Earth's species.⁸⁵ Although the theory is in its early stages and lacks legal backing, it is increasingly influencing global environmental governance.⁸⁶ Alongside other projects such as the 30x30 movement⁸⁷ and Nature Needs Half,⁸⁸ Half-Earth has

81. *The World Now Protects 15% of Its Land, but Crucial Biodiversity Zones Left Out*, IUCN (Sept. 3, 2016), <https://www.iucn.org/news/secretariat/201609/world-now-protects-15-its-land-crucial-biodiversity-zones-left-out>.

82. Meilan Solly, *The U.S. Loses a Football Field-Sized Patch of Nature Every 30 Seconds*, SMITHSONIAN MAG. (Aug. 12, 2019), <https://www.smithsonianmag.com/smart-news/us-loses-football-field-sized-patch-nature-every-30-seconds-180972881/#:~:text=This%20figure%2C%20detailed%20in%20a,of%20land%20every%2030%20seconds>.

83. Jordan Davidson, *Amazon Deforestation Rate Hits 3 Football Fields per Minute, Data Confirms*, ECOWATCH (Jul. 26, 2019), <https://www.ecowatch.com/amazon-deforestation-unrecoverable-tipping-point-2639358982.html>; Jim Robbins, *Salvation or Pipe Dream? A Movement Grows to Protect Up to Half the Planet*, YALE ENV'T 360 (Feb. 13, 2020), <https://e360.yale.edu/features/salvation-or-pipe-dream-a-movement-grows-to-protect-up-to-half-the-planet>.

84. B. Büscher et al., *Half-Earth or Whole Earth? Radical Ideas for Conservation, and Their Implications*, 51(3) ORYX 407, 407 (2017).

85. Stuart L. Pimm et al., *How to Protect Half of Earth to Ensure it Protects Sufficient Biodiversity*, SCI. ADVANCES, Aug. 2018, at 2.

86. Erle C. Ellis, *To Conserve Nature in the Anthropocene, Half Earth is Not Nearly Enough*, 1 ONE EARTH 163, 163 (2019).

87. UNEP Open-ended Working Group on the Post-2020 Global Biodiversity Framework, *Zero Draft of the Post-2020 Global Biodiversity Framework Second Meeting*, CTR. FOR BIOLOGICAL DIVERSITY (Jan. 6, 2020), <https://www.cbd.int/doc/c/Efb0/1f84/a892b98d2982a829962b6371/wg2020-02-03-en.pdf>.

88. *What We Do*, NATURE NEEDS HALF, <https://natureneedshalf.org/what-we-do/> (last visited Jan. 22, 2022).

gained traction, and its proponents are pressing the protection of half of Earth by 2030.⁸⁹ The proposal has been considered by the Post-2020 Global Biodiversity Framework of the Convention on Biological Diversity (CBD).⁹⁰

As mentioned, protected areas play a fundamental role in preventing the emergence of new disease outbreaks by monitoring wildlife, limiting human-driven changes in host and reservoir abundance and distribution, and avoiding contact between humans, livestock, and wildlife, which preserves ecosystem health and integrity.⁹¹ Protected areas may further help evaluate emerging conflicts from banning wildlife trade and understanding the interlink between wildlife trade, conservation, and the risk of future zoonoses.⁹² When states implement new protected areas, their proposals should include a “disease risk mitigation” aspect to merge human health considerations with global biodiversity conservation policies.⁹³ Therefore, extensive internationally or regionally funded and managed protected areas would effectively preserve ecosystem health and become a priority both at the international and regional levels.⁹⁴

In line with the goal of implementing protected areas to protect biodiversity, a 2019 report by IPBES supported (although unintentionally) the Half-Earth theory at an international level.⁹⁵ The IPBES found that more than one million species are at risk of extinction and underscored the life-support functions of species and the critical role of ecosystems.⁹⁶ It also linked the threat of extinction to drivers such as land and sea-use change, including agricultural expansion and direct exploitation of wild species,

89. Robbins, *supra* note 83.

90. Erle C. Ellis & Zia Mehrabi, *Half Earth: Promises, Pitfalls, and Prospects of Dedication Half of Earth's Land to Conservation*, CURRENT OP. ENV'T SUSTAINABILITY, May 17, 2019, at 22, 30.

91. Julien Terraube et al., *Strengthening Protected Areas to Halt Biodiversity Loss and Mitigate Pandemic Risks*, CURRENT OP. ENV'T SUSTAINABILITY, 2020, at 35-38, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7525266/pdf/main.pdf> (citing Simone C. Bauch et al., *Public Health Impacts of Ecosystem Change in the Brazilian Amazon*, 112 PROC NAT'L ACAD SCI. U.S.A., 2015, at 7414-7419; A. Marm Kilpatrick et al., *Conservation of Biodiversity as a Strategy for Improving Human Health and Well-being*, PHIL. TRANS. R. SOC. B., 2017, at 372; Julien Terraube et al., *The Role of Protected Areas in Supporting Human Health: A Call to Broaden the Assessment of Conservation Outcomes*, CURRENT OP. ENV'T SUSTAINABILITY, 2017, at 50-58; Julien Terraube, *Can Protected Areas Mitigate Lyme Disease Risk in Fennoscandia?*, ECOHEALTH, 2019, at 184-190).

92. *Id.* (citing I. Vandebroek, et al., *The Future of Ethnobiology Research after the COVID-19 Pandemic*, 6 NATURE PLANTS 723, 724 (2020); Gabriele Volpato et al., *supra* note 17, at 3).

93. *Id.* (citing P. Visconti et al., *Protected Area Targets Post-2020*, 364 SCI. 239, 239-41 (2019)).

94. *Id.* (citing Christoph Nolte et al., *Governance Regime and Location Influence Avoided Deforestation Success of Protected Areas in the Brazilian Amazon*, 110 PROC. NAT'L ACAD. SCI. U.S. 4956, 4958-60 (2013)).

95. See generally IPBES, GLOBAL ASSESSMENT REPORT ON BIODIVERSITY AND ECOSYSTEM SERVICES (2019), <https://ipbes.net/global-assessment> (explaining the importance of safeguarding protected areas).

96. Robbins, *supra* note 83.

climate change, and pollution, which are shaped by other drivers like social changes and economic interests.⁹⁷ Scientists are concerned that the extent of environmental damage may have prompted humanity to a tipping point of climate and biological disruption.⁹⁸ In response to these challenges, the Half-Earth project proposes to reverse habitat and biodiversity loss and maintain environmental health.⁹⁹ The Half-Earth project could be the next step for countries to support conservation efforts worldwide, implement good habitat management, and ensure biodiversity protection.

Among the promises of this approach is simplicity and universality; Half-Earth project proponents believe that its encompassing nature will appear fair, reasonable, and achievable to preserve most of Earth's ecological heritage.¹⁰⁰ Proponents view the theory as a catalyst for societal engagement in conservation efforts that are broad, prosocial, proactive, and socially scalable.¹⁰¹ In addition to advocating for the protection of 50% of Earth's surface, the project calls for strategies to prevent land displacement and empower Indigenous Peoples as stewards of biodiversity.¹⁰²

B. Critiques to Half-Earth Theory

Despite widespread support, the Half-Earth theory needs further analysis to be considered as a ruling paradigm. Currently, it faces myriad challenges ranging from lack of effectiveness to obscuring and perpetuating the struggles of historically oppressed groups.

1. Lack of Effectiveness in Protecting Biodiversity

Despite the goal of protecting 85% of the Earth's species, the theory does not clarify how protecting half of the planet would achieve conservation goals. Protecting half of the Earth without paying attention to specific places, and the species they contain, would be ineffective.¹⁰³ It remains unclear which "half" would be protected and what its components would be. For example, would it only encompass land or include oceans, rivers, or the

97. Pamela McElwee et al., *Ensuring a Post-COVID Economic Agenda Tackles Global Biodiversity Loss*, 3 ONE EARTH 448, 449 (2020).

98. Robbins, *supra* note 83.

99. Brian M. Napoletano, *Half-Earth: A Biodiversity 'Solution' that Solves Nothing*, CLIMATE & CAPITALISM (Oct. 2, 2018), <https://climateandcapitalism.com/2018/10/02/half-earth-a-biodiversity-solution-that-solves-nothing>.

100. Ellis & Mehrabi, *supra* note 90, at 22.

101. *Id.* at 23.

102. *Id.*

103. Pimm et al., *supra* note 85, at 2.

Arctic? These details are significant given the propensity of governments to protect “the wild,” seen as remote, cold, or arid areas that tend to hold relatively fewer species, rendering conservation efforts useless.¹⁰⁴

Furthermore, finding where to ensure equitable and effective conservation is essential.¹⁰⁵ A rigid division between the protected half and the human-inhabited half is unsustainable and does not align with the ecosystems’ functioning.¹⁰⁶ Even if one could separate humanity from nature, the proposal would need to address how to carry out activities in the human half because they will undoubtedly have significant consequences on the entire planet.¹⁰⁷ The solution is not to set aside large portions of land, especially given the planet’s current damaging condition and the fragmented state of the world’s biodiversity.¹⁰⁸ The challenges are enormous; a systematic approach is the only way to promote and achieve the goals outlined in the Half-Earth theory in a way that genuinely protects biodiversity and is equitable and fair to humankind.

The theory also ignores the root causes of biodiversity loss, particularly the powerful engines behind resource extraction and consumption, which would eventually have negative impacts on people (especially impoverished people) and biodiversity.¹⁰⁹ Degradation factors, like climate change-inducing activities, have accelerated displacement of both human and animal populations, making them already vulnerable to any additional change in their ways of living.¹¹⁰ Critics of the Half-Earth theory underscore that preservation areas will likely do more harm than good by exacerbating preexisting conflicts and inequalities and avoiding addressing underlying drivers of biodiversity loss,¹¹¹ such as extractive activities. Any conservation strategy pre- and post-pandemic needs to focus on the real drivers of biodiversity loss if it expects to be successful.¹¹² This entails addressing how the global economy works, especially concerning resource extraction and consumption.¹¹³

104. *Id.*

105. Ellis & Mehrabi, *supra* note 90, at 23.

106. Robbins, *supra* note 83.

107. Büscher et al., *supra* note 84, at 408.

108. Robbins, *supra* note 83.

109. Büscher et al., *supra* note 84, at 408.

110. Ellis & Mehrabi, *supra* note 90, at 24.

111. Brian M. Napoletano, *Half-Earth: A Biodiversity ‘Solution’ that Solves Nothing*, CLIMATE & CAPITALISM (Oct. 2, 2018), <https://climateandcapitalism.com/2018/10/02/half-earth-a-biodiversity-solution-that-solves-nothing/>.

112. Judith Schleicher et al., *Protecting Half of the Planet Could Directly Affect over One Billion People*, NATURE SUSTAINABILITY, 2019, at 3–4, <https://doi.org/10.1038/s41893-019-0423-y>.

113. Büscher et al., *supra* note 84, at 408.

The idea of preserving a pristine nature with no human intervention has been receding, giving way to a paradigm where knowledge of local communities in conservation and land management efforts is at the center stage. Nevertheless, power imbalances, inequality, and stakeholder engagement arise when analyzing the pitfalls of this approach, especially due to the long history of land reallocations and conservation practices that have already impacted disadvantaged rural and agricultural populations negatively.¹¹⁴ Therefore, a multi-level, bottom-up (as opposed to a top-down) mode of governance is needed, where local and regional institutions and new ways of social collaboration and community governance are part of the solution.¹¹⁵

2. Impacts on Marginalized Populations

At the core of the proposal to increase protected areas is its consequences on human populations. Half-Earth entails a complex system of socio-environmental challenges by managing multiple levels of governance. Covering vast areas of the Earth could affect one billion people and increase poverty by disrupting the lives of those living inside potential protected areas.¹¹⁶ It is critical to consider social aspects to ensure benefits for the biosphere and the humans that inhabit it,¹¹⁷ especially in a post-pandemic scenario. Meaningful participation of relevant stakeholders is thus crucial.¹¹⁸ Otherwise, we risk making decisions that negatively affect entire populations by, for example, forcing displacement from their ancestral home and making them face more burdens to access resources for their survival.¹¹⁹

Moreover, the Half-Earth proposal pushes for a restrictive type of protected area that does not allow human activity, which entails challenges of physical and economic displacements that can be seen in current strict protected areas embedded with deep social conflicts.¹²⁰ Similarly, critics argue that by focusing on conservation, the approaches obscure other sets of strategies and practices that have also been essential to successful

114. Ellis & Mehrabi, *supra* note 90, at 27.

115. *Id.*

116. Schleicher et al., *supra* note 112, at 3–4.

117. Robbins, *supra* note 83.

118. Büscher et al., *supra* note 84, at 408.

119. *Id.*; See also Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean, princ. 10, Apr. 22, 2021, United Nations publication LC/PUB.2018/8/-*, https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtmsg_no=XXVII-18&chapter=27&clang=en.

120. Büscher et al., *supra* note 84, at 408.

biodiversity conservation efforts¹²¹ and helped nuance strict conservation-only approaches.¹²² It is critical to be mindful of the current state of Earth's surface: agriculture, settlements, and forestry already occupy approximately 57% of ice-free area; cities and other infrastructure cover about 2%, cropland accounts for 12%, livestock grazing covers about 25%, and forestry production and multi-use forests account for 18% approximately.¹²³ Given the human need for agricultural consumption and the current economic model, the Half-Earth theory would need to expand conservation areas without displacing these activities.¹²⁴ Otherwise, a "nature only" approach would cost 31% of current global cropland and 25% of crop calories, making it unrealizable.¹²⁵

Furthermore, the Half-Earth theory rests on three dubious premises: (i) all humans share equal responsibility for the biodiversity crisis; (ii) the rights of nature circumscribe the needs of humans; and (iii) it is the only solution to this crisis, and thus is a moral imperative.¹²⁶ The first premise is the most problematic, where humans are seen as an abstract entity that is race-free, gender-free, and class-free.¹²⁷ This obscures the historical struggles of marginalized groups while considering everyone to bear the same level of responsibility in transgressing the rights of nature regardless of reality.¹²⁸ Such an approach is dangerous as it ignores global historical responsibility, which could help fuel class conflicts and further divide humanity, while unfairly punishing those least responsible for the biodiversity crisis.¹²⁹

The second premise is then understood as being supported by allegedly unbiased and neutral science, where nature has intrinsic value, and its conservation should therefore trump any possible harm it may cause to humans. However, this approach is naive at best since metaphors used in natural science are deeply rooted in socio-political concepts. Once again, the historically evolved social relations are obscured to give way to a "human nature" that encompasses all.¹³⁰ The third premise would be uncontested if it resolved the biodiversity crisis by addressing the root and underlying causes

121. *Id.* Such as land use planning, threatened and endangered species programs, taxation and economic development programs, among others.

122. Büscher et al., *supra* note 84, at 408.

123. Ellis & Mehrabi, *supra* note 90, at 25.

124. *Id.*

125. *Id.* at 25–26.

126. Napoletano, *supra* note 99.

127. *Id.*

128. Napoletano, *supra* note 99.

129. Brian M. Napoletano & Brett Clark, *An Ecological-Marxist Response to the Half-Earth Project*, 18(1) CONSERVATION & SOCIETY 37, 42 (2020).

130. Napoletano, *supra* note 99.

rather than just the apparent and immediate issues.¹³¹ Nevertheless, as mentioned earlier, setting aside half of the planet for undisturbed conservation diverts the attention from the activities and populations that are truly responsible for the biodiversity crisis, thus doing nothing to prevent them from happening again.

C. The Future of Half-Earth Theory: An Answer to Biodiversity Loss or a Burden in Building Back Better?

Suppose all the issues mentioned above remain unresolved. In that case, the approach could turn into a tool against progressive social struggles, preventing historically marginalized groups from accessing redress and achieving progress in modern society. But it could also help strengthen efforts against conservation by pitting it against social movements that will end up fighting those efforts. Therefore, it is critical to put the Half-Earth theory and progressive social struggles in conversation with one another and join forces to fight against instrumentalism, both of nature and historically oppressed groups.¹³²

One thing is clear: these conservation theories need to be more deeply studied and further developed, especially regarding who gets to control said protected areas and how. Current conservation efforts tend to focus on biodiversity-rich areas that generally coincide with low-income countries with major poverty problems and a lack of infrastructure, industry, and employment.¹³³ The fact that the removal of land from non-conservation use will impact the poorest and least responsible communities is one aspect that the Half-Earth theory fails to address.¹³⁴

One opportunity could be found in advancing land sovereignty by Indigenous Peoples. Doing so, however, would require further discussion prior to setting Half-Earth in motion. Half-Earth proponents argue that a critical part in achieving the 50% goal is to support Indigenous lands, given that these communities occupy or manage around 28% of the planet's land, out of which 40% correspond to protected areas.¹³⁵ For example, Indigenous

131. *Id.*

132. *Id.*

133. Büscher et al., *supra* note 84, at 408.

134. *Id.*

135. Robbins, *supra* note 83.

communities in Latin America have been known to help reduce deforestation in the Amazon region.¹³⁶

On the other hand, some proponents have argued that local communities sometimes pose a threat to nature. This understanding is deeply bound to a colonial mindset: the categorization of local communities as ecological villains, heroes, or passive recipients of the impertinent ideology.¹³⁷ The colonial mindset only serves to obscure numerous contingent factors that underlie their worldviews and interactions with nature, as well as the historic struggles they have faced.¹³⁸ More than a goal to be managed and implemented by a single institution, the project should be conceived as an emergent social project that cuts through different people, cultures, institutions, conceptions, definitions, and practices in a system that aims to combine livelihoods and land use with urban food systems, environmental governance, and other social functions.¹³⁹

Finally, the Half-Earth theory has to cope with the current scenario during and post-Covid-19. One benefit of the approach is allowing more interaction between animals and humans.¹⁴⁰ However, given the alleged origin of Covid-19 and the emphasis on preventing the emergence of zoonoses, this benefit might as well be a threat to the emergence of future pandemics. Moreover, the world economy has been hit hard, and poverty has reached unprecedented highs.¹⁴¹ Some estimate that over \$5 trillion will be wiped out of the world's economy.¹⁴²

The downsides for biodiversity and conservation derived from the pandemic are inextricably linked to the severe global economic recession it has triggered.¹⁴³ People experiencing economic hardships can turn to the production and consumption of wild species to derive livelihoods for their subsistence.¹⁴⁴ Likewise, conservation organizations' financial and human capital is expected to be reduced due to Covid-19-related consequences.¹⁴⁵

136. FOOD & AGRIC. ORG. OF THE UNITED NATIONS, FOREST GOVERNANCE BY INDIGENOUS AND TRIBAL PEOPLES: AN OPPORTUNITY FOR CLIMATE ACTION IN LATIN AMERICA AND THE CARIBBEAN 42 box 1 (2021), <https://doi.org/10.4060/cb2953en>.

137. *Id.*

138. Napoletano & Clark, *supra* note 129, at 41.

139. Ellis & Mehrabi, *supra* note 90, at 28.

140. *Id.* at 25.

141. *Id.*

142. Melissa Leach et al., *Post-Pandemic Transformations: How and Why COVID-19 Requires Us to Rethink Development*, 138 WORLD DEV. 3, 6 (Feb. 2021).

143. Chris Sandbrook et al., *Biodiversity Conservation in a Post-COVID-19 Economy*, ORYX: J. FAUNA PRES. SOC'Y (2020), doi:10.1017/S0030605320001039.

144. *Id.* at 1.

145. *Id.*

Conservation efforts should thus support measures that address inequality; otherwise, it would not be feasible.¹⁴⁶ Returning to a “business as usual” economic model—which was already unsustainable pre-Covid-19 and nevertheless seemed to be most appealing for politicians, businesses, and the public—would hurt both nature and those outside the power elites.¹⁴⁷

As it is today, the Half-Earth proposal insufficiently responds to the biodiversity crisis by relying on misconceptions of underlying and systemic forces that drive nature’s destruction,¹⁴⁸ which is only exacerbated by the pandemic. Covid-19 response measures have already forced displacement of several communities who seek to improve their socio-economic conditions.¹⁴⁹ A restrictive conservation strategy like Half-Earth would intentionally and unintentionally contribute to this forced displacement of local communities both through direct dispossession or processes of expropriation-without-dispossession, that is, through land-use restrictions and other measures that would only undermine livelihoods of marginalized populations.¹⁵⁰ Adopting a narrow focus on the immediate drivers of habitat loss allows the neglect of larger-scale and systemic impacts of extractivism, as well as the structural, political, and economic forces that undergird them.¹⁵¹ The pandemic has exposed the limits of conventional framings of development in both the Global North and South, which is not necessarily a bad thing and could help move humanity forward towards radical ways of understanding the world.¹⁵² The Covid-19 pandemic has shown us the interconnectedness of economies and societies, just like nature and its ecosystems. This undoubtedly calls for global and international cooperation and solidarity, which can lead to significant environmental benefits while protecting people and their livelihoods simultaneously, as critical factors in the ongoing environmental crises.¹⁵³

146. Büscher et al., *supra* note 84, at 409.

147. Sandbrook et al., *supra* note 143, at 2.

148. Napoletano & Clark, *supra* note 129, at 38.

149. Manfred Lenzen et al., *Global Socio-Economic Losses and Environmental Gains from the Coronavirus Pandemic*, 15 PLOS ONE 7, 9 (2020), <https://doi.org/10.1371/journal.pone.0235654>.

150. *Id.* at 40.

151. *Id.* at 41.

152. Leach et al., *supra* note 142, at 1.

153. Lenzen et al., *supra* note 149, at 9.

III. INTERNATIONAL COOPERATION: COULD INTERNATIONAL LAW BETTER PROTECT BIODIVERSITY?

Beyond the consequences of climate-driven shifts on humans and ecosystems, the Covid-19 health crisis has had a significant impact on biodiversity and calls for solid solutions at the international level to incorporate both biodiversity and human health concerns into post-pandemic recovery. Countries worldwide need to consider environmental protection as a core value and strengthen their conservation efforts, both at a national and international level. Environmental protection theories such as Half-Earth still need to be further developed before implementing them. This leaves us questioning: where could we find the answer to biodiversity protection as we seek to overcome the Covid-19 pandemic?

Two proposals that could help mitigate the devastating effects of deforestation and the wildlife trade could be international regulation and cooperation. Based on the principle of solidarity, States should cooperate towards creating and implementing international norms to protect biodiversity, a healthy environment, and thus, the health of the world's population.¹⁵⁴ States must negotiate in good faith and adopt international measures to regulate wildlife trade, deforestation, and any other threats that biodiversity faces, such as habitat loss and fragmentation, pollution, invasive species, and climate change. These regulations must enforce cooperation by creating administrative and judiciary bodies at the international level to hold countries accountable.

Some argue that the development of public health agencies would help detect and avoid future pandemics and strengthen global health security.¹⁵⁵ In contrast, others call for the development of a “network of forensic laboratories” at the regional level to address wildlife trafficking and the emergence of zoonosis.¹⁵⁶ However, restricting the interactions between humans and wildlife,¹⁵⁷ preserving forests and biodiversity would better

154. Daniel Noroña, *Grow Together or Perish Alone: The Obligation to Cooperate as a Guarantee for the Full Realization of Human Rights*, VÖLKERRECHTSBLOG (Feb. 25, 2021), <https://voelkerrechtsblog.org/grow-together-or-perish-alone/>.

155. *Id.*

156. Michel Halbwax, *Addressing the Illegal Wildlife Trade in the European Union as a Public Health Issue to Draw Decision Makers Attention*, 251 BIOLOGICAL CONSERVATION 1, 2 (2020).

157. *Id.* (citing William Karesh et al., *Ecology of Zoonoses: Natural and Unnatural Histories*, 380 THE LANCET 1936, 1936–45 (2012), and Kathryn H. Jacobsen et al., *Lessons from the Ebola Outbreak: Action Items for Emerging Infectious Disease Preparedness and Response*, 13 ECOHEALTH 200, 200–12 (2016)).

prevent the emergence and the spread of zoonotic diseases.¹⁵⁸ While some existing agreements such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) are already being implemented, they require better enforcement mechanisms and enhanced international cooperation.¹⁵⁹ This section addresses the existing agreements and collaboration on biodiversity protection, and their weaknesses, before envisioning a post-pandemic scenario.

A. International Cooperation for Biodiversity Protection

The need to address wildlife trade and biodiversity loss at the international level led States to adopt international legal frameworks such as CITES and the Convention of Biological Diversity (CBD).¹⁶⁰ However, the three crises we are facing today—biodiversity, environmental, and health crises—unequivocally highlight these agreements’ weaknesses.

1. CITES: Benefits and Shortcomings in Biodiversity Protection

While CITES could provide a critical legal framework for biodiversity protection at the international level, capacity and resources are often inadequate to implement it fully.¹⁶¹ CITES was adopted in 1973 to ensure that the international trade of wild animals and plants does not threaten their survival and overexploit them.¹⁶² The Convention came into force in 1975 and is ratified by 183 countries.¹⁶³ CITES regulates the international trade of approximately 5,800 animal species and 30,000 plant species listed in the three CITES Appendices.¹⁶⁴ Appendix I includes “species that are the most endangered,” while Appendix II references “species that are not necessarily

158. Halbwax, *supra* note 156 (first citing Alex Hyatt et al., *Effective Coordination and Management of Emerging Infectious Diseases in Wildlife Populations*, 12 *ECOHEALTH* 408, 408–11 (2015); then citing Moreno Di Marco et al., *Sustainable Development Must Account for Pandemic Risk*, 117 *PROC. NAT’L ACAD. SCI. U.S.* 3888, 3888–92 (2020), and then citing Brian Pike et al., *The Origin and Prevention of Pandemics*, 50 *CLINICAL INFECTIOUS DISEASES* 1636, 1636–40 (2010)).

159. Convention on International Trade in Endangered Species of Wild Fauna and Flora, Mar. 3, 1973, U.N.T.S. 243, <https://cites.org/sites/default/files/eng/disc/CITES-Convention-EN.pdf>.

160. Convention on Biological Diversity, April 6, 1993, U.N.T.S. 1760, <https://www.cbd.int/doc/legal/cbd-en.pdf>.

161. Janine E. Robinson et al., *Supplying the Wildlife Trade as a Livelihood Strategy in a Biodiversity Hotspot*, 23 *ECOLOGY AND SOC’Y* 1 (2018).

162. *What is CITES?*, CITES, <https://cites.org/eng/disc/what.php> (last visited Jan. 25, 2022).

163. *List of Parties to the Convention*, CITES, <https://cites.org/eng/disc/parties/index.php> (last visited Dec. 9, 2021).

164. P. DASZAK ET AL. *supra* note 2, at 37.

now threatened with extinction but that may become so unless trade is closely controlled.”¹⁶⁵ Finally, Appendix III covers “species included at the request of a Party that already regulates trade in the species, and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation.”¹⁶⁶ CITES is considered one of the “cornerstones of international conservation” as well as “one of the best tools we have for addressing international wildlife crime. . . .”¹⁶⁷

The CITES compliance mechanism has had an important, yet unforeseen, influence on the types of traded species. However, CITES is not self-executing, and implementation is highly dependent on domestic legislation and governance that ensure adequate controls by State agencies.¹⁶⁸ Signatory countries that implement CITES must enforce national legislation that prohibits any trade violation and penalizes.¹⁶⁹ When countries do not comply with their CITES obligations, the Conference of the Parties (COP) and the Standing Committee can recommend the suspension of trade with the country concerned.¹⁷⁰

Besides, resolutions adopted during the meetings of the COP include recommendations regarding wildlife health and what is expected of countries.¹⁷¹ Despite their non-binding nature, the resolutions represent a “consensus of action” necessary for the protection of endangered species.¹⁷² For example, the CITES resolution on Compliance and Enforcement Resolution Conference 11.3(Rev. CoP15) highlights the necessity to gather more resources and efforts to combat illegal wildlife trade¹⁷³ and the importance of making illegal trade “a matter of high priority for their national law enforcement agencies.”¹⁷⁴ This resolution gives a detailed list of what an effective compliance and enforcement regime looks like. Furthermore, the

165. *Id.*

166. *The CITES Appendices*, CITES, <https://cites.org/eng/app/index.php> (last visited Dec. 9, 2021).

167. *CITES*, WORLD WILDLIFE, <https://www.worldwildlife.org/pages/cites> (last visited Dec. 9, 2021); *The CITES Species*, CITES, <https://cites.org/eng/disc/species.php> (last visited Dec. 9, 2021).

168. *National Laws for Implementing the Convention*, CITES, <https://cites.org/eng/legislation> (last visited Dec. 9, 2021).

169. Borsky et al., *supra* note 32, at 1012.

170. *Id.* at 1004.

171. *The CITES Secretariat*, CITES, <https://cites.org/eng/disc/sec/index.php> (last visited Jan. 25, 2022).

172. Patricia L. Farnese, *The Prevention Imperative: International Health and Environmental Governance Responses to Emerging Zoonotic Diseases*, 3 TRANSNATIONAL ENV'T L. 296 (2014).

173. *Id.* at 299 (citing CITES Res. Conf. 11.3 (Rev. CoP15), Compliance and Enforcement); U.N. Res. Conf. 11.3 (Rev. CoP15), <https://cites.org/sites/default/files/eng/res/all/11/E11-03R15.pdf>.

174. Farnese, *supra* note 172, at 299.

CITES Secretariat administered by the UNEP assists countries at their request with legislation and enforcement.¹⁷⁵

Yet, CITES only covers species threatened by international trade, not those threatened by internal trade or habitat loss.¹⁷⁶ Of the 6,495 different species of recognized mammals globally as of 2020, Appendix I only lists 318 species and Appendix II lists 513 species.¹⁷⁷ Besides, it is estimated that between 1998 and 2007, 300 CITES-listed species, for a total of 30 million animals, were illegally wild-caught in South-East Asia before being exported worldwide.¹⁷⁸

For example, although all E.U.-member states and the E.U. ratified CITES, the illegal importation of CITES-listed species, including bushmeat and live animals, still occurs frequently.¹⁷⁹ Weaknesses of E.U. policies toward wildlife protection, loopholes in their enforcement, insufficient inspection measures, and a lack of resources are proof that even developed countries do not efficiently tackle wildlife trafficking.¹⁸⁰ The E.U. should thus show leadership and implement measures to address illegal wildlife trade.

States should also implement electronic databases to record illegal trade activity, create more robust controls at the borders to search for illegal bushmeat, and better monitor the trade of wildlife.¹⁸¹ The UNEP and other partners conducted a study on the relationship between the legal and illegal international animal trades.¹⁸² The study highlighted the need to maintain long-term records of border seizures and enforcement effort, and to account for “known illegal trade when setting quotas and determining the level of legal trade that is sustainable to strengthen non-detriment findings under

175. *The CITES Secretariat*, *supra* note 172.

176. De Sadeleer & Godfroid, *supra* note 4, at 223.

177. *Id.* (citing Connor J. Burgin et al., *How Many Species of Mammals Are There?*, 99 J. MAMMALOGY 1–14 (2018), <https://doi.org/10.1093/jmammal/gyx147>).

178. Halbwax, *supra* note 156 (citing Vincent Nijman, *An Overview of International Wildlife Trade from Southeast Asia*, 19 BIODIVERSITY & CONSERVATION 1101–14 (2010)).

179. Halbwax, *supra* note 156.

180. *Id.* (first citing Tanya Wyatt & Anh Ngoc Cao, *Corruption and Wildlife Trafficking*, U4 ANTI-CORRUPTION RESOURCE CTR., CHR MICHELSEN INST. (2015), and then citing Jennifer Maher & Ragnhild Sollund, *Law Enforcement of the Illegal Wildlife Trafficking: A Comparative Strengths, Weaknesses, Opportunities and Threats Analysis of the UK and Norway*, 2 J. TRAFFICKING, ORGANIZED CRIME & SEC. 82, 82–99 (2016)).

181. Halbwax, *supra* note 156 (citing Gail Emilia Rosen & Katherine F. Smith, *Summarizing the Evidence on the International Trade in Illegal Wildlife*, 7 ECOHEALTH 24, 24–32 (2010)).

182. Zahawi et al., *supra* note 55, at 803.

CITES.”¹⁸³ Finally, although the illegal wildlife trade is one of the biggest threats to biodiversity, other threats that wildlife face—including habitat loss and fragmentation, pollution, invasive species, and climate change—must be addressed together.¹⁸⁴ As a result of CITES weaknesses, many argue that an international trade agreement is the answer to effectively manage zoonotic disease risk if it helps limit the number of contacts between humans and animals effectively.¹⁸⁵

2. Lack of Solid Cooperation on Biodiversity Protection

Although Covid-19 is not the first zoonotic disease, there is almost no specific provision on what this means and how it should be addressed from an environmental perspective. While CITES should be the most comprehensive international agreement regarding zoonosis, the Convention does not explicitly address it. The lack of global and regional regulation has made the measures against zoonotic spillovers still a relatively underdeveloped topic. Likewise, international regulation on habitat restoration is currently lacking.¹⁸⁶

Additionally, the CBD, which also provides a general and nominal framework for biodiversity conservation, addresses wildlife diseases as a threat to biodiversity rather than a reservoir of pathogens for livestock and humans.¹⁸⁷ Because negotiations advance too slowly to respond to the fast and irreversible decline of biodiversity, meetings of the COP have not led to any binding agreements on essential solutions to address the extinction of species.¹⁸⁸

Despite the gravity of the pandemic, the past year clearly illustrates the lack of cooperation between States. Instead of cooperating to fight the disease’s spread, each country chose to apply its own rules to its territory. As of February 2022, the Global North is failing to fully cooperate at the international level to take measures demanded by the principles of solidarity and morality to ensure that Covid-19 vaccines are available to the entire

183. *Progress in the Implementation of Resolution 2/14 on Illegal Trade in Wildlife and Wildlife Products*, UNEP/EA.5/21 at 3 (Nov. 26, 2020) [hereinafter *Resolution 2/14*]; Derek Tittensor et al., *Evaluating the Relationships between the Legal and Illegal International Wildlife Trades*, J. SOC’Y FOR CONSERVATION BIOLOGY, Sept./Oct. 2020, at 9, <https://doi.org/10.1111/conl.12724>.

184. *Resolution 2/14*, *supra* note 183, at 2.

185. Borsky et al., *supra* note 32, at 1013.

186. Zahawi et al., *supra* note 55, at 803.

187. De Sadeleer & Godfroid, *supra* note 4, at 221.

188. MARIA ANTONIA TIGRE, GAPS IN INTERNATIONAL ENVIRONMENTAL LAW: TOWARD A GLOBAL PACT FOR THE ENVIRONMENT 3 (2020).

world, thus risking prolonging the pandemic.¹⁸⁹ States must now realize that seeing their interest instead of prioritizing the international community's interest will never help remediate these crises.

In sum, despite the existence of some frameworks that could ignite regional and international cooperation for the protection of biodiversity, the implementation challenges they face have proven to be more influential than the desire to cooperate, rendering all these efforts relatively ineffective.

B. Envisioning a Post-Pandemic Scenario

While some countries may have well-developed national laws to deal with wildlife trade, illegal forest cutting, and other sources of deforestation,¹⁹⁰ either regional cooperation, international cooperation, or both, would strengthen these laws and their enforcement.¹⁹¹ At a global level, while the United Nations Human Rights Council adopted resolution A/HRC/48/L.23/Rev.1 recognizing the human right to a safe, clean, healthy and sustainable environment,¹⁹² there is no one treaty or internationally binding instrument that recognizes the right to a healthy environment. The adoption of either at the international level could potentially play a crucial role in advancing the protection of biodiversity.¹⁹³ An international framework that clearly defines the roles, rights, responsibilities, and duties of all stakeholders at the national, regional, and international levels with the control of administrative and judiciary bodies would ensure more robust implementation and accountability from governments.¹⁹⁴

189. Claire-Marie Richter, *Time to Counter "Vaccine Nationalism"?: International Obligations of States in the Context of the COVID-19 Pandemic*, VÖLKERRECHTSBLOG (Mar. 26, 2021), <https://voelkerrechtsblog.org/time-to-counter-vaccine-nationalism/>; Miguel Calmon Dantas, *A Glimmer of Hope for All?*, VÖLKERRECHTSBLOG (Mar. 26, 2021), <https://voelkerrechtsblog.org/a-glimmer-of-hope-for-all/>.

190. Tigre, *supra* note 23, at 403.

191. See REGIONAL COOPERATION IN AMAZONIA, *supra* note 23, at 353-89 (analyzing the flaws of the ACTO).

192. See Maria Antonia Tigre & Victoria Lichet, *Historic Breakthrough for Environmental Justice: The UNHRC Recognizes the Right to a Healthy Environment as a Human Right*, OPINIO JURIS, 2021, <http://opiniojuris.org/2021/10/20/historic-breakthrough-for-environmental-justice-the-unhrc-recognizes-the-right-to-a-healthy-environment-as-a-human-right/> (last accessed January 31, 2022).

193. U.N. Gen. Assembly, *Follow-up to the Report of the Ad Hoc Open-Ended Working Group Established Pursuant to General Assembly Resolution 72/277*, U.N. Doc. A/RES/73/333 (Sep. 05, 2019) [hereinafter U.N. Doc. A/RES/73/333]; see TIGRE, *supra* note 189; Maria Antonia Tigre & Victoria Lichet, *Update on Negotiation of a New International Environmental Agreement*, ENV'T L. REP. 10818, 10819 (2020).

194. Christian Prip, *The Convention on Biological Diversity as a Legal Framework for Safeguarding Ecosystem Services*, 29(B) ECOSYSTEM SERVS. 199, 202 (Feb. 2018).

The U.N. is currently debating a new political declaration on international environmental law to be adopted in 2022.¹⁹⁵ Ignited by the Global Pact for the Environment (GPE), this new declaration could be an opportunity to bring biodiversity to the heart of international environmental law. Additionally, the declaration could incorporate innovative concepts and principles that would respond to the environmental, biodiversity, and health crises we currently face, rather than simply repeating previous declarations. For example, the current draft of the GPE includes the Principle of Resilience, requiring States to “take necessary measures to maintain and restore the diversity and capacity of ecosystems and human communities to withstand environmental disruptions and degradation and to recover and adapt.”¹⁹⁶ The Principle of Resilience implies that States must understand the capability of ecosystems and communities to resist disturbance in order to reinforce their ability to recover and adapt. Despite the significant importance of this principle to fight the biodiversity crisis, it has never been included in a legally binding instrument. Yet, it was defined in the 1970s by C.S. Holling as “[t]he capacity of a system to absorb disturbances and reorgani[z]e itself while undergoing change to still retain essentially the same function, structure, identity, and feedback.”¹⁹⁷

The current draft of the GPE also includes the principle of “integration and sustainable development” which would require States to “integrate the requirements of environmental protection into the planning and implementation of their policies and national and international activities, especially to promote the fight against climate change, the protection of oceans and the maintenance of biodiversity.” This draft illustrates the willingness of some countries to truly cooperate and fight against biodiversity loss. While the GPE was first intended as an international environmental treaty, States, unfortunately, chose to relegate the GPE to a political declaration because a few States were against the adoption of a legally binding text.¹⁹⁸ This declaration is scheduled for adoption at the next Earth Summit in 2022—the 50th anniversary of the Stockholm Declaration and the 30th anniversary of the Rio Declaration. All States should use this opportunity to negotiate the text in good faith while keeping in mind the urgency of the three crises we are facing. Including biodiversity at the heart

195. See Tigre & Lichet, *supra* note 193 (discussing possible U.N. legislation for 2022).

196. *Draft of the Global Pact for the Environment*, GLOB. PACT FOR ENV'T, <https://globalpactenvironment.org/uploads/EN.pdf> (last visited Jan. 25, 2022) (quoting article 16 Resilience).

197. C. S. Holling, *Resilience and Stability of Ecological Systems*, 4 ANN. REV. ECOLOGY & SYSTEMATICS, 1973 at 1, 7.

198. TIGRE, *supra* note 188; U.N. Doc. A/RES/73/333, *supra* note 193.

of this declaration would pave the way towards more vigorous international cooperation regarding biodiversity protection. The initiative continues to offer an opportunity for post-pandemic collaboration. For example, the declaration could recommend negotiating and adopting a legally binding treaty guaranteeing concrete actions to protect the environment and fight biodiversity loss.

Additionally, the universal right to a healthy environment could help develop new norms to protect the environment while strengthening human health-related provisions.¹⁹⁹ Preexisting environmental challenges such as climate change, water scarcity, and illegal wildlife trafficking, as well as new ones derived from the pandemic, call for better protection of the environment. At the same time, adopting an integral perspective takes into consideration the lives and health of present and future generations. Thus, international cooperation is crucial for advancing these goals and for Building Back Better.

2020 was supposed to be vital for advancing environmental negotiations. Two key United Nations meetings were delayed due to the pandemic—the 26th COP to the Framework Convention on Climate Change (COP26) and the 15th COP to the CBD (COP15)—impeding national governments from assessing current progress or renewing restoration commitments.²⁰⁰ The implementation of the Paris Agreement was further delayed along with the International Union for Conservation of Nature.²⁰¹ Postponement of these summits allowed countries to move towards economic recovery without considering environmental protection.²⁰² In October of 2021, CBD’s COP 15 met virtually in the first of a two-part summit.²⁰³ The second part will meet in May 2022 in China under the theme “Ecological Civilization: Building a Shared Future for All Life on Earth” to review the achievement of the Strategic Plan for Biodiversity 2011.²⁰⁴ These meetings are crucial to address the current biodiversity crisis.

Finally, a more significant focus on how humans interact with nature is necessary. Initiatives such as the One Health Approach could help emphasize

199. Maria-Antonia Tigre & Victoria Lichet, *The Human Rights Council Urges States to Realize the Rights of the Child through a Healthy Environment*, GLOB. NETWORK FOR STUDY HUM. RTS. & ENVIRONMENT (Oct. 19, 2020), <https://gnhre.org/environmental-rights-2/the-human-rights-council-urges-states-to-realize-the-rights-of-the-child-through-a-healthy-environment/>.

200. *Id.*

201. Nyckwere, *supra* note 17, 104–05.

202. *Id.* at 106 (explaining the negative impact of suspending environmental regulations).

203. *Convention on Biological Diversity*, U.N. FOOD SYS. SUMMIT 2021, <https://www.un.org/en/food-systems-summit-2021-en/un-biodiversity-conference> (indicating that the UN Biodiversity Conference was scheduled for May 8, 2021 in Kunming, China).

204. *Id.*

the need for multidisciplinary cooperation at different governance levels.²⁰⁵ The current research system cannot deal with a complex phenomenon that involves geophysical, biological, and human diversity from a systemic and integrated perspective, limiting the capacity to generate knowledge and create policies and actions to address Covid-19.²⁰⁶ Therefore, there is an urgent need to implement a holistic approach involving the human, animal, and environmental health communities to respond to the illegal trade of wildlife and forest products.²⁰⁷ However, so far, examples of collaboration barriers like power imbalances, conflicts of interest, and coordination gaps have represented challenges for designing and implementing One Health strategies.²⁰⁸

States can no longer prioritize their own interests because zoonoses have no borders. Considering the gravity of the Covid-19 crisis and the understanding of the causes of zoonosis, States have an unequivocal moral obligation to negotiate in good faith the adoption of an international agreement that would better regulate the causes of zoonoses. The solutions to address biodiversity loss and zoonotic diseases must encompass a proper understanding of the human activities that cause species extinction and transmission of zoonotic diseases to humans. International cooperation will be crucial in the coming years to prevent future pandemics and face biodiversity loss and climate change.

CONCLUSION

The Covid-19 pandemic has shown the connection between economies, societies, ecosystems, and human health. This connection reflects the need for holistic responses that address economic balance and environmental protection. As our understanding of the drivers of the emergence and spread of Covid-19 progresses, it is vital to regulate human–animal interactions. To achieve transformational change in the post-pandemic scenario, States need to address the structural and systemic causes of biodiversity loss: changes in land use and exploitation of wildlife.

While the Half-Earth proposal insufficiently responds to the biodiversity crisis, it has prompted international debate and pushed the international

205. JOHN S. MACKENZIE ET AL., ONE HEALTH: THE HUMAN-ANIMAL-ENVIRONMENT INTERFACES IN EMERGING INFECTIOUS DISEASES 114 (Juergen A. Richt ed., 2013)(ebook).

206. *Id.*

207. *Resolution 2/14*, *supra* note 183, at 3.

208. Carolina dos S. Ribeiro et al., *Overcoming Challenges for Designing and Implementing the One Health Approach: A Systematic Review of the Literature*, ONE HEALTH, Mar. 18, 2019, at 1, 2.

agenda towards protecting biodiversity as a shared goal among States. Despite the existence of some frameworks that could ignite regional and international cooperation for the protection of biodiversity, the challenges regarding their implementation can render these frameworks ineffective. This unequivocally calls for international cooperation and solidarity, which can lead to significant environmental benefits while protecting human health. International cooperation will thus be crucial in the coming years to prevent future pandemics and face biodiversity loss and climate change.

CHARGING FORWARD: ACCELERATING LONG-TERM ENERGY STORAGE DEVELOPMENT

*Collin Wilfong and Robert Bullington**

Introduction	157
I. An Overview of Long-Term Energy Storage Technologies and Policies	159
A. A Long History of Energy Storage	159
B. Why Growing the Nation's Long-Term Energy Storage Capacity Matters	161
1. Renewable Energy and Energy Storage	162
2. Short- versus Long-Term Energy Storage: Limitations and Costs	164
3. Existing Long-Term Energy Storage Technologies	165
C. Current Energy Storage Policies	167
II. Analyzing the Gaps in Long-Term Energy Storage Policies	169
A. Under-internalization of Long-Term Energy Storage Benefits	170
B. Reducing Investment Risks for Long-Term Energy Storage Development	172
C. Lowering Barriers to Entry in the Long-Term Energy Storage Industry	173
III. Accelerating the Long-Term Energy Storage Buildout	174
A. Targeted Research Grants	174
B. Long-Term Energy Storage Investment Tax Credits	175
C. Federal Loan Guarantees	178
D. Long-Term Energy Storage Portfolio Standard Carve-outs	179
Conclusion	180

INTRODUCTION

In the summer of 2020, unprecedented heat and raging wildfires created a major energy shortage across the southwestern United States.¹ The temperature in Death Valley, California, reached a scorching 130°F on August 16, 2020,² while Los Angeles County logged its highest recorded temperature of 121°F.³ This excessive heat caused a spike in electricity demand across the Southwest region which triggered major brownouts throughout much of California.⁴ This occurred because utility companies shut off electric transmission infrastructures to reduce the risk of the equipment creating more fires.⁵

The Southwest's growing fleet of utility-scale lithium-ion battery facilities and other short-term energy storage systems eased some of the stress placed on the region's electricity grid during the 2020 heat wave.⁶ Ultimately, it could not prevent the disruptive power outages that ensued.⁷ Public safety power shutoff (PSPS) requirements, instituted after recent wildfires, required California grid operators to shut down parts of the state's grid to avoid sparking new blazes amid the hot, dry conditions.⁸ Unfortunately, the region presently lacks the energy storage capacity to compensate for such shutdowns, especially on blistering days

* Robert Bullington and Collin Wilfong are both 2021 J.D. Candidates and Sustainability Law Research Fellows at Arizona State University's Sandra Day O'Connor College of Law. Robert graduated with a B.S. in Economics and a B.A. in Business-Law from Arizona State University in 2018. Collin graduated with a B.S. in Criminology and Criminal Justice from Arizona State University in 2018. Many thanks ASU's other 2020-21 Sustainability Law Student Research Fellows and Professor Troy Rule for their invaluable comments and input on the issues covered in this article.

1. Robert Hart, *280,000 Customers Face Losing Power in California Amid Fire-Safety Blackouts*, FORBES (Jan. 19, 2021), <https://www.forbes.com/sites/roberthart/2021/01/19/280000-customers-face-losing-power-in-california-amid-fire-safety-blackouts/?sh=211ef5fb1675>.

2. Kasha Patel, *California Heatwave Fits a Trend*, NASA EARTH OBSERVATORY (2020), <https://earthobservatory.nasa.gov/images/147256/california-heatwave-fits-a-trend#:~:text=The%20darkest%20red%20areas%20are,Palmdale%2C%20also%20hit%20record%20highs>.

3. Alex Wigglesworth, et al., *Intense Heat Wave Breaks Numerous Records, Fuels Dangerous Fires Across California*, L.A. TIMES (Sept. 6, 2020), <https://www.latimes.com/california/story/2020-09-05/heres-where-record-breaking-heat-is-forecast>.

4. Doha Madani et al., *Threat of Rolling Blackouts in California Passes—for Now*, NBC NEWS (Aug. 18, 2020), <https://www.nbcnews.com/news/us-news/millions-facing-power-outages-heatwave-overwhelms-california-energy-grid-n1237015>.

5. See Hart, *supra* note 1 (explaining that utility companies shut off power due to events such as downed trees and power lines).

6. Jeff McMahon, *How California Wildfires Are Driving Energy Storage Beyond Lithium-Ion*, FORBES (Oct. 5, 2020), <https://www.forbes.com/sites/jeffmcmahon/2020/10/05/how-california-wildfires-are-driving-energy-storage-beyond-lithium-ion/?sh=51e8cf914954>.

7. *Id.*

8. *Id.*

when air conditioning use and electricity demand are high.⁹ During California's November 2019 wildfires, the average time for a short PSPS outage was 11 hours, with longer outages lasting three to five days—much longer than the four-hour duration that most lithium-ion batteries can reliably supply backup power.¹⁰

Although California and numerous other states are aggressively promoting buildouts of short-term energy storage capacity, batteries alone cannot protect against drawn out power supply disruptions.¹¹ Accordingly, much more long-term energy storage capacity is needed to allow states to continue their shift to wind and solar energy sources while simultaneously preparing for the intensifying heat and wildfire risks brought about by climate change.¹² Long-term energy storage devices can store massive quantities of energy when there is excess supply in the grid system.¹³ Then, it can dispatch electricity to address power supply shortages for days or even longer.¹⁴ Microgrids, supported by long-term energy storage capacity, could also enable some rural communities in the West to become less dependent on the larger grid and more resilient against brownouts during wildfire seasons.¹⁵ Such reliability and resiliency advantages are only some of the potential benefits that long-term energy storage could provide as the nation transitions to a carbon-free renewable energy system.

Despite the importance of long-term energy storage development, it has been underemphasized in sustainable energy policy over the past quarter-century.¹⁶ Long-term storage can provide unique stabilizing and security benefits presently available through no other carbon-free energy

9. See, e.g., *id.* (discussing how California will have only mere fraction of the energy it needs by 2045).

10. *Id.*

11. Gregory Meyer, *California Bets on Batteries to Ease Blackout Worries*, FIN. TIMES (Aug. 25, 2020), <https://www.ft.com/content/2c5f7678-1323-4886-9917-a77ef86f1e4d>.

12. See McMahon, *supra* note 6 (explaining that California officials believe other technologies can provide reliability and safety during long power outages).

13. *California Opens Up Opportunities for Microgrids to Play Role in Boosting Reliability of Energy Mix*, ENERGY STORAGE NEWS (Jan. 21, 2021), <https://www.energy-storage.news/news/california-opens-up-opportunities-for-microgrids-to-play-role-in-boosting-r>.

14. Ken Silverstein, *For the U.S. to Become Carbon Neutral, Long-Term Energy Storage is a Must*, FORBES (July 26, 2021), <https://www.forbes.com/sites/kensilverstein/2021/07/26/for-the-us-to-become-carbon-neutral-long-term-energy-storage-is-a-must/?sh=644aadfb241e>.

15. ENERGY STORAGE NEWS, *supra* note 13.

16. See Omar J. Guerra, *Beyond Short-Duration Energy Storage*, 6 NATURE ENERGY 460, 460 (2021) (stating that long-duration energy storage accounts for only 7% of total energy storage capacity compared to 93% for short-term energy storage).

strategies.¹⁷ Yet, government programs aimed at facilitating their advancement and deployment have lagged those focused on renewable energy generation or short-term storage.¹⁸ Fortunately, it is possible to fill this gap through innovative new policies designed to incentivize far more private investment in long-term storage development.

Part I of this article describes the history and importance of long-term energy storage and provides an overview of current policies aimed at promoting long-term energy storage development. Part II outlines certain frameworks for analyzing long-term energy storage policies and applies those frameworks to highlight shortcomings in the policy regimes that presently govern these technologies. Part III then identifies specific policies capable of accelerating the advancement and deployment of long-term energy technologies throughout the U.S.

I. AN OVERVIEW OF LONG-TERM ENERGY STORAGE TECHNOLOGIES AND POLICIES

Because of the intermittent nature of wind and solar resources, long-term energy storage capacity is crucial to building any clean and renewable energy system. The term “energy storage” describes systems and devices capable of storing energy for dispatch as electricity at a later time.¹⁹ Electric energy storage systems (the primary focus of this article) store electrical energy primarily through chemical or physical means.²⁰ Longer-term energy storage facilities and devices are just one category within this broader class of energy storage systems.²¹

A. A Long History of Energy Storage

For as long as humankind has been gathering resources, it has been storing energy resources for later use.²² Practices and methods for storing and preserving food, which itself is a form of stored energy, are

17. ETHAN N. ELKIND ET AL., *THE POWER OF ENERGY STORAGE: HOW TO INCREASE DEPLOYMENT IN CALIFORNIA TO REDUCE GREENHOUSE GAS EMISSIONS* 5 (2010).

18. *See id.* at 8 (discussing how California has taken multiple steps to reduce greenhouse gas emissions through increased use of renewable energy technology).

19. *Id.* at 1.

20. YE JI-LEI ET. AL., *GRID-SCALE ENERGY STORAGE SYSTEMS AND APPLICATIONS* 3 (Fu-Bao Wu et al. eds., 2020).

21. Examples of other energy storage systems include pumping water, multiple battery technologies, flywheels, and more. ELKIND ET AL., *supra* note 17, at 1.

22. Tim Maly, *A Brief History of Human Energy Use*, *THE ATLANTIC* (Nov. 13, 2015), <https://www.theatlantic.com/technology/archive/2015/11/a-brief-history-of-human-energy-use/415749/>.

well documented across a variety of ancient civilizations.²³ Early Middle Eastern, Asian, and Roman cultures, some dating as far back as 12,000 B.C., utilized the sun's rays to build up dried fruit reserves.²⁴ Alternatively, prehistoric cultures in colder climates used ice to freeze and refrigerate meats.²⁵ After the advent of farming some 12,000 years ago, Greek farmers in the Neolithic era used ceramic vessels and clay-lined pits to store surplus crops.²⁶ Such food-based energy storage strategies eventually gave way to harnessing the power of domesticated animals, waterwheels, and windmill-powered wells, each of which allowed humans to utilize stored energy in various ways.²⁷

Energy storage technologies advanced dramatically in the late 18th century.²⁸ The electric battery was invented by Italian scientist Alessandro Giuseppe Antonio Anastasio Volta in 1799.²⁹ Almost a century later, a utility company in New York City began utilizing lead-acid batteries to power its road lamps at night.³⁰ These advancements eventually paved the way for the emergence of early long-term energy storage systems in the late 19th and early 20th centuries.³¹ It primarily took the form of pumped hydro storage projects—facilities that use electricity to pump water uphill and then release that water down through turbines to generate power at a later time.³² In the 1950s, a flurry of pumped hydro storage construction began spreading across the globe.³³ From the 1950s through the early 1990s, worldwide pumped hydro storage capacity grew rapidly from 1600 megawatts (MW) to 79,000 MW.³⁴ However, pumped hydro storage growth then ground to a near

23. Linda Hyuck, *Food Preservation Is as Old as Mankind*, MICH. STATE UNIV. EXTENSION (June 11, 2012), https://www.canr.msu.edu/news/food_preservation_is_as_old_as_mankind.

24. Dushka Urem-Kotsuo, *Storage of Food in the Neolithic Communities of Northern Greece*, 49 *WORLD ARCHEOLOGY* 73, 82–83 (2017).

25. See Brian A. Nummer, *Historical Origins of Food Preservation*, *National Center for Home Food Preservation*, NAT'L CTR. HOME FOOD PRES. (May 2002), https://nchfp.uga.edu/publications/nchfp/factsheets/food_pres_hist.html. (discussing different methods of food preservation across various cultures and countries).

26. Dushka Urem-Kotsuo, *supra* note 24, at 82–83.

27. See Maly, *supra* note 22 (discussing the evolution of energy-generating inventions and strategies).

28. JI-LEI ET AL., *supra* note 20, at 3.

29. *Id.*

30. *Id.*

31. *Id.* at 3–4.

32. *Id.* at 4.

33. *Id.*

34. *Id.*

halt—especially in the U.S., where the last pumped hydro storage facility was built in 1995.³⁵

Although pumped hydro energy storage development all but ceased in the U.S. a quarter century ago, new energy storage technologies have filled some of that gap in recent years. Lithium-ion battery technologies have matured and driven a new type of energy storage development boom.³⁶ This recent surge in lithium-ion battery innovation is attributable in part to the rise of electric vehicles.³⁷ These battery systems are also increasingly serving roles in utility-scale energy storage and grid management.³⁸ Lithium-ion battery prices have plummeted over the past decade, with one 2018 projection estimating that the capital cost of a utility-scale lithium-ion storage system would fall by 52% by 2030.³⁹ Simultaneously, demand for these batteries has more than doubled since 2015, while their per unit cost has dropped by about 87% in the last ten years.⁴⁰

B. Why Growing the Nation's Long-Term Energy Storage Capacity Matters

Energy storage systems operate much like a sponge, soaking up excess energy and then feeding it back into the grid when needed. “Short-term” energy storage systems generally supply electricity for only a few hours, while “long-term” energy storage typically can supply stored electricity for ten hours or longer.⁴¹ Energy storage capacity—including long-term energy storage—is taking on an increasingly important role as the nation transitions toward a carbon-free, sustainable energy system.

35. Charles R. Sensiba et al., *Deep Decarbonization and Hydropower*, 48 ENV'T. L. REP. NEWS & ANALYSIS 10309, 10331 (2018).

36. *The Battery Boom Is Coming, as Costs Drop Quickly*, BLOOMBERG (Nov. 15, 2018), <https://www.industryweek.com/supply-chain/article/22026687/the-battery-boom-is-coming-as-costs-drop-quickly>.

37. *Id.*

38. *See id.* (explaining that “the majority of storage capacity will be utility-scale until the mid-2030s.”).

39. *Id.*

40. *Virus Crisis Halts EV Battery Boom, for Now*, AUTOMOTIVE NEWS EUR. (June 30, 2020), <https://europe.autonews.com/automakers/virus-crisis-halts-ev-battery-boom-now>.

41. David Schmitt & Glenn M. Stanford, *Energy Storage: Can We Get It Right?* 39 ENERGY L.J. 447, 457 (2018).

1. Renewable Energy and Energy Storage

Large amounts of short-term and long-term energy storage capacity will be needed to support a full transition to renewable energy sources in the U.S.⁴² Short-term energy storage systems are helpful in addressing the “duck curve” problem—a grid load balancing challenge that results from the fact that solar energy production tends to peak in the early afternoon, but electricity demand generally peaks in the early evening.⁴³ In regions where solar energy systems account for a large proportion of a grid’s electricity supply, short-term energy storage technologies are well-suited to combat the duck curve problem by supplying a few hours of stored solar power to help fill this gap.⁴⁴

Unfortunately, short-term energy storage systems are far less equipped to deal with electricity shortages that persist for days at a time. An energy system dependent largely on wind and solar energy can be particularly vulnerable to such days-long electricity shortages during extended periods of cloudiness or non-windy conditions.⁴⁵ As an increasing proportion of the nation’s energy generation is supplied by these renewable sources, the need for longer-term reserves of power to address prolonged periods of intermittency also increases.⁴⁶ Longer-term reserves of power also serve crucial roles in certain crises, such as California’s deadly combination of heat and wildfires and Texas’ recent severe ice storm that resulted in rolling blackouts for roughly four million people.⁴⁷ Evidence suggests that such extreme weather events are likely to occur even more frequently with climate change in the coming years.⁴⁸

42. *Long Duration Storage Shot*, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY (July 2021), <https://www.energy.gov/eere/long-duration-storage-shot>.

43. Becca Jones-Albertus, *Confronting the Duck Curve: How to Address Over-Generation of Solar Energy*, OFF. ENERGY EFFICIENCY & RENEWABLE ENERGY (Oct. 12, 2017), <https://www.energy.gov/eere/articles/confronting-duck-curve-how-address-over-generation-solar-energy>.

44. *Id.*

45. Max Tuttleman & Scott Litzelman, *Why Long-Duration Energy Storage Matters*, ADVANCED RSCH. PROJECTS AGENCY-ENERGY (Apr. 1, 2020), https://arpa-e.energy.gov/news-and-media/blog-posts/why-long-duration-energy-storage-matters#_ftn3.

46. *Id.*

47. Brad Plumer, *A Glimpse of America’s Future: Climate Change Means Trouble for Power Grids*, N.Y. TIMES (Feb. 18, 2021), <https://www.nytimes.com/2021/02/16/climate/texas-power-grid-failures.html> (“But as climate change accelerates, many electric grids will face extreme weather events that go far beyond the historical conditions those systems were designed for, putting them at risk of catastrophic failure.”).

48. See Meyer, *supra* note 11 (quoting Benoit Allehaut, managing director in Capital Dynamics’ clean energy infrastructure team, “‘Unfortunately, climate change is a reality. And climate change leads to fires. Fires sometimes hit transmission lines.’”).

Energy storage systems can also help to reduce renewable energy waste by allowing wind and solar energy project operators to store excess energy rather than curtailing their projects' generation of power.⁴⁹ When there is a surplus of electric power on the grid, grid operators sometimes issue curtailment orders compelling wind or solar generators to temporarily reduce the amount of power they are feeding onto the grid to help avoid grid overloads.⁵⁰ Such curtailment orders can be costly for wind and solar farm operators but could become more common as renewables supply an ever-increasing proportion of the nation's electricity.⁵¹ For example, one study projected that if the share of renewable energy were to double between now and 2030, total energy storage capacity would need to grow from 4.67 terawatt-hours to 11.89–15.72 terawatt-hours to handle this change.⁵² By contrast, current estimates suggest that there will be only about 4,500 MW of total energy storage in the U.S. by the year 2024.⁵³ This suggests the nation will need significantly more energy storage capacity to accommodate these changes to the energy mix.

A few technical terms are helpful when assessing the effectiveness and features of energy storage systems. The term “levelized cost of storage” (LCOS) describes the total lifetime cost of an energy storage technology divided by its cumulative delivered electricity, expressing it as the discounted cost of electricity per unit discharged.⁵⁴ The LCOS, which is generally expressed in dollars per kilowatt-hour (kWh), is a versatile metric that is used to compare the costs of various energy storage technologies.⁵⁵ Another common metric “roundtrip efficiency” describes the amount of energy a storage system loses from charge to discharge.⁵⁶ A storage device's “cycle life” and “calendar life” describe

49. See Schmitt & Stanford, *supra* note 41, at 465–66 (outlining various renewable energy methods).

50. *Id.* at 466.

51. Michelle Bowman, *EIA Projects that Renewables will Provide Nearly Half of World Electricity by 2050*, ENERGY INFO. ADMIN. (Oct. 2, 2019), <https://www.eia.gov/todayinenergy/detail.php?id=41533> (expressing that the U.S. Energy Information Administration projects that by 2050, renewable sources will supply almost half of the world's electricity).

52. *Electricity Storage and Renewables: Costs and Markets to 2030*, INT'L RENEWABLE ENERGY AGENCY 8 (2017).

53. Oliver Schmidt et al., *Projecting the Future Levelized Cost of Electricity Storage Technologies*, 3 JOULE 81, 81 (Jan. 2019).

54. Schmidt et al., *supra* note 53, at 81.

55. *Id.* at 81–82.

56. Robert Fares & Michael Webber, *What are the Tradeoffs Between Energy Storage Cycle Life and Calendar Life in the Energy Arbitrage Application*, 16 J. ENERGY STORAGE 37, 37–40 (2018).

how quickly the device's capacity to store energy degrades over time.⁵⁷ Collectively, these metrics assist industry in comparing and evaluating energy storage systems.

2. Short- versus Long-Term Energy Storage: Limitations and Costs

Although short-term energy storage technologies and markets have expanded significantly in the past decade, these developments alone will be unable to support a rapid and complete transition to intermittent, renewable energy sources.⁵⁸ Short-term energy storage technologies can typically supply their maximum power output only for about four hours on average.⁵⁹ Because lithium-ion batteries are a relatively inexpensive and efficient form of short-term energy storage, boasting a \$0.35/kWh LCOS,⁶⁰ utilities have increasingly relied on them in recent years to help mitigate “duck curve” problems arising from increased reliance on wind and solar energy.⁶¹ Although lithium-ion batteries are well-suited for supplying short-term energy storage capacity, they are a costly and inefficient approach to bulk long-term storage.⁶² Much of this is due to the poor scalability of lithium-ion battery systems.⁶³ These systems can only double their storage capacity through a doubling of the size or number of batteries involved.⁶⁴

Although there is clearly a growing need across the country for additional energy storage capacity designed to store power for just a few hours, there is also an unprecedented need for a long-term energy storage that is engineered and rated to store energy for 24 hours or longer.⁶⁵ It is estimated that roughly \$662 billion of investment will be needed to address the “storage gap” of energy storage technologies for the 6–100+ hour range.⁶⁶ Recognizing this challenge, California officials have

57. *Id.*

58. Silverstein, *supra* note 14.

59. Emily Pontecorvo, *How do You Save Clean Energy? This Company Plans to p=ump it Underground*, GRIST (June 30, 2020), <https://grist.org/energy/how-do-you-save-clean-energy-this-company-plans-to-pump-it-underground/>.

60. *Id.*

61. Louis Brasington, *The Long Duration Energy Storage Search – How Close are we to Low Costs and Zero Carbon*, CLEANTECH GRP. (Dec. 29, 2019), <https://www.cleantech.com/the-long-duration-energy-storage-search-how-close-are-we-to-low-costs-and-zero-carbon/>.

62. *Id.*

63. *Id.*

64. Pontecorvo, *supra* note 59.

65. Brasington, *supra* note 61.

66. *Id.*

determined that their state alone will need to add at least one gigawatt (GW) of new long-term storage by 2026.⁶⁷

3. Existing Long-Term Energy Storage Technologies

A diverse array of long-term energy storage technologies already exists, although many of these technologies are not fully matured and are still quite expensive.⁶⁸ Arguably, the five most promising long-term energy storage technologies today are: (1) pumped hydro; (2) flow batteries; (3) compressed-air; (4) gravity-based; and (5) hydrogen energy.⁶⁹ Each of these technologies has its own strengths and weaknesses in terms of efficiency, cost, calendar life, and geographic range, among other factors.⁷⁰ However, many of them are novel and remain somewhat unproven.⁷¹ No single technology is the clear front-runner for meeting the planet's long-term energy storage needs. Accordingly, all of them could potentially play a role in providing long-term energy storage support for a carbon-free and sustainable energy sector.

Pumped hydro-electric energy storage technologies have existed in multiple forms for over a century.⁷² Conventional pumped hydro facilities consist of two water reservoirs, each at a different elevation.⁷³ When there is an abundance of low-cost electricity on the grid, these facilities pump water from their lower reservoir to the higher reservoir to store energy.⁷⁴ Then, when there is a need for greater electricity supply on the grid, facility operators release water down through electromagnetic turbines to the lower reservoir, generating dispatchable

67. Julian Spector, *California: We Need 1GW of New Long-Duration Energy Storage by 2026*, GREENTECH MEDIA (Apr. 7, 2020), <https://www.greentechmedia.com/articles/read/california-we-need-1gw-long-duration-storage-by-2026>.

68. Jason Plautz, *Long-Duration Storage Market on the 'Cusp of Maturity': ESS CEO*, UTILITY DIVE (July 29, 2021), <https://www.utilitydive.com/news/long-duration-storage-market-on-the-cusp-of-maturity-ess-ceo/604106/>.

69. Julian Spector, *The 5 Most Promising Long-Duration Storage Technologies Left Standing*, GREENTECH MEDIA (Mar. 31, 2020), <https://www.greentechmedia.com/articles/read/most-promising-long-duration-storage-technologies-left-standing>.

70. Nestor A. Sepulveda et al., *The Design Space for Long-Duration Energy Storage in Decarbonized Power Systems*, 6 NATURE ENERGY 506, 506–07 (May 2021).

71. See Plautz, *supra* note 68.

72. *Pumped Storage Hydropower*, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY, <https://www.energy.gov/eere/water/pumped-storage-hydropower> (last visited Aug. 17, 2021).

73. Schmitt & Stanford, *supra* note 41, at 457.

74. *Id.*

power.⁷⁵ In the U.S., pumped hydro energy storage accounts for 95% of existing energy storage used by utilities,⁷⁶ providing it at an average LCOS of \$0.17/kWh.⁷⁷ Unfortunately, new pumped hydro storage development projects tend to involve relatively high initial capital costs and face significant geographical constraints because most of the viable sites for pumped hydro facilities are already in use.⁷⁸

Another potential form of long-term energy storage—flow batteries—consists of chemically complex battery systems that store electrical charges in tanks of liquid electrolytes.⁷⁹ Most current flow battery technologies utilize significant amounts of vanadium, which is becoming increasingly rare and expensive.⁸⁰ However, there are alternative approaches in development that use less rare materials and show some promise.⁸¹ The flow battery market is projected to become a \$1 billion annual industry over the next five years.⁸² Flow batteries' per unit storage costs are still relatively high, but they have long cycle and calendar lives that allow for service times up to 30 years.⁸³

Compressed-air energy storage systems use energy to cool, compress, and store air over long periods so it can later be released to generate electric current.⁸⁴ Although compressed-air storage facilities have relatively low roundtrip efficiencies and are somewhat geographically limited, they are not as geographically constrained as pumped hydro storage facilities and can store vast amounts of energy.⁸⁵ Compressed-air storage facilities often store air underground, and some existing caverns or man-made subsurface structures such as mineshafts present good candidates for hosting such systems.⁸⁶

75. *Id.*

76. Pontecorvo, *supra* note 59.

77. Brasington, *supra* note 61.

78. *Id.*

79. Robert Service, *New Generation of 'Flow Batteries' Could Eventually Sustain a Grid Powered by the Sun and Wind*, SCIENCE (Oct. 31, 2018), <https://www.sciencemag.org/news/2018/10/new-generation-flow-batteries-could-eventually-sustain-grid-powered-sun-and-wind>.

80. *Id.*

81. *Id.*

82. *Id.*

83. Tisha Scroggin-Wicker & Kieran McNerney, *Flow Batteries: Energy Storage Option for a Variety of Uses*, POWERMAG: SOLAR (Mar. 2, 2020), <https://www.powermag.com/flow-batteries-energy-storage-option-for-a-variety-of-uses/>.

84. Schmitt & Sanford, *supra* note 41, at 483.

85. Spector, *supra* note 69.

86. *Id.*

Gravity-based energy storage systems, like pumped hydro storage facilities, use gravitational potential to store energy.⁸⁷ Most gravity-based energy storage systems in development store that energy using heavy concrete blocks that are stacked vertically by robotically operated cranes.⁸⁸ Gravity-based energy storage systems are appealing in that they have relatively small land footprints, can operate in most any geographic area, and require little or no water—a feature that could make them particularly useful in arid climates.⁸⁹ Gravity-based energy storage systems could also be scaled down and fitted to meet the long-term energy needs of smaller, isolated communities.⁹⁰

Hydrogen energy storage technologies involve the use of excess energy to produce hydrogen, which is then stored for conversion into electric current at some point in the future.⁹¹ Hydrogen energy storage strategies have a high energy density, do not generate carbon dioxide emissions, and are increasingly cost-competitive on the wholesale energy market with an LCOS of around \$0.16–\$0.19.⁹² Hydrogen energy storage technologies have some additional appeal because of hydrogen’s ability to serve a wide variety of industrial and commercial uses beyond energy storage as well.⁹³

C. Current Energy Storage Policies

Energy storage policies currently in place at the federal and state levels provide valuable support for energy storage development but have some shortcomings that prevent them from adequately driving growth in the long-term energy storage industry.⁹⁴ Many of these existing policies do not even distinguish between long-term and short-term energy storage, and those that do generally fail to provide meaningful incentives for targeted private investments of long-term energy storage technologies.⁹⁵

87. Julian David Hunt, et al., *Mountain Gravity Energy Storage: A New Solution for Closing the Gap Between Existing Short- and Long-Term Storage Technologies*, 190 ENERGY 1, 2 (2020).

88. *Id.*

89. *Id.* at 1.

90. *Id.* at 4.

91. PAUL BREEZE, POWER SYSTEM ENERGY STORAGE TECHNOLOGIES 69–77 (2018).

92. *Id.*

93. *See id.* (discussing hydrogen’s use in hydrocarbon reformation, vehicle fuel cells, and capturing energy from wind farms).

94. Richard L. Revesz & Burcin Unel, *Managing the Future of the Electricity Grid: Energy Storage and Greenhouse Gas Emissions*, 42 HARV. ENV’T L. REV. 139, 174 (2018).

95. *Id.* at 181.

At the federal level, the Federal Energy Regulatory Commission (FERC) is the primary regulator of long- and short-term energy storage.⁹⁶ FERC Orders 755 and 841 constitute the latest and most significant efforts by the agency to advance long-term energy storage.⁹⁷ FERC Order 755 attempts to open up more energy storage revenue streams.⁹⁸ Specifically, Order 755 makes it possible for technologies such as lithium-ion batteries and flywheels, that can regulate frequency on the grid, to be compensated for that service.⁹⁹ FERC Order 841 seeks to open additional streams of revenue for long-term energy storage providers by providing capacity, energy, and certain other ancillary services.¹⁰⁰ Both FERC Order 755 and 841 help to provide some extra incentives for the advancement of the long-term energy storage industry.¹⁰¹ In crafting policies to promote long-term energy storage, it is important to ensure that the unique benefits and services long-term energy storage can provide are recognized and fairly compensated so that there will continue to be adequate private investment in long-term energy storage development.

At the state government level, California and New York are at the forefront of long-term energy storage policy. California was the first state to enact a state-level energy storage mandate.¹⁰² California's SB 2514, enacted in 2010, required the California Public Utilities Commission to study the need for energy storage capacity in California.¹⁰³ Additionally, it issued an energy storage procurement target for the load-serving entities in the state.¹⁰⁴ This led the California Public Utilities Commission to require that the state's regulated utilities procure at least 1,325 MW of energy storage by the year 2024.¹⁰⁵ In 2017, New York's state government also created an Energy Storage Deployment Program.¹⁰⁶ In 2018, this led to a goal of developing 3,000 MW of long-

96. *Id.* at 174.

97. *Id.*; see also, *Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators*, Order No. 841, 162 FERC ¶ 61 (2018) [hereinafter Order No. 841].

98. Revesz & Burcin Unel, *supra* note 94, at 174; see also, Order No. 841, *supra* note 97.

99. *Id.*

100. Nathan Howe et al., *California Energy Storage Initiatives: Surfing the Storage Wave*, 34 CHI. AM. BAR ASS'N NAT'L RES. & ENV'T 18, 20 (2019); see also, see also, Order No. 841, *supra* note 97.

101. Howe et al., *supra* note 100, at 20; see also, Order No. 841, *supra* note 97.

102. Howe et al., *supra* note 100, at 20.

103. *Id.*

104. *Id.*

105. *Id.*

106. *Id.*

term energy storage capacity in the state by the year 2030.¹⁰⁷ New York has also set the goal of being 100% free from carbon emissions in their energy generation by the year 2040.¹⁰⁸ California and New York's energy storage mandate policies are creating additional demand for energy storage capacity in those states. However, they could be strengthened if the states were to provide special incentives for long-term energy storage technologies, which remain comparatively less developed and in need of more targeted government support.

There is evidence that California and New York's policies are already beginning to successfully drive some long-term energy storage development. For example, in February 2017, California's San Diego Gas & Electric deployed what was, at the time, the world's largest lithium-ion battery storage facility.¹⁰⁹ It can store up to 120 MWh of electricity.¹¹⁰ The construction of the facility was laudable, but it fulfilled only a tiny percentage of the total California energy storage goal and did little to increase the state's long-term energy storage capacity.¹¹¹ Moreover, a majority of states will have no long-term energy storage incentive policies, and the federal government's policies are far too modest to propel the type of growth needed to support the country's transition to renewable energy.¹¹² In short, federal and state energy storage incentive policies are helping to jumpstart the long-term energy storage industry. However, they still fall short of promoting the long-term energy storage development that will be needed to support the nation's accelerating transition to a carbon-free, sustainable energy system.

II. ANALYZING THE GAPS IN LONG-TERM ENERGY STORAGE POLICIES

A few specific factors have contributed to the relatively slow pace of long-term energy storage development in the United States over the past

107. *Id.*

108. *New York Announces \$280 Million Available for Energy Storage Projects*, T&D WORLD: DISTRIBUTED ENERGY RES.: ENERGY STORAGE (May 1, 2019), <https://www.tdworld.com/distributed-energy-resources/energy-storage/article/20972530/new-york-announces-280-million-available-for-energy-storage-projects>.

109. *Id.*

110. Thomas Overton, *SDG&E Unveils World's Largest Li-Ion Storage Battery*, POWERMAG: ENERGY STORAGE (Feb. 24, 2017), <https://www.powermag.com/sdge-unveils-worlds-largest-li-ion-storage-battery/>.

111. *Id.*

112. Revesz & Unel, *supra* note 94, at 169.

few decades. In particular, existing market structures often fail to fully compensate producers for the unique benefits long-term energy storage provides.¹¹³ Long-term energy storage projects involve comparatively high investment risks, and the high capital costs of these projects create barriers to entry that further deter private investment.¹¹⁴ Recognizing these factors is an important first step towards addressing them and ultimately accelerating the growth of the long-term energy storage industry over the coming years.

A. Under-internalization of Long-Term Energy Storage Benefits

Externality problems, both negative and positive, are partly to blame for the nation's comparatively slow long-term energy storage development. Negative externality problems arise when actors do not internalize all the costs of a particular activity, leading to over-engagement in it.¹¹⁵ For instance, when a coal plant burns coal—a form of chemical energy storage—that combustion process results in emissions of sulfur dioxide, nitrous oxide, and carbon dioxide.¹¹⁶ The process imposes substantial environmental and health costs borne by parties other than coal plant operators or owners.¹¹⁷ Because they do not bear all of these external costs, rational and self-interested coal plant operators are incentivized to engage in sub-optimally high levels of coal-fired power generation.¹¹⁸ The electricity industry's long-standing strategy of relying heavily on inventories of coal as a primary means of storing energy for future use results in environmental and health costs that coal-fired power generators do not fully internalize in many jurisdictions.¹¹⁹

A positive externality problem also exists in the context of long-term energy storage because some of the unique benefits of long-term storage

113. Lawrence Wai-chung Lai, *'The Problem of Social Cost': The Coase Theorem and Externality Explained: Using Simple Diagrams and Examples to Illustrate the Role of Land Use Planning in Tackling Externalities*, 78 TOWN PLANNING REV. 335, 344 (2007).

114. DHARUV BHATNAGAR ET AL., MARKET AND POLICY BARRIERS TO ENERGY STORAGE DEPLOYMENT 21–34 (2013).

115. Wai-chung Lai, *supra* note 113, at 344.

116. Patrick Charles McGinley, *Climate Change and the War on Coal: Exploring the Dark Side*, 13 VT. J. ENV'T L. 255, 278 (2011).

117. Xinming Du et al., *Transboundary Air Pollution from Coal-Fired Power Generation*, 270 J. ENV'T MGMT. 1, 2 (2020) ("Coal was also estimated to have produced 77% of SO emissions from fossil fuel-burning power plants, 75% of nitrous oxide emissions, and 73% of carbon dioxide emissions.").

118. McGinley, *supra* note 116, at 278.

119. *Id.* at 324.

are not presently accounted for and rewarded in most markets.¹²⁰ This leads to under-investment in new long-term energy storage development.¹²¹ Positive externalities arise when actors do not internalize all the benefits of a particular activity, leading to under-engagement in it.¹²² For example, individuals who receive a vaccination benefit not only benefit themselves but also benefit society by reducing the risk of further transmission.¹²³ Absent government intervention, the fact that individuals do not recognize all the broader societal benefits of getting vaccinated tends to lead to sub-optimally low vaccination rates.¹²⁴

Considering these market failures, government interventions that compel or enable energy industry stakeholders to internalize more of the costs and benefits of their actions are needed to bring long-term energy storage development investment to more optimal levels.¹²⁵ Today's U.S. energy industry relies heavily on coal, oil, and natural gas—carbon-rich substances packed with chemically stored energy—to store energy for future use.¹²⁶ These fossil fuels are fairly easy to extract and stockpile to burn at later times when additional energy is needed at a low cost.¹²⁷ A basic way to encourage energy industry actors to transition away from these socially costly energy storage strategies could be to implement policies that require industry actors to internalize more of the broader social costs of this practice. For instance, a tax on burning fossil fuels or other carbon-based energy sources could lead to more efficient levels of this activity by compelling actors to internalize more of the societal costs associated with it.¹²⁸

Conversely, policies designed to allow long-term energy storage facility owners to internalize more of the unique, broader benefits of their

120. Susannah Maltz, *Rights in Common: A Deconstruction of Political Speech, Agency Fee Structure, and The Union as Commons After Janus v. AFSCME*, 21 CUNY L. REV. 285, 316 (2018).

121. Ian Oxenham, *Charging Onwards: Removing Barriers to Energy Storage in Restructured New England States*, 43 VT. L. REV. 575, 611 (2019).

122. Maltz, *supra* note 120, at 316.

123. FE Andre et al., *Vaccination Greatly Reduces Disease, Disability, Death and Inequity Worldwide*, BULLETIN OF THE WORLD HEALTH ORG. 140, 143 (Feb. 2008) <https://www.who.int/bulletin/volumes/86/2/07-040089.pdf>.

124. COREY WHITE, MEASURING THE SOCIAL AND EXTERNALITY BENEFITS OF THE INFLUENZA VACCINE 1 (2018).

125. Kevin Counsell, *Privacy Versus Views: A Law and Economics Approach to Balancing Conflicting Urban Values*, 22 N.Z. J. ENV'T L. 147, 147, 163 (2018).

126. John B. Goodenough, *Electrochemical Energy Storage in a Sustainable Modern Society*, 7 ENERGY & ENV'T SCI. 14, 14 (2014).

127. *Id.*

128. GILBERT E. METCALF, PAYING FOR POLLUTION: WHY A CARBON TAX IS GOOD FOR AMERICA 45 (2018).

operations could lead to more optimal levels of investment in their development.¹²⁹ For instance, increasing long-term energy storage capacity can: (1) improve grid reliability; (2) provide critical temporary backup energy supplies for emergency use; and (3) mitigate challenges associated with some renewable energy sources' intermittency.¹³⁰ At least some of these unique broader societal benefits are not as available through short-term energy storage, and yet, they are not fully accounted for in existing policies. This contributes to sub-optimally low levels of investment.¹³¹ Tax credit programs, targeted grant programs, and other policies that enable long-term energy storage project developers and owners to internalize more of these unique benefits could help address this underinvestment problem.¹³² Some programs could act as a Pigouvian Subsidy, seeking to promote more optimal levels of long-term energy storage development that better reflect its distinct value to society and to the broader energy.¹³³

*B. Reducing Investment Risks for Long-Term
Energy Storage Development*

Another obstacle to the advancement, and deployment, of long-term energy storage technologies is the relatively high investment risk associated with many types of long-term energy storage development.¹³⁴ Introducing new policies aimed at better mitigating these risks could be another potential way of accelerating long-term energy storage development.¹³⁵

Many long-term energy storage strategies are relatively new and unproven, making them an inherently riskier investment than many other types of investments. As discussed above, the most well-established types of long-term energy storage are presently pumped hydro facilities and lithium-ion battery systems. However, both strategies suffer major geographical or cost constraints. Other potential long-term energy storage technologies are unproven and plagued by investment

129. Revesz & Unel, *supra* note 94, at 180–83.

130. *See id.* at 147–48 (explaining the multiple ways energy storage systems can optimize supply).

131. *Id.* at 167–68.

132. Morgan Lewis, *Are Investment Tax Credit Changes in Store for Energy Storage?*, JD SUPRA (June 15, 2021), <https://www.jdsupra.com/legalnews/are-investment-tax-credit-changes-in-8883438/>.

133. Lisa Grow Sun & Brigham Daniels, *Mirrored Externalities*, 90 Notre Dame L. Rev. 135, 170–71 (2014).

134. *Id.* at 82.

135. *Id.*

uncertainty.¹³⁶ Such uncertainty tends to lead to under-investment and tepid growth,¹³⁷ and policy uncertainty related to these technologies has also contributed to the slow advancement of long-term energy storage.¹³⁸ Policies that mitigate either of these types of uncertainty could further help to accelerate U.S. long-term energy storage development.

C. Lowering Barriers to Entry in the Long-Term Energy Storage Industry

Unusually high barriers to entry, due to the inherently large size of many types of long-term energy storage facilities, may also be contributing to the slow growth in development of these projects.¹³⁹ These barriers exist for three reasons: novelty, high capital costs, and the lack of an adequate policy structure focused on long-term energy storage and investment risks.¹⁴⁰ By contrast, short-term energy storage developers do not face similar barriers to entry because most short-term energy storage projects do not match long-term projects in size, budget, or minimum scale.¹⁴¹ For example, lithium-ion batteries are currently a popular source of energy storage.¹⁴² Accordingly, potential developers tend to need far less capital for typical short-term energy storage projects.¹⁴³ This makes it comparatively more difficult for long-term energy storage developers to enter these markets and compete.¹⁴⁴

136. Jacques-Bernard Sauner-Leroy, *Managers and Productive Investment Decisions: The Impact of Uncertainty and Risk Aversion*, 42 J. SMALL BUS. MGMT. 1, 13 (2004) (discussing investment risk).

137. LUKE C.D. STEIN & ELIZABETH STONE, THE EFFECT OF UNCERTAINTY ON INVESTMENT, HIRING, AND R&D: CAUSAL EVIDENCE FROM EQUITY OPTIONS 1 (2013) (on file with Arizona State University) (discussing how uncertainty has been found to depress capital investment).

138. Merrill Jones Barradale, *Impact of Public Policy Uncertainty on Renewable Energy Investment: Wind Power and the Production Tax Credit*, 38 ENERGY POL'Y 7698, 7700 (2010) ("The wind industry experienced a 'boom-bust' cycle as there would be an increase in wind plant production during times of production tax credits, and a sharp decrease during the expiration of those credits.").

139. Iordanis M. Eleftheriadis & Evgenia G. Anagnostopoulou, *Identifying Barriers in the Diffusion of Renewable Energy Sources*, 80 ENERGY POL'Y 153, 163 (2015).

140. Edward Peter Stringham et al., *Overcoming Barriers to Entry in an Established Industry: Tesla Motors*, 4 CAL. MGMT. REV. 85, 86 (2015) (expressing that it is similar to the barriers to entry in the electric car industry).

141. *See Id.* (describing the cost of lithium-ion battery energy storage).

142. MAMDOUH EL HAJ ASSAD & MARC. A ROSEN, DESIGN AND PERFORMANCE OPTIMIZATION OF RENEWABLE ENERGY SYSTEMS Ch. 14 (Mamdouh El Haj Assad & Marc A. Rosen eds. 2021).

143. *See* K. Mongird et al., *Energy Storage Technology and Cost Characterization Report*, U.S. DEP'T OF ENERGY (2019), <https://energystorage.pnnl.gov/pdf/PNNL-28866.pdf> (comparing multiple examples of performance improvement forecasts).

144. *Id.* at 8 (The projected cost of a lithium-ion energy storage project is projected at \$362/kWh in the year 2025. However, in order to meet the demands and services of long-term energy storage, the

Policies designed to remove or lower such barriers to entry into long-term energy storage development markets could do much more to increase competition and overall investment, thereby driving more rapid expansion and maturation of these markets.

III. ACCELERATING THE LONG-TERM ENERGY STORAGE BUILDOUT

Although the U.S. long-term energy storage industry has, before now, faced numerous obstacles to its growth, there are policy strategies with the capability of addressing these challenges.¹⁴⁵ The policies also unleash much more rapid long-term energy storage growth.¹⁴⁶ Research grant programs specifically targeting long-term energy storage innovation could help to accelerate investment in the research needed to speed up the maturity of these technologies, just as they have with other ventures. Policies focused on monetizing the unique capabilities and value of long-term energy storage within relevant markets could address positive externality problems limiting development. Energy storage investment tax credits and energy storage loan guarantees could reduce investment risks for long-term energy storage projects, lower barriers to entry, and further overcome these externality problems.¹⁴⁷ Additionally, long-term energy storage portfolio standards at the state level could generate additional market demand for long-term energy storage projects, helping to accelerate the pace of such developments.¹⁴⁸

A. Targeted Research Grants

Expanding grant programs targeted at long-term energy storage research could be one way for the federal government to accelerate innovation in long-term energy storage markets. The U.S. Department of Energy (DOE) uses various grant programs to incentivize and subsidize

capacity must be exponentially larger into multiple MW's. This increase in necessary capacity increases the overall size of the project and results in a larger overall cost as compared to even short-term energy storage.).

145. See generally, *Energy Dep't Grants & Funding*, FED. REG., <https://www.federalregister.gov/energy-department-grants-funding> (last visited Mar. 17, 2021) (listing the various energy grant and funding opportunities).

146. Mongird et al., *supra* note 143.

147. Patrick Lam & Angel Law, *Financing for Renewable Energy Projects: A Decision Guide by Developmental Stages with Case Studies*, 90 RENEWABLE & SUSTAINABLE ENERGY REV. 937, 938 (2018).

148. Anthony E. Chavez, *Using Renewable Portfolio Standards to Accelerate Development of Negative Emissions Technologies*, 43 WM. & MARY ENV'T L. & POL'Y REV. 1, 9 (2018).

certain energy-related research.¹⁴⁹ Such programs can be well structured to be accessible to businesses, non-profit organizations, and research institutions that may have difficulty receiving funding through other sources.¹⁵⁰ For instance, the DOE's Energy Storage Grant Challenge aims to position the U.S. as a world leader in energy storage and has invested \$7.6 million in energy storage research.¹⁵¹ Unfortunately, grant programs for long-term energy storage research are slow to materialize; most research funding is allocated to short-term storage projects.¹⁵² Expanding and more narrowly targeting these grant programs to promote long-term energy storage would help to address this funding gap and accelerate innovation related to long-term storage technologies. The DOE has the resources and authority to create such targeted research grant programs for long-term energy storage.¹⁵³ As of February 2021, the DOE had not allocated \$27.5 billion of its \$66.5 billion budget.¹⁵⁴ Based on future cost estimates, it would be much more worthwhile for research grant funding to go to long-term energy storage projects than short-term projects.¹⁵⁵ Such research grants would create a viable option for investors and research institutions to break into the long-term energy storage market.

B. Long-Term Energy Storage Investment Tax Credits

Another policy strategy for incentivizing investment in long-term energy storage development is to enact tax credit programs and other policies. These policies better compensate developers for the unique

149. *Id.* at 39.

150. *Grant Eligibility*, GRANTS.GOV, <https://www.grants.gov/web/grants/learn-grants/grant-eligibility.html> (last visited Jan. 30, 2022).

151. *DOE Invests Nearly \$7.6 Million to Develop Energy Storage Projects*, OFF. OF FOSSIL ENERGY (Dec. 22, 2020), <https://www.energy.gov/fecm/articles/areas-interest-doe-invests-nearly-76m-develop-energy-storage-projects>.

152. Andy Colthorpe, *\$1.3 Billion Funding Proposed for U.S. energy Storage R&D, Demonstrations, and Manufacturing*, ENERGY STORAGE NEWS (2020), <https://www.energy-storage.news/news/us1.3-billion-funding-proposed-for-us-energy-storage-rd-deployment-manufact> (In 2020 a subcommittee of the U.S. House Appropriations Committee approved a bill allowing research grants for the development of new energy storage technologies and advancements to help reliability on the grid).

153. Chavez, *supra* note 148.

154. *Status of Funds*, DEPARTMENT OF ENERGY BUDGETARY RESOURCES, <https://www.usaspending.gov/agency/930> (stating that the U.S. Department of Energy has \$65.5 Billion in budgetary resources and as of February 28, 2021 they have only obligated \$26.5 Billion of that total budget) (last visited Feb. 2, 2021).

155. Mongird et al., *supra* note 143 (estimating that by the year 2025, the total project cost for lithium-ion battery storage will be \$362/kWh).

benefits that long-term energy storage capacity provides. Today's energy storage markets, which focus primarily on short-term energy storage, arguably fail to account for these distinct benefits.¹⁵⁶ Thus, the markets under-incentivize private investment in long-term energy storage development.¹⁵⁷ This market failure results because long-term energy storage providers are unable to internalize all the benefits of their products, leading to sub-optimally low investment in long-term energy storage.¹⁵⁸ Introducing a new federal tax credit program specifically targeting long-term energy storage development would be a straightforward way to help mitigate this problem.

Long-term energy storage capacity provides several specific benefits that short-term energy storage cannot. One of these benefits is greater grid resiliency against prolonged disruptive events.¹⁵⁹ The days-long backup energy supplies available through long-term energy storage capacity can help prevent brownouts and other power outages during disasters, potentially avoiding billions of dollars in monetary losses each year and even sparing lives.¹⁶⁰ During prolonged spikes in wholesale electricity prices, long-term storage capacity can also help utilities access the banked energy.¹⁶¹ The increased storage saves millions of dollars in expenses that the utilities will later pass along to retail customers through rate adjustments.¹⁶² Like short-term storage facilities, long-term energy storage systems can also provide valuable ancillary grid management services, such as frequency response, voltage support, and spinning.¹⁶³ FERC has recently made it possible for long-term energy storage providers to enter the markets for these services.¹⁶⁴ The possibilities create new market opportunities that could expand through additional incentives and programs.¹⁶⁵

156. Andy Colthorpe, *US Department of Energy: Cost Reduction Target of 90% by 2030 Set for Long-Duration Energy Storage*, ENERGY STORAGE NEWS (July 14, 2021), <https://www.energy-storage.news/us-department-of-energy-cost-reduction-target-of-90-by-2030-set-for-long-duration-energy-storage/>.

157. Jeremy Richardson, *How to Ensure Energy Storage Policies Are Equitable*, UNION OF CONCERNED SCIENTISTS (Nov. 19, 2019), <https://ucsusa.org/resources/equitable-energy-storage>.

158. Ramteen Sioshansi et al., *Market and Policy Barriers to Deployment of Energy Storage*, 2 ECON. ENERGY & ENV'T POL'Y. 47, 49 (2012).

159. Revesz & Unel, *supra* note 94, at 147–49.

160. *Id.* at 149.

161. Colthorpe, *supra* note 156.

162. ADITYA MISHRA ET AL., SCALING DISTRIBUTED ENERGY STORAGE FOR GRID PEAK REDUCTION, e-Energy 13 (2013).

163. Revesz & Unel, *supra* note 94, at 148.

164. Colthorpe, *supra* note 156.

165. Sepulveda, *supra* note 70.

Congress could easily reform existing energy incentive policies to reward long-term energy storage developers more fully with the unique additional benefits of these services. Congress would be able to provide for this through investment tax credits.¹⁶⁶ Investment tax credit programs allow taxpayers that expend funds on specific qualifying activities to reduce their tax liability by amounts based on the magnitude of those investments.¹⁶⁷ In recent years, the federal government has offered investment tax credits of up to 30% for qualifying investments in solar energy development.¹⁶⁸ Investment tax credits can act as a type of Pigouvian Subsidy to subsidize an activity that would otherwise suffer from under-investment due to positive externality problems such as those plaguing the long-term energy storage industry.¹⁶⁹

Congress would need to create a new federal investment tax credit program targeted at long-term energy storage. This targeted credit could be made available only for long-term energy storage systems and facilities—those with the capacity to store energy in excess of 24 hours. As it has done in the past for the Solar Investment Tax Credit,¹⁷⁰ Congress could likewise set forth a phase-out period for this long-term energy storage credit program that gradually reduced the amount of credit over several years.¹⁷¹ This phase-out approach is generally preferred over a single program termination date because it allows the industry to adjust to scaled-back government support over time as the industry matures.¹⁷² Congress would have the power to adjust this phase-out schedule as needed in future years to help maintain desired levels of long-term energy storage investment.¹⁷³

166. Colthorpe, *supra* note 156.

167. 26 U.S.C. § 48.

168. Stephen Comello & Stefan Reichelstein, *The U.S. Investment Tax Credit for Solar Energy: Alternatives to the Anticipated 2017 Step-down*, 55 RENEWABLE & SUSTAINABLE ENERGY REV. 591, 591 (2016).

169. Gregmar I. Galinato & Jonathan Y. Yoder, *An Integrated Tax-Subsidy Policy for Carbon Emission Reduction*, 32 RES. & ENERGY ECON. 310, 311 (2010).

170. The solar investment tax credit was extended to its current form where there will be a step down from 30% to 22% and so on until it eventually reaches 0%. The extension was necessary as George Washington University Solar Institute projected data that without the extension, utility-scale solar projects would have declined 100%. *ITC Step Down: Understanding Solar Federal Tax Credits*, THE URBAN GRID (June 18, 2019), <https://www.urbangridsolar.com/itc-step-down-understanding-solar-federal-tax-credits/>.

171. Lewis, *supra* note 132.

172. Girish Upreti et al., *Impacts of the American Recovery and Reinvestment Act and the Investment Tax Credit on the North American Non-Automotive PEM Fuel Cell Industry*, 41 INT'L J. HYDROGEN ENERGY 3664, 3674 (2016).

173. Lewis, *supra* note 132.

C. Federal Loan Guarantees

A new federal loan guarantee program could also accelerate utility-scale, long-term energy storage development by improving developer access to capital and helping to lower the barriers to entry associated with these large projects. Federal loan guarantee programs can reduce a private lender's risks associated with helping to finance new types of development.¹⁷⁴ In 2019, \$1.4 trillion of the \$1.5 trillion in federally provided credit assistance took the form of loan guarantees.¹⁷⁵ The availability of a federal loan guarantee makes private lenders more willing to provide financing, which can be crucial in the context of large long-term energy storage projects.¹⁷⁶ This increased access to capital could help drive increased investment activity within the long-term energy storage development industry.¹⁷⁷ There are examples of loan-guaranteed solar ventures that failed and cost the government millions of dollars.¹⁷⁸ However, loan guarantees have proven to be a successful tool in accelerating solar industry development and innovation in the U.S.¹⁷⁹

Congress could create a program for long-term energy storage development like it did for the solar industry's 2009 American Recovery and Reinvestment Act's Section 1705 loan guarantee program.¹⁸⁰ The DOE administered Section 1705, and under the program, the federal government guaranteed \$16.15 billion in loans for renewable energy projects.¹⁸¹ Of that \$16.15 billion, \$13.27 billion in guaranteed loans were for solar projects.¹⁸² A detailed application process and clear eligibility guidelines could help ensure a new loan guarantee program

174. *Id.*

175. Natalie Bachas et al., *Loan Guarantees and Credit Supply*, 139 J. FIN. ECON. 872, 872 (2020).

176. *Id.* at 894.

177. Qigui Liu et al., *To What Extent Did the Economic Stimulus Package Influence Bank Lending and Corporate Investment Decisions?*, 86 J. BANKING & FIN. 177, 178–79 (2018).

178. Jeff Brady, *After Solyndra Loss, U.S. Energy Loan Program Turning a Profit*, NPR (Nov. 13, 2014), <https://www.npr.org/2014/11/13/363572151/after-solyndra-loss-u-s-energy-loan-program-turning-a-profit> (last visited Feb. 2, 2021) (U.S. government had to pay out \$535 million in loan guarantees to the failure of the solar project Solyndra).

179. *Key Facts: Solyndra Solar*, DEP'T OF ENERGY, <https://www.energy.gov/key-facts-solyndra-solar> (last visited Feb. 2, 2021) (Loan guarantees from the Department of Energy now have forty successful solar projects and 60,000 people employed).

180. PHILLIP BROWN, R42059, CONG. RSCH. SER., SOLAR PROJECTS: DOE SECTION 1705 LOAN GUARANTEES 1 (2011).

181. *Id.*

182. *Id.*

that specifically targets long-term energy storage rather than short-term energy storage development.¹⁸³ Such a program would lower barriers to entry into these markets and help address the obstacle of high investment risk that currently constrains growth in the long-term energy storage development industry.

D. Long-Term Energy Storage Portfolio Standard Carve-outs

At the state government level, one other potential strategy for driving long-term energy storage growth is the introduction of energy storage portfolio standards with special carve-out provisions requiring utilities to steadily increase their long-term energy storage capacity. State-level renewable portfolio standards have been tremendously influential in driving renewable energy development across much of the U.S.¹⁸⁴ These standards require regulated electric utilities to procure certain percentages of their electric power from qualifying renewable energy sources.¹⁸⁵ Some standards feature additional “carve-out” provisions requiring that specific minimum percentages of renewable energy production are obtained from rooftop solar, wind, or other sources.¹⁸⁶ These policies create additional market demand, helping to drive investment in these new technologies.¹⁸⁷ Renewable portfolio standards have especially benefited the U.S. wind¹⁸⁸ and solar¹⁸⁹ industries in recent years.

California set a goal of installing 1 GW of energy storage by the year 2026.¹⁹⁰ This has already led to Southern California Edison announcing contracted projects for 770 MW of primary solar-paired energy storage

183. See FED. REG., *supra* note 145 (explaining factors the Department of Energy looked at before granting a loan guarantee and the timeline associated with granting the loan guarantee).

184. Vicki Arroyo et al., *State Innovation on Climate Change: Reducing Emissions from Key Sectors While Preparing for a “New Normal,”* 10 HARV. L. & POL’Y REV. 385, 398 (2016).

185. Corey N. Allen, *Untapped Renewable Energy Potential: Lessons for Reforming Virginia’s Renewable Energy Portfolio Standard from Texas and California*, 35 VA. ENV’T L.J. 117, 120 (2016).

186. U.S. ENV’T PROT. AGENCY, ENERGY AND ENV’T GUIDE TO ACTION 5-10 (2015).

187. *Id.* at 5.

188. By 2016, seventy-nine percent of wind power additions either were in RPS states but exceeded RPS mandates or were installed in non-RPS states. RYAN WISER & MARK BOLINGER, WIND TECHS. MKT. REP. 67 (2016).

189. In 2016, solar accounted for seventy-nine percent of all new builds for renewables under an RPS. GALEN BARBOSE, U.S. RENEWABLES PORTFOLIO STANDARDS: 2017 ANN. STATUS REPORT 6 (2017).

190. Spector, *supra* note 69.

to meet regional needs.¹⁹¹ However, even California's goal does not have a carve-out provision aimed specifically at long-term storage. Moreover, most states in the U.S. presently have no portfolio standards relating to energy storage.¹⁹² Adding such standards and including long-term energy storage carve-out provisions in them could be another impactful way to hasten the pace of this increasingly important type of energy development.

CONCLUSION

As intermittent renewable energy sources comprise an increasing share of the nation's energy mix, long-term energy storage capacity will need to greatly expand to help ensure the lights stay on—even when it is not windy, or the sun is not shining. As climate change causes extreme weather events like those in California and Texas to become more common, greater long-term energy storage capacity could help limit the impacts of these growing threats to the resiliency of the nation's critically important electricity grid infrastructure. Sadly, the nation's existing policy regime is failing to generate the degree of private investment needed to ensure that adequate long-term energy storage capacity is in place to support the transition to a zero-carbon, fully sustainable energy system. Although policies adopted in recent years have accelerated short-term energy storage growth, long-term storage growth continues to lag and could hamper the nation's shift to renewable energy.

Fortunately, several policy strategies are available that have proven successful in other areas of energy policy and could provide the government assistance needed to drive rapid progress in the United States' long-term energy storage markets. By enacting targeted research grant programs, investment tax credits, federal loan guarantee programs, and state long-term energy storage portfolio standards, policymakers have an opportunity to facilitate a massive expansion of the nation's long-term energy storage industry and lay critical groundwork for a far more sustainable energy future.

191. Jeff St. John, *Southern California Edison Contracts Huge Storage Portfolio to Replace Gas Plants*, GREENTECH MEDIA (May 01, 2020), <https://www.greentechmedia.com/articles/read/southern-california-edison-picks-770mw-of-energy-storage-projects-to-be-built-by-next-year>.

192. See U.S. ENV'T PROT. AGENCY, *supra* note 186, at tbl. 5.1 (demonstrating that while there is a mandatory requirement for states to have energy storage standards, most states do not).

GROUNDWATER LAW, THE SAN LUIS VALLEY, AND CLIMATE CHANGE

*Rachel Grabenstein**

Introduction	181
A. Historical Context for San Luis Valley Voluntary Measures	185
I. Part I.....	188
II. Part II	193
A. Evolution and History of Water Self-governance in the Valley	193
B. Analysis of Self-governance Measures.....	197
III. Part III	205
Conclusion.....	208

INTRODUCTION

Ask anyone who lives in the Southwest, and they will tell you it has been a dry year—but that may just be the way the Southwest is now. The Southwest has been in a severe drought since 2000.¹ 2021 looks to be no different. In fact, 2021 may usher in a whole new level of drought never experienced before.² A sample of regional newspapers headlines include:

* J.D., University of New Mexico, 2022; B.S. Wildlife Biology, University of Montana, 2016. Many thanks to the editorial staff at the Vermont Journal of Environmental Law for all their hard work and to Tanner for his constant support.

1. *Climate Change Indicators: A Closer Look: Temperature and Drought in the Southwest*, EPA, <https://www.epa.gov/climate-indicators/southwest> (last visited Feb. 14, 2021) [hereinafter *Climate Change Indicators*]; Henry Fountain, *Southwest Drought Rivals Those of Centuries Ago, Thanks to Climate Change*, N.Y. TIMES (Apr. 16, 2020), <https://www.nytimes.com/2020/04/16/climate/drought-southwest-climate-change.html>.

2. Andrew Freedman & Hannah Dormido, *Drought is the Sleeper Weather Story You'll Hear More About in 2021*, WASH. POST (Jan. 7, 2021), <https://www.washingtonpost.com/weather/2021/01/07/drought-expands-north-america/?arc404=true>; Theresa Davis, *NM Water Managers Warn Communities to Prepare for Low Rio Grande*, ALBUQUERQUE J. (Jan. 31, 2021), <https://www.abqjournal.com/2354734/nm-water-managers-warn-communities-to-prepare-for-low-rio-grande.html>; *Contra* Climate Prediction Center Internet Team, *U.S. Seasonal Drought Outlook*, NAT'L WEATHER SERV. CLIMATE PREDICTION CTR, https://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.php (last visited Feb. 14, 2021) (stating that “[e]ntering into a climatologically wetter season for much of the west, coupled with the development of La Niña conditions, increases chances for improving drought conditions.”)).

“NM water managers warn communities to prepare for low Rio Grande”; “Winter recovering in Southwest Colorado, but intense drought lingers”; “Drought conditions expected to continue to worsen through spring months”; and “Upper Colorado River drought plan triggered for first time.”³

There is no denying that climate change is here. Climate change is and has been a well-accepted phenomenon in the scientific community for decades.⁴ In fact, “a vast region of the western United States, extending from California, Arizona and New Mexico north to Oregon and Idaho, is in the grips of the first climate change-induced megadrought observed in the past 1,200 years.”⁵

Climate change is no longer a hypothetical future—western communities experience unprecedented events related to wildfires and drought today.⁶ The Southwest is warmer.⁷ There is less precipitation, which falls in different places and at different times than it did historically.⁸

Communities are seeing their ways of life change completely due to climate change.⁹ Climate change prevents some indigenous communities from being able to perform traditional ceremonies.¹⁰ The looming water crisis has the ability to limit development and certain activities in arid states

3. Andrew Shipley, *Drought Conditions Expected to Continue to Worsen Through Spring Months*, VALLEY CENT. (Jan. 29, 2021), <https://www.valleycentral.com/weather/drought-conditions-expected-to-continue-to-worsen-through-spring-months/>; Davis, *supra* note 2; Luke Runyon, *Upper Colorado River Drought Plan Triggered for First Time*, KUNC (Jan. 20, 2021), <https://www.kunc.org/environment/2021-01-20/upper-colorado-river-drought-plan-triggered-for-first-time>; Jim Mimiaga, *Winter Recovering in Southwest Colorado, but Intense Drought Lingers*, THE JOURNAL (Feb. 4, 2021), <https://www.the-journal.com/articles/winter-recovering-in-southwest-colorado-but-intense-drought-lingers/>; Luke Runyon, *Upper Colorado River Drought Plan Triggered for First Time*, KUNC (Jan. 20, 2021), <https://www.kunc.org/environment/2021-01-20/upper-colorado-river-drought-plan-triggered-for-first-time>.

4. *Do Scientists Agree on Climate Change?*, NASA, <https://climate.nasa.gov/faq/17/do-scientists-agree-on-climate-change/> (last visited Feb. 14, 2021).

5. Becky Bollinger & Andrew Freedman, *Historic Drought Deepens in the West as Window for Rain, Snow Closes*, WASH. POST (Mar. 3, 2021), <https://www.washingtonpost.com/weather/2021/03/03/drought-worsens-west/>.

6. Andrew Freedman & Darryl Fears, *The Western U.S. is Locked in the Grips of the First Human-caused Megadrought, Study Finds*, WASH. POST (Apr. 15, 2020), <https://www.washingtonpost.com/weather/2020/04/16/southwest-megadrought-climate-change/>; Fountain, *supra* note 1.

7. *Climate Change Indicators*, *supra* note 1.

8. CLIMAS, *Climate Change in the Southwest*, UNIV. ARIZ., <https://climas.arizona.edu/sw-climate/climate-change-southwest> (last visited Nov. 22, 2021).

9. Lauren Paskus, *Climate Report Details Deep Hits to the Southwest*, HIGH COUNTRY NEWS (Nov. 26, 2018), <https://www.hcn.org/articles/climate-change-the-fourth-national-climate-assessment-details-deep-hits-to-the-southwest>.

10. Anna V. Smith, *Ongoing Fish Kill on the Klamath River is an “Absolute Worst-Case Scenario*, HIGH COUNTRY NEWS (May 27, 2021), <https://www.hcn.org/issues/53.7/indigenous-affairs-fish-ongoing-fish-kill-on-the-klamath-river-is-an-absolute-worst-case-scenario>.

like Arizona.¹¹ Farmers are altering their practices in response to the changing climate.¹² Hurricanes and wildfires have destroyed communities and will likely continue to do so, making return impossible for some communities after such disasters.¹³ The impacts of climate change are being felt now.

One resource is particularly impacted by climate change: water. Much has been written about the relationship between water and climate change.¹⁴ It is hard to ignore this relationship for several reasons. First, dry rivers or *bathtub rings* in low-level reservoirs are visually striking and difficult to ignore. Second, communities in the United States have started to feel and experience the impacts of climate change on their water resources.¹⁵

A notorious example of climate change's impact on a community's water resources occurred in California during the 2015 drought. That was the first year the State of California implemented mandatory water restrictions.¹⁶ Those restrictions required California water agencies "to cut their output by 25 percent or face fines of up to \$10,000 per month."¹⁷ In an effort to reduce use, water agencies asked homeowners to water their lawns and wash their cars less.¹⁸ Homeowners who failed to comply could be fined.¹⁹ Additionally, large landscapes like golf courses and cemeteries had to stop water use immediately.²⁰

11. Sarah Tory, *Rapid Growth in Arizona's Suburbs Bets Against an Uncertain Water Supply*, HIGH COUNTRY NEWS (June 1, 2021), <https://www.hcn.org/issues/53.6/south-water-rapid-growth-in-arizonas-suburbs-bets-against-an-uncertain-water-supply>.

12. Meera Subramanian, *The Flash Drought Brought Misery, But Did it Change Minds on Climate Change?*, HIGH COUNTRY NEWS (July 17, 2018), <https://www.hcn.org/articles/climate-change-the-flash-drought-brought-misery-but-did-it-change-minds-on-climate-change>.

13. Piper McDaniel, *After the Camp Fire, Paradise is still home*, HIGH COUNTRY NEWS (Apr. 6, 2020), <https://www.hcn.org/articles/south-wildfire-after-the-camp-fire-paradise-is-still-home>.

14. Michael Dettinger et al., *Western Water and Climate Change*, 25 ECOLOGICAL APPLICATIONS 2069, 2069 (2015); Kenneth D. Frederick & David C. Major, *Climate Change and Water Resources*, in 37 CLIMATE CHANGE 7, 7 (1997).

15. Dettinger et al., *supra* note 14, at 2078.

16. Darryl Fears, *As Water Runs Dry, Californians Brace for a New Way of Life*, WASH. POST (Apr. 4, 2015), https://www.washingtonpost.com/national/health-science/as-water-runs-dry-californians-brace-for-a-new-way-of-life/2015/04/04/f1ebb4ba-daba-11e4-b3f2-607bd612aeac_story.html.

17. *Id.*

18. *Id.*

19. *Id.*

20. *Id.*; Darryl Fears, *Calif. Governor Orders Statewide Mandatory Water Restrictions*, WASH. POST (Apr. 1, 2015), https://www.washingtonpost.com/national/health-science/calif-governor-orders-statewide-mandatory-water-restrictions/2015/04/01/3495867a-d89e-11e4-8103-fa84725dbf9d_story.html.

It was clear during the 2015 California drought that surface water was either unavailable or available in much lower amounts than usual.²¹ Surface water includes all above-ground water sources like in rivers, lakes, and oceans.²² It is common during droughts and climatic events to focus on surface water because it is the most visible resource.²³ Therefore, most of the discussions in the United States regarding climate change and water relate to surface water.²⁴

However, there is another water source impacted by climate change that does not receive comparable attention: groundwater. Groundwater is also of particular significance for the United States because it “constitutes about 22% of the nation’s fresh water supply” and “about one-half of the population of the United States relies on groundwater as its primary source of drinking water.”²⁵ But because groundwater is underground, as the saying goes, it is often out of sight and out of mind. However, in times of drought and crisis, groundwater is the resource that everyone relies upon.²⁶

Most legal research and analysis in the United States focuses on surface water.²⁷ There has been less of a focus on groundwater.²⁸ Recent progress in legal research and analysis has focused on new groundwater laws or climate change adaptations.²⁹

Conjunctive management, or the “coordinated use of surface water and groundwater,” is one of the best paths forward to deal with climate change.³⁰

21. See Zoe Meyers, *Millions in Debt, a Community Wonders if its Water Source will Provide*, HIGH COUNTRY NEWS: WORTH OF WATER (Dec. 8, 2015), <https://www.hcn.org/articles/worth-of-water-mountain-house-drought-california-debt> (showing how the California drought in 2015 has diminished irrigation from surface water and how that has impacted residents).

22. *Surface Water*, USGS DICTIONARY OF WATER TERMS, https://www.usgs.gov/special-topic/water-science-school/science/dictionary-water-terms?qt-science_center_objects=0#qt-science_center_objects (last visited Nov. 11, 2021) (Definition of surface water).

23. *Drought and Climate Change*, CTR. FOR CLIMATE & ENERGY SOLS., <https://www.c2es.org/content/drought-and-climate-change/> (last visited Jan. 29, 2022).

24. See *Generally* BUREAU OF RECLAMATION, LITERATURE SYNTHESIS ON CLIMATE CHANGE IMPLICATIONS FOR WATER AND ENVIRONMENTAL RESOURCES (3rd ed. 2013) (suggesting that surface water is discussed more than other types of water regarding climate change).

25. *Id.*

26. ANTHONY DAN TARLOCK & JASON ANTHONY ROBISON, LAW OF WATER RIGHTS AND RESOURCES §4:4 (2020 ed.).

27. Robin Kundis Craig, *Water Law and Climate Change in the United States: A Review of the Scholarship* (Jan. 2, 2020) (research paper No. 357, available on the Utah Law Digital Commons), <https://dc.law.utah.edu/scholarship/186/>.

28. *Id.*

29. *Id.*

30. *Conjunctive Use, WATER EDUC. FOUND.*, <https://www.watereducation.org/aquapedia/conjunctive-use> (last visited Nov. 9, 2021); See Brian E. Gray, *Global Climate Change: Water Supply Risks and Water Management Opportunities*, 14 HASTINGS

However, there has been little focus on the “traditional groundwater legal regimes as a climate change issue.”³¹

This paper explores how climate change and the current groundwater legal regimes interact in Colorado’s San Luis Valley (Valley). The Valley was chosen as a case study because it is an example of a community that introduced voluntary measures to address the overuse of groundwater. This paper examines how those measures might have been sufficient if not for the additional challenge of climate change.

This paper will first explain the history of water management in the Valley. This paper will then provide a brief overview of groundwater hydrology and groundwater law in Colorado. Next, it will explain how voluntary water management developed in the Valley. Then, the paper will analyze why the voluntary water management system is not adequate in light of climate change and argue that the time for binding enforcement measures is now. The paper concludes that, without institutional accountability, groundwater law and management practices will continue to struggle with climate change.

A. Historical Context for San Luis Valley Voluntary Measures

The Valley is located in Southern Colorado, extending briefly into Northern New Mexico. It is a valley surrounded by mountains, the San Juan to the west and the Sangre de Cristo range to the east. It is an area in which the primary economic income is derived from farming.³² The main crops are potatoes, barley, and alfalfa; all water intensive crops.³³ The valley has been consumed by a never-ending water saga.

The Valley does not receive much, if any, rainfall. It only receives about seven inches of rain per year on average.³⁴ So, where does the water that

W.-N.W. J. ENV’T. L. & POL’Y 1453, 1457 (2008) (explaining the impacts of climate change on the water supply and recommendations to mitigate those impacts); *See generally*, Justice Gregory J. Hobbs, Jr., *Protecting Prior Appropriation Water Rights Through Integrating Tributary Groundwater: Colorado’s Experience*, 47 IDAHO L. REV. 5, 11 (2010) (explaining conjunctive management and Colorado water law); John Hedges, *Currents in California Water Law: The Push to Integrate Groundwater and Surface Water Management Through the Courts*, 14 U. DENV. WATER L. REV. 375, 382 (2011).

31. Craig, *supra* note 27.

32. Carly Carswell, *Farmers Agree to Tax Those Who Deplete Groundwater*, HIGH COUNTRY NEWS (Feb. 25, 2013), <https://www.hcn.org/issues/45.3/conservative-farmers-agree-to-tax-those-who-deplete-groundwater>.

33. *Id.*

34. Paige Blankenbuehler, *After Years of Drought and Overuse, the San Luis Valley Aquifer Refills*, HIGH COUNTRY NEWS (May 26, 2016), <https://www.hcn.org/articles/after-years-of-drought-and-overuse-a-water-basin-refills-in-the-san-luis-valley>.

sustains the agricultural economy come from? Two places: (1) the Rio Grande River running through the Valley and (2) the two large aquifers that sit beneath the Valley.³⁵

Water issues in the Valley originate from the compact delivery obligations placed upon the Rio Grande. Under the Rio Grande Compact and an international treaty with Mexico, Colorado must send a certain amount of water downstream to New Mexico, Texas, and Mexico.³⁶ The water delivery requirement is legally binding and, therefore, enforceable upon violation.³⁷ Colorado first violated these delivery obligations when a drought struck the Valley in the 1950s.³⁸ This drought led to a rise in groundwater pumping which took water away from the Rio Grande.³⁹

After years of under-deliveries, Texas and New Mexico finally sued Colorado in 1966 for an “accumulated underdelivery of 944,000 acre-feet.”⁴⁰ To comply with these delivery obligations, Colorado shut down or greatly restricted Rio Grande (i.e., surface water) users.⁴¹ However, during this same time, well (i.e., groundwater) users faced no restrictions and continued pumping.⁴² The differences in treatment between surface and groundwater users lead to litigation.⁴³ Many users fell into both categories because farmers in the Valley historically used wells to supplement their surface water supplies.⁴⁴

In the 1970s, Colorado coordinated with the U.S. Bureau of Reclamation to develop the Closed Basin Project (CBP) to allocate water fairly between users.⁴⁵ The Closed Basin is a part of the Valley that is unconnected hydrologically to the Rio Grande.⁴⁶ There, water that flows into the Closed

35. Helen Smith, *San Luis Valley Water: Beneath the Surface*, ALAMOS NEWS (May 17, 2017), <https://alamosanews.com/article/san-luis-valley-water-beneath-the-surface>.

36. Rio Grande Compact, N.M.S.A. § 72-15-23 Art. II-III (1978).

37. NICOLE T. CARTER ET AL., CONG. RSCH. SERV., R45430, SHARING THE COLORADO RIVER AND THE RIO GRANDE: COOPERATION AND CONFLICT WITH MEXICO 5 (2018).

38. Kathleen A. Miller et. al., *Groundwater Rights in an Uncertain Environment: Theoretical Perspectives on the San Luis Valley*, 33 NAT. RES. J. 727, 748 (1993).

39. *Id.*

40. *Id.*

41. Carswell, *supra* note 32.

42. *Id.*

43. Carswell, *supra* note 32; G.E. RADOSEVICH & R.W. RUTZ, SAN LUIS VALLEY WATER PROBLEMS: A LEGAL PERSPECTIVE, COLO. WATER RES. RSCH. INST. 25–29 (1979).

44. See William A. Paddock, *Implementation of Integrated Surface and Groundwater Administration Under the 1969 Act in the Rio Grande Basin*, Water Division No. 3, 22 U. DENV. WATER L. REV. 247, 266 (2019) (explaining how the moratorium on issuing well permits impacted users depending on both confined and unconfined aquifers).

45. Carswell, *supra* note 32.

46. Paddock, *supra* note 44, at 250.

Basin does not enter the Rio Grande.⁴⁷ That is, *inter alia*, a reason why the Closed Basin water is excluded from the waters of the Rio Grande Compact.⁴⁸ The “lowest part of the Closed Basin is known . . . as the ‘sump.’”⁴⁹ The *sump* is an area where water pools and collects.⁵⁰ “There is no drainage from the basin and much of the water that flows into it is lost through evapotranspiration.”⁵¹

The CBP was an attempt to take advantage of this unused water and satisfy multiple stakeholders at once. The CBP works by using wells to pump and drain water out of the Closed Basin area.⁵² Then the “[w]ater salvaged from the . . . area is to be delivered to the Rio Grande River to help meet Colorado’s obligations to New Mexico and Texas under the Rio Grande Compact.”⁵³

The reasoning behind the CBP was that by tapping into a previously inaccessible water source for compact deliveries, compact delivery obligations could be satisfied and well pumping would not have to stop.⁵⁴ Thus, well users through the Valley could keep pumping because the compact deliveries would be satisfied by another source of water.⁵⁵

Unfortunately, the CBP never lived up to its promise. In the 1980s and 1990s it worked fairly well because there was plenty of precipitation and, therefore, multiple wet years.⁵⁶ Because of the ample precipitation, there was both enough water for well users to pump and enough surface water to meet delivery obligations.⁵⁷ However, the Closed Basin Project underdelivered.⁵⁸ This became a problem when drought struck the Valley in the early 2000s.⁵⁹

Because the Project always underdelivered, Colorado could no longer meet its delivery obligations when drought arrived.⁶⁰ As a result, there was not enough water available for both well users and surface water users to

47. *Id.* at 269–70; Carswell, *supra* note 32 (stating “streams don’t drain to the Rio Grande.”).

48. *Id.* at 252.

49. PHILIP A. EMERY, HYDROGEOLOGY OF THE SAN LUIS VALLEY, COLORADO – AN OVERVIEW AND A LOOK AT THE FUTURE I (1996).

50. *See generally* Paddock, *supra* note 44, at 251 (describing the *sump* in the Rio Grande Basin).

51. Wm. Joe Simonds, *The San Luis Valley Project*, U.S. BUREAU OF RECLAMATION (last updated Aug. 4, 2015), <https://www.usbr.gov/history/sanluisv.html>.

52. Paddock, *supra* note 44, at 250–51.

53. *Closed Basin Landowners Ass’n v. Rio Grande Water Conservation Dist.*, 734 P.2d 627, 629 (Colo. 1987).

54. Paddock, *supra* note 44, at 280–281; Carswell, *supra* note 32 (“The Closed Basin Project seemed like a win-win: Wells kept pumping, river irrigators got water, and regulators backed off.”).

55. Paddock, *supra* note 44, at 274.

56. Carswell, *supra* note 32.

57. *Id.*

58. *Id.*

59. Carswell, *supra* note 32; Paddock, *supra* note 44, at 295.

60. Carswell, *supra* note 32.

sustain use as before the drought struck.⁶¹ This led Colorado to cut off surface water users again while no limits were imposed on well users.⁶² Old fights rose anew. The modern-day struggles of water management in the Valley had begun—and they have not stopped since.

I. PART I

Groundwater hydrology and groundwater law will help people understand the Valley's issues. To that end, this section first discusses the hydrologic relationship between surface water and groundwater. It then provides a brief historical overview of the development of groundwater law in Colorado, before moving onto legal structures unique to the Valley.

The scientific definition of groundwater is water that “exists in saturated soils beneath the earth’s surface and in aquifers.”⁶³ Groundwater can be either a finite or a renewable source depending on where it is located.⁶⁴

The Valley has surface water and groundwater stored in aquifers.⁶⁵ “Aquifers are shallow and deep geologic formations” which store water underground.⁶⁶ They can either be confined or unconfined.⁶⁷ Water in a confined aquifer is trapped and cannot easily leave the aquifer.⁶⁸ This, in turn, creates constant pressure on the confined aquifer.⁶⁹

In contrast, an unconfined aquifer moves around easier, and the water table rises and falls subject to atmospheric pressure.⁷⁰ Unconfined aquifers “are usually closer to the Earth’s surface than confined aquifers are, and as such are impacted by drought conditions sooner than confined aquifers.”⁷¹

61. *Id.*

62. *Id.*

63. TARLOCK & ROBISON, *supra* note 26, at 179.

64. *Id.* at 180. Typically, an aquifer can be considered to be a renewable resource if it has a high rate of recharge and is sustainably managed. A high rate of recharge means there is a large amount of water entering the aquifer. To sustainably manage an aquifer, managers must not take out more water than goes into the aquifer on average. “Pumping that exceeds a safe or sustained yield is mining” and turns an aquifer into a non-renewable resource. Then, an aquifer does not have water coming in to replace how quickly the water is being removed. *Id.* at §4:5.

65. EMERY, *supra* note 49, at 3.

66. TARLOCK & ROBISON, *supra* note 26, at 179.

67. *Id.*

68. *What is the Difference Between a Confined and Unconfined (Water-Table) Aquifer?*, USGS, <https://www.usgs.gov/faqs/what-difference-between-confined-and-unconfined-water-table-aquifer#:~:text=A%20confined%20aquifer%20is%20an,the%20top%20of%20the%20aquifer> (last visited Jan. 29, 2022).

69. *Id.*

70. *Id.*

71. *See id.* (stating that water in unconfined aquifers is able to “rise and fall.”).

The Valley has both an unconfined and a confined aquifer.⁷² The unconfined aquifer sits on top of the confined aquifer.⁷³ Generally, the two different aquifers exchange some water.⁷⁴ However, the unconfined aquifer interacts closer with surface water uses than the confined aquifer does.⁷⁵

Confined aquifers are valuable because they are under constant pressure. Due to this pressure, when “the aquifer is first tapped . . . the cost of extraction is low.”⁷⁶ Confined aquifers are “classified as artesian” sources.⁷⁷ This classification as *artesian* made a difference because historically “groundwater was subdivided into three major arbitrary and unscientific categories: artesian, percolating, and underground watercourses.”⁷⁸ While groundwater laws in the United States have evolved over time, these classifications can still make a difference in how a particular type of groundwater is managed.

When water laws were developing, states, scientists, and lawyers did not have the technical understanding of groundwater that they do today.⁷⁹ Initially, it was thought that groundwater and surface water were two separate, distinct systems.⁸⁰ However, it is well known now that groundwater and surface water can be intimately related and are often the same system.⁸¹ Actions that affect groundwater also affect surface water and vice versa. For example, “[p]umping and withdrawal of groundwater supplies often diminishes surface water supplies, causing it to percolate in aquifers, while diversion of surface water often leads to depletion of groundwater supplies.”⁸² Conversely, “surface water levels may increase when groundwater use is restricted.”⁸³

Unfortunately, this historical misunderstanding of the relationship between surface water and groundwater resulted in the development of a complicated groundwater management system. The initial belief that surface

72. EMERY, *supra* note 49, at 3.

73. *Id.*

74. *Id.*

75. *Id.*

76. TARLOCK & ROBISON, *supra* note 26, at 179.

77. *Id.*

78. *Id.*

79. *Id.*

80. *Id.*

81. Ruopu Li et al., *Evaluating Hydrologically Connected Surface Water and Groundwater Using a Groundwater Model*, 52 J. AM. WATER RES. ASS’N 799, 799 (2016).

82. Allison Evans, *The Groundwater/Surface Water Dilemma in Arizona: A Look Back and a Look Ahead Toward Conjunctive Management Reform*, 3 PHOENIX L. REV. 269, 273 (2010).

83. *Id.*

and groundwater were two separate systems led many states to manage them under two distinct legal regimes as separate resources.⁸⁴

Historically, Colorado treated groundwater and surface water as two different resources.⁸⁵ Thus, initial efforts to comply with delivery obligations in the Valley resulted in a limitation on surface water users exclusively.⁸⁶

Starting in the 1940s, “the amount of ground water appropriation dramatically increased” and “[c]onflicts between surface water users and ground water users became common.”⁸⁷ Colorado started to see changes in surface flows due to poorly regulated groundwater pumping.⁸⁸ Change came in the 1960s when Colorado began to integrate surface and groundwater management.⁸⁹

Colorado recognized that surface water use and groundwater use were connected. To maximize water usage and satisfy both surface and groundwater users, Colorado enacted the 1965 Groundwater Management Act (1965 Act).⁹⁰ This 1965 Act “was intended to bring groundwater into surface water rule.”⁹¹

The surface water rule was that of prior appropriation.⁹² Under prior appropriation, priority is given to “uses that are first in time.”⁹³ This means that in times of scarcity, senior users are prioritized ahead of junior users.⁹⁴ This “doctrine is prevalent in the western United States” and when related to groundwater, “is the only doctrine . . . that does not necessarily relate water rights to ownership of the land overlying the groundwater.”⁹⁵

By recognizing that surface and groundwaters were connected, Colorado began to conjunctively manage its water resources. “‘Conjunctive use’ is the coordinated appropriation of ground and surface waters that are hydrologically connected.”⁹⁶ This means that the same law is applied to both

84. LINDA A. MALONE, ENVIRONMENTAL REGULATION OF LAND USE – PRESERVATION OF ENVIRONMENTAL QUALITY § 9:2 (2020 ed.).

85. See Hobbs, J., *supra* note 30, at 12 (explaining that the Colorado Doctrine first recognized both surface and groundwater as a public resource).

86. *Id.*

87. Gallegos v. Colo. Ground Water Comm’n, 147 P.3d 20, 27 (Colo. 2006).

88. See RAST ET AL., GUIDANCE DOCUMENT – CONJUNCTIVE MANAGEMENT OF SURFACE AND GROUNDWATER IN THE RIO GRANDE BASIN 12 (2010).

89. Gallegos, 147 P.3d at 27–28.

90. Ari J. Stiller-Shulman, *No Seat at the Water Table: Colorado’s New Groundwater Basin Statute Leaves Senior Surface Rights in the Lurch*, 84 U. COLO. L. REV. 819, 830 (2013).

91. RAST ET AL., *supra* note 88, at 12.

92. Stiller-Shulman, *supra* note 90, at 828.

93. LINDA A. MALONE, ENV’T. REGUL. OF LAND USE § 9:2 (2020 ed.).

94. TARLOCK & ROBISON, *supra* 26, at § 5:32.

95. *Id.*

96. *Id.*

surface and groundwater, usually in recognition of how closely connected the two types of waters are.⁹⁷ Conjunctive use is recognized as one of the better approaches for managing water.⁹⁸ The 1965 Act created the Colorado Groundwater Commission, which had the authority to regulate groundwater pumping through the issuance of permits and by designating “basins where groundwater would not injure surface rights.”⁹⁹

Colorado groundwater management was further refined with the Water Right Determination and Administration Act of 1969 (1969 Act). The 1969 Act essentially codified prior appropriation as the system of allocation for groundwater.¹⁰⁰ Significantly for the Valley, “well pumping came under the existing priority system, but junior rights would not be curtailed unless they caused definable injury to senior water rights.”¹⁰¹ Junior well users managed to squeak by and continue to pump through the use of temporary augmentation plans (aug plans).¹⁰² Under an *aug plan*, well users balance what they extract by increasing supplies for senior-right holders in other ways.¹⁰³

However, in the infamous South Platte litigation, the Colorado Supreme Court revoked the State engineer’s authority to allow these temporary plans.¹⁰⁴ This meant well owners had to come up with permanent plans. Unfortunately, permanent *aug plans* are hard to create and get approved. To do so takes a lot of time and money, resources that most users cannot afford.¹⁰⁵ The threat of these permanent plans, combined with the drought that began in 2000, scared the Valley’s groundwater users.¹⁰⁶ As a result, the groundwater users began to think of ways they could avoid having their water shut off.¹⁰⁷

The Valley was able to consider alternative ways to solve their water crisis under the Rio Grande Compact and the Rio Grande Convention.¹⁰⁸ Colorado is legally obligated to deliver a certain amount of Rio Grande water

97. *Id.*

98. Gray, *supra* note 30; Hedges, *supra* note 30; Hobbs, J., *supra* note 30 (discussing water management practices and climate change).

99. Stiller-Shulman, *supra* note 90, at 830-831.

100. Gallegos v. Colo. Ground Water Comm’n, 147 P.3d 20, 27 (Colo. 2006).

101. RAST ET AL., *supra* note 88, at 12.

102. See Carswell, *supra* note 32 (explaining that well owners used annual plans to continue pumping water).

103. *Id.*

104. Empire Lodge Homeowners’ Ass’n v. Moyer, 39 P. 3d 1139, 1152 (Colo. 2001).

105. Carswell, *supra* note 32.

106. *Id.*

107. *E.g. id.* (describing proposals made by groundwater users to improve the aug plan system).

108. *Id.*

to Texas, New Mexico, and Mexico.¹⁰⁹ This obligation is Colorado's primary concern in its management of the Valley water resources and what motivated the State's previous enforcement of groundwater delivery.¹¹⁰

This is different than other parts of Colorado. Usually, "Colorado water law requires water right owners to take an active role in protecting their rights against possible injury."¹¹¹ Today, much of the work to prevent injury is done by user-to-user compliance.¹¹² This self-policing means users monitor one another for overuse and sue one another when they think there has been a violation.¹¹³

However, Colorado is primarily concerned with Compact delivery obligations in the Valley.¹¹⁴ If users came up with a solution of their own and still satisfied Compact deliveries, the State would likely let the Valley manage its own water resources.

But the water resources outlook in the Valley has changed yet again. It is entering another year of drought, a drought that shows no signs of letting up.¹¹⁵ In the next section, this paper argues that due to climate change, Colorado must step in and manage water in the Valley. The self-imposed, voluntary measures have not done enough to conserve water in the aquifer, nor will they, due to climate change.

II. PART II

The first part of this section will go through the history and evolution of self-governance in the Valley. Legislation provided users in the Valley with three options: develop an aug plan, create fallow fields, or join a Subdistrict. The focus will be primarily on that legislation and the development of Subdistricts. The second part of this section will discuss why these measures have not been effective in managing groundwater. The primary reason being that economics and behavior do not incentivize conserving groundwater.

109. *Supra* Introduction, § A. *Historical Context for San Luis Valley Voluntary Measures*.

110. *Id.*

111. Miller et al., *supra* note 38, at 750.

112. Eds. note: Author's assertion

113. Eds. note: Author's assertion

114. Kelsey C. Cody et al., *Emergence of Collective Action in a Groundwater Commons: Irrigators in the San Luis Valley of Colorado*, 28:4 SOC'Y & NAT. RES. 405, 407 (2015); RADOSEVICH & RUTZ, *supra* note 43, at 3–5.

115. See Carswell, *supra* note 32 (discussing the Rio Grande Basin's record-setting drought).

A. Evolution and History of Water Self-governance in the Valley

In the early 2000s, drought struck all of Colorado.¹¹⁶ Groundwater users across the State faced a reckoning. How could they reconcile their usage with the diminishing supplies available? In several regions, the State had to step in and limit usage.¹¹⁷ And that was precisely what the Valley was afraid of. Rather than have the State step in and tell them what to do, farmers in the Valley thought to try and save their lives and community before someone else stepped in who would not.¹¹⁸ To that end, users in the Valley pushed through legislation, developed strategies to conserve the aquifer, and even managed to restore some of the aquifer.¹¹⁹

The first step the Valley took in trying to deal with its water management issues was through the creation of a bill. In 2004, the Colorado General Assembly enacted Senate Bill 04-222 (SB 04-222).¹²⁰ SB 04-222 amended the 1969 Act by adding a new section that is only applicable to the “use of ‘underground water’” in the Valley.¹²¹ This legislation was unique in that it allowed a “form of self-regulation not available in other parts of the state.”¹²² This speaks to, and perpetuates, the difference in how Colorado allows the Valley to manage its water.

There were two significant parts to SB 04-222. First, it “directed the state to finally develop well regulations for the [V]alley.”¹²³ In 2004, the Colorado State Engineer promulgated new rules governing the new groundwater uses in the Valley.¹²⁴ The rules were promptly challenged but subsequently upheld by the Colorado Supreme Court.¹²⁵

Second, SB 04-222 recognized that the goal was no longer maximum utilization of water; instead, the goal was to sustainably manage groundwater

116. Bradley Udall & Jonathan Overpeck, *The Twenty-First Century Colo. River Hot Drought and Implications for the Future*, Water Res. Rsch., Mar. 24, 2017, at 2404.

117. Carswell, *supra* note 32.

118. *Id.*

119. *Id.*

120. Paddock, *supra* note 44, at 295.

121. *Id.*

122. *Id.* at 296.

123. Carswell, *supra* note 32.

124. There were nine new rules. “Rule 1 is the title, Rule 2 states the authority for the rules, and Rule 3 explains the scope and purpose of the rules... Rule 4 contains the definition of terms used in the New Use Rules... Rule 5 contains the principles and findings upon which the New Use Rules are based. Rule 5 summarizes the legal and factual standards the state engineer must apply when promulgating the rules.... Rule 6 is...the requirements for new withdrawals of groundwater affecting the Confined Aquifer System.” Paddock, *supra* note 44, at 297–300.

125. *Id.* at 300–01.

long term.¹²⁶ To do this SB 04-222 “authorized sub-districts to charge for pumping and create court-approved groundwater management plans and state-endorsed annual plans to bolster rivers.”¹²⁷

SB 04-222 left citizens of the Valley with three options: “participate in a district, fallow their fields or work with water engineers to develop their own augmentation plans, which in turn need to be approved by state water courts.”¹²⁸

The idea of subdistricts came from citizens of the Valley itself.¹²⁹ The idea was that these subdistricts would be divided and set up by geography, so they would group those who already worked and lived together into a formal organization.¹³⁰ This would allow these subdistricts to make hard decisions internally.

These subdistricts would charge for pumped water and use that money to pay to fallow fields. Additionally, “[c]omputer models would determine the collective impact of each sub-district’s wells to figure out how much the group needed to trim its pumping to rebuild the aquifer.”¹³¹

In 2006, the rubber started to hit the road and Subdistrict 1 was created.¹³² “Subdistrict 1 contains some 174,000 acres of irrigated farmland and approximately 3,000 irrigation wells, some 300 of which withdraw water from the confined aquifer system, and the balance of which withdraw water from the unconfined aquifer.”¹³³ The board of managers of Subdistrict 1 were tasked with developing a water management plan.¹³⁴

The goal of that water management plan was to restore water levels and “maintain a sustainable irrigation water supply in the [u]nconfined [a]quifer.”¹³⁵ The plan provided an alternative to state-imposed water management regulations that would limit the use of irrigation wells within Subdistrict 1.¹³⁶ Instead, the water management plan used “a system of self-regulation based on economic incentives to promote responsible irrigation water use and management.”¹³⁷

126. *Id.* at 296.

127. Carswell, *supra* note 32.

128. Blankenbuehler, *supra* note 34.

129. Carswell, *supra* note 32.

130. *Id.*

131. *Id.*

132. *Id.*

133. Paddock, *supra* note 44, at 308.

134. *Id.* at 309.

135. *Id.*

136. *Id.*

137. *Id.*

There were multiple objections filed after publication of the initial water management plan.¹³⁸ After a series of lawsuits and amendments, an amended plan was created.¹³⁹ The amended plan gave Subdistrict 1 until 2031 to “restore the aquifer” and required the creation of annual replacement plans.¹⁴⁰ The amended plan was upheld in 2011 and the State Engineer approved Subdistrict 1’s first annual replacement plan in 2012.¹⁴¹

The annual replacement plan was challenged as well and went all the way to the Colorado Supreme Court, where it was upheld.¹⁴² “Subdistrict No. 1 has submitted an [annual replacement plan] and received state engineer approval thereof every year since 2012; none of which have been opposed.”¹⁴³

Unfortunately, under its water management plan Subdistrict 1 lacks enforcement authority. For example, it cannot require water cutbacks.¹⁴⁴ Furthermore, nowhere in SB 04-222 were water cutbacks statutorily required.¹⁴⁵ This meant Subdistrict 1 had “minimal tools besides higher taxes to restrain pumping or manage competition between members.”¹⁴⁶ This lack of enforcement power is crucial because, as will be explained below, without enforcement power the Valley has not been able to conserve enough water.

The Valley has learned some lessons. There are now six subdistricts in the Valley, five new ones and the original Subdistrict 1.¹⁴⁷ All of these subdistricts can charge pumping fees, use that money to pay farmers to fallow fields, and pay farmers for general reductions in water use.¹⁴⁸

There are a couple of significant differences between Subdistrict 1 and these newer subdistricts. First, the newer subdistricts can require water

138. *Id.* at 310.

139. *Id.* at 310–11.

140. Caitlin Coleman, *Hundreds of San Luis Valley Farm Wells at Risk as State Shortens Deadline to Repair the Rio Grande River*, WATER EDUCATION COLO. (Aug. 5, 2020), <https://www.watereducationcolorado.org/fresh-water-news/hundreds-of-san-luis-valley-farm-wells-at-risk-as-state-shortens-deadline-to-repair-rio-grande-river/> [hereinafter *Hundreds of Farm Wells at Risk*]; see Paddock, *supra* note 44, at 316 (explaining that the first ARP was submitted to the state engineer in April 2012 and interested parties were given notice and opportunity to object the ARP).

141. Paddock, *supra* note 44, at 311–16.

142. *Id.* at 316–21.

143. *Id.* at 321.

144. Nick Bowlin, *Colorado Farmers Fight to Save Their Water and Their Community’s Future*, HIGH COUNTRY NEWS (Sept. 16, 2019), <https://www.hcn.org/issues/51.16/water-colorado-farmers-fight-to-save-their-water-and-their-communitys-future>.

145. *Id.*

146. *Id.*

147. Blankenbuehler, *supra* note 34; The new subdistricts are “Conejos, Alamosa-La Jara, Rio Grande, San Luis, and Saguache Creek Response Areas.” Paddock, *supra* note 44, at 332.

148. Carswell, *supra* note 32.

restrictions.¹⁴⁹ On the other hand, these newer subdistricts are based on an ‘opt-in’ approach where irrigation groundwater users within a response area elect to be included in the sub-district.¹⁵⁰ This results in a *checkerboard* subdistrict that includes parcels of land that may not be contiguous.¹⁵¹ It is worth noting that some users in the Valley will never be part of a subdistrict because they are geographically outside the boundaries of the subdistricts or because they are a municipality or on federal land.¹⁵²

For a while, the subdistrict initiatives worked. In 2012, the aquifer levels in the Valley were rebounding.¹⁵³ “Water users in sub-district 1 pumped one-third less water . . . Area farmers have fallowed 10,000 acres . . . Since a low point in 2013, the aquifer . . . recovered nearly 250,000 acre-feet of water.”¹⁵⁴ It appeared the aquifer would keep recovering. Then a dry spell in 2018 wiped out any gains.¹⁵⁵ The aquifer dropped “about 800,000 acre-feet below the . . . legally mandated recovery level.”¹⁵⁶ The next section will explore why the subdistrict’s voluntary measures, particularly those of Subdistrict 1, are not sufficient in the context of climate change.

B. Analysis of Self-governance Measures

In an attempt to conserve their communal resource, groundwater users in the Valley supported legislation that provided users in the Valley with three options.¹⁵⁷ Users could “participate in a district, fallow their fields or work with water engineers to develop their own augmentation plans.”¹⁵⁸ These districts in turn could adopt rules that would increase the cost to pump water, pay farmers to fallow fields, or use other tools they developed.¹⁵⁹

Ultimately, due to climate change, these initiatives have not been enough to conserve groundwater in the Valley. Climate change and the prolonged

149. Bowlin, *supra* note 144.

150. *Id.*

151. Paddock, *supra* note 44, at 333.

152. *Id.* at 334.

153. Blankenbuehler, *supra* note 34.

154. *Id.*

155. Bowlin, *supra* note 144.

156. *Id.*

157. Blankenbuehler, *supra* note 34.

158. *Id.*

159. Bowlin, *supra* note 144 (“Subdistrict 1 has several tools at hand to curb pumping. The primary one is a fee on pumped water, . . . There is also a program that pays farmers to take land out of production”); *Enhancing and Protecting the Water Rights of the Citizens of the San Luis Valley who Reside Within the Boundaries of the District*, RIO GRANDE WATER CONSERVATION DIST., <https://www.rgwcd.org/sd-1-conservation-page> (last visited Jan. 29, 2022).

drought have put the Valley on the edge of a *tragedy of the commons*. The economics and behavior of water usage do not incentivize conserving water.

The *tragedy of the commons* occurs when there is uninhibited access to a communal resource. Some users begin to take more than their fair share of that resource, which in turn encourages others to take more than their fair share as well.¹⁶⁰ This leads to unsustainable resource consumption to the point of depletion.¹⁶¹ “As long as users show restraint the resource is maintained.”¹⁶²

An idea that is closely related to the tragedy of the commons is a *common pool resource*. A *common pool resource* is any resource “from which it is difficult to exclude or limit users once the resource is provided” by nature or produced by humans.¹⁶³ A common pool resource is prone to depletion when one’s use of the resource makes it unavailable for another person’s use. When a common pool resource has a high value, but weak legal or institutional constraints, users have strong incentives to take as much as they can and deplete the overall supply available for future users.¹⁶⁴

That is exactly what happened in the Valley. Prior appropriation, combined with lax management of groundwater in the Valley led water users to pump water to the full extent of their rights with little regard for other users. This overuse combined with drought caused Colorado to fall behind on compact deliveries in the 1960s.¹⁶⁵ As a last-ditch effort, Colorado imposed water restrictions.¹⁶⁶

This is a classic example of a common pool tragedy; individuals work to maximize their own benefit at the expense of others. With weak constraints in effect for some, and no constraints at all for others, well users continued to pump away. Potentially, had all water users worked together to ration the limited resource, then more users could have kept using the resource in the future. However, conservation for mutual benefit is difficult to achieve.

Research has shown that “resource dilemmas are best resolved when there is communication between group members, when a sense of group identity or solidarity exists among group members, or when education is

160. Kennon M. Sheldon & Holly A. McGregor, *Extrinsic Value Orientation and the “Tragedy of the Commons”*, 68 J. OF PERSONALITY 383, 384.

161. *Id.* at 383–85.

162. *Id.* at 384.

163. Elinor Ostrom, *Coping with Tragedies of the Commons*, 2 ANNU. REV. POL. SCI. 493, 497 (1999).

164. Melissa K. Scanlan, *Droughts, Floods, and Scarcity on a Climate-Disrupted Planet: Understanding the Legal Challenges and Opportunities for Groundwater Sustainability*, 37 VA. ENVTL. L.J. 52, 59 (2019).

165. Carswell, *supra* note 32.

166. *Gallegos v. Colo. Ground Water Comm’n*, 147 P.3d 20, 27 (Colo. 2006).

given regarding the long-term benefits of cooperation.”¹⁶⁷ The Valley has taken all of these steps and, so far, managed to avoid a complete collapse of its groundwater resources. The Valley has avoided this tragedy because users began to work together to conserve their groundwater, their common pool resource.¹⁶⁸ As users became aware of the effects of their actions on others, some began to recognize that if they all wanted to continue to pump water, they would have to work together and impose limits on everyone in order for everyone to continue pumping, albeit at a lower rate.¹⁶⁹

These self-governance efforts are not enough without enforcement power to actually shut off and limit pumping. There are lots of reasons for farmers in the Valley to only look out for themselves and there are lots of economic incentives to do so as well. Small farmers are struggling with expensive bills.¹⁷⁰ Other farmers who can afford to pump are outcompeting those who cannot.¹⁷¹ But the biggest problem, by far, is the weather, a factor that no one can control. If the Valley continues to experience drought, no amount of conservation will solve the problem.

Think of an aquifer like a bank account. When more water goes in, more water can be taken out or in the alternative saved. When less water goes in, less water can be taken out. If the Valley continues to have dry years, it does not matter how little water is taken out of the aquifer because there is not enough water going in to make up for the amount being taken out.

Ultimately, the *tragedy of the commons* is a behavioral issue. To work to preserve a common resource so everyone can keep using it takes some thought. You have to buy into the solutions, and you need to care about those affected. In the Valley, that is not always the case. There are some who simply do not care. They have “vowed that as long as there’s water in their hole, they’re going to pump it.”¹⁷² Others say there is a “mindset of, ‘I can pay for it, so it’s my neighbor’s problem.’”¹⁷³ It makes no sense for others to conserve a resource when they can see others who are not conserving it. It undermines the whole project.

The communal mindset also suffers in the Valley due to its changing demographics. The Valley was historically a tightly knit community.¹⁷⁴

167. Sheldon & McGregor, *supra* note 160, at 384.

168. See also Cody et al., *supra* note 114, at 406.

169. Carswell, *supra* note 32; Bowlin, *supra* 144.

170. Bowlin, *supra* note 144.

171. *Id.*

172. Carswell, *supra* note 32.

173. Bowlin, *supra* note 144.

174. Cody et al., *supra* 114, at 418; Bowlin, *supra* note 144.

Today, only about 50,000 people live in the entire area.¹⁷⁵ Agriculture has driven the economy for decades, often with small farms.¹⁷⁶ But that has started to change. No longer is the community composed of only tightly knit neighbors. As families sell and leave the Valley, farms are purchased and consolidated by corporations.¹⁷⁷ “Department of Agriculture census records show an increase in the number of large . . . farms in recent decades.”¹⁷⁸ “In the past few years . . . three locally owned farms nearby sold, in part due to the ever-rising pumping fee, with most of the land going to out-of-state investment firms.”¹⁷⁹ For farms and companies with a smaller stake in taking care of the Valley, it is not a life-or-death matter if they cannot continue farming and living in the area. These large corporate farms do not care as much about the community nor conserving its resources.

This brings up the second reason why the Valley is turning into a *tragedy of the commons*—economics. In order to stave off a *tragedy of the commons*, everyone must take a cut so everyone can still prosper. This does not work when some farms cannot survive, even with a small cut or when there are those who can afford to pay more for the resource.

As mentioned earlier, the Valley was historically a tight-knit community made up of small farms.¹⁸⁰ These small farms operate on tight financial budgets.¹⁸¹ In order to simply survive, these small farms will pump as much groundwater as they legally can. They will not be able to survive otherwise. This problem is exacerbated in wetter years. When there is enough water to go around, farms will choose to plant more water-intensive crops like alfalfa and barley because these water-intensive crops are more lucrative than other crops.¹⁸² This means in wetter years, short term farming economics incentivize more water use instead of conservation, which might restore groundwater reserves.

In drier years, the Valley has tried to conserve groundwater by increasing the price farmers pay per gallon when pumping groundwater.¹⁸³ Unfortunately, this also has unintended consequences. Increasing the price of groundwater favors senior water right holders and large corporate farms.

175. Blankenbuehler, *supra* note 34.

176. Bowlin, *supra* note 144 (“The San Luis Valley depends on agriculture.”).

177. *Id.*

178. *Id.*

179. *Id.*

180. Bowlin, *supra* note 144.

181. *Id.*

182. *Id.*

183. *Id.*

Increasing the price to pump groundwater favors senior water rights by working in combination with another water conserving tool: a credit.¹⁸⁴ Under this credit system, “those with excess water can sell it to those who want more.”¹⁸⁵ This favors senior water rights because in wetter years, they can either use that water to grow the lucrative water-intensive crops such as alfalfa or barley, or in drier years they can sell that water.¹⁸⁶ Either way, senior water users profit at the expense of junior users.

However, senior water users do not always profit from this scheme. Some senior water users have seen their crops suffer as large commercial farms around them take advantage of the credit system.¹⁸⁷ The credit system only allows permitted groundwater to be drawn out of the system. It doesn’t allow more water to be drawn out than that. Thus, it shouldn’t matter if a senior or junior user draws that water because they have a right to do so.

Yet, due to the complexities of hydrology, depending on where the water is physically pumped from, it can lower the water table for other water users, preventing them from being able to use their water rights.¹⁸⁸ So, in some cases, a large farm will buy credits with the effect that a neighboring senior rights holder will be unable to pump their share of water.¹⁸⁹

It is also hard for the Valley to conserve water by increasing the price of water because smaller farms, with tighter operating budgets, struggle to afford these higher water prices.¹⁹⁰ Larger farms can.

This has potential to create a vicious feedback loop where smaller farms cannot compete with larger farms, and the smaller farms are forced out of business.¹⁹¹ This in turn could free up more water for larger corporate farms. These large farms are not as invested in the Valley, and do not always subscribe towards the communal view necessary to save groundwater in the Valley. Some farmers also argue that the price set for water is artificially

184. *Id.*

185. *Id.*

186. *Id.*

187. *Id.*

188. This is a phenomenon known as the groundwater cone of depression. *Groundwater and Wells: Understanding Groundwater*, OR. STATE UNIV., <https://wellwater.oregonstate.edu/groundwater/understanding-groundwater/groundwater-and-wells> (last visited Jan. 29, 2022).

189. *E.g.*, Carswell, *supra* note 32 (“Plus, the North Star wells and others have for years slowly strained the supply of creek water and lowered the water table.”).

190. Bowlin, *supra* note 144.

191. *Id.*

low.¹⁹² Farmers are still paying less for pumped water than they would for imported water.¹⁹³ This is part of what encourages large commercial farms.

Another economic issue facing the Valley is that of water exportation. The Valley has long been eyed by front-range developers for its water.¹⁹⁴ For smaller farms, if the price paid for exported water is high enough, it could be hard to say no. While not many in the Valley support exporting water, some may have no choice.

Finally, another incentive Subdistrict 1 has tried to implement is paying farmers to fallow fields instead of planting crops.¹⁹⁵ This only works if fallowing is more than, or at least as profitable as, farming. That is not always the case.

In years where commodity prices are higher than what Subdistrict 1 can pay to fallow fields, the high prices make conserving water hard because it is not economically worth it.¹⁹⁶ For one farmer, “[t]he \$96,000 payment from Sub-district 1 for fallowing a quarter of his total acreage was at most a third of what the Coors beer company would have paid for a rotational barley crop.”¹⁹⁷

2012 was the first year the Valley paid farmers in Subdistrict 1 to fallow fields.¹⁹⁸ The goal is to ultimately fallow 40,000 acres by 2021.¹⁹⁹ In 2012, 8,300 acres were fallowed through contracts with Subdistrict 1.²⁰⁰ While “another 15,000 to 20,000 acres were rested through private insurance that pays farmers not to plant during droughts,” the private program does not promote the long-term fallowing that Subdistrict 1 seeks to achieve.²⁰¹ “10,000 acres were fallowed by 2016.”²⁰² 2020 saw the highest participation in the fallow program yet with an additional 13,000 acres enrolled.²⁰³ But that is still short of the 40,000-acre goal.

The Valley is not simply fighting against economics. Economics can be figured out. The weather is the biggest challenge facing the Valley’s

192. Carswell, *supra* note 32.

193. *Id.*

194. *Id.*

195. Paddock, *supra* note 44, at 310.

196. Carswell, *supra* note 32.

197. *Id.*

198. *Id.*

199. *Id.*

200. *Id.*

201. *Id.*

202. Blankenbuehler, *supra* note 34.

203. Caitlin Coleman, *Wells at Risk as State Shortens Deadline to Repair Rio Grande River*, THE FENCE POST (Aug. 5, 2020), <https://www.thefencepost.com/news/hundreds-of-san-luis-valley-farm-wells-at-risk-as-state-shortens-deadline-to-repair-rio-grande-river/>.

groundwater and conservation efforts—it threatens to pull out the rug from underneath all the residents’ efforts is the weather. Despite residents’ efforts, no progress has been made on restoring the aquifer, and aquifer levels have declined.²⁰⁴ “Between July 2019 and July 2020 the [V]alley’s unconfined aquifer . . . dropped by 112,600 acre-feet. All told, the aquifer has lost around 1 million acre-feet of water since the drought of 2002.”²⁰⁵

2018 was an incredibly dry year. “The U.S. Department of Agriculture designated the valley a drought disaster area.”²⁰⁶ Because the Valley was so dry that year, farmers pumped so much groundwater they wiped out the gains and replacements they had put into the aquifer in previous years.²⁰⁷ In other years when the Valley has been dry, the aquifer has lost more water than it has gained.²⁰⁸ Even when wet years are interspersed with dry ones, the wet years do not help the aquifer.²⁰⁹ Due to the economic situations mentioned previously, when there are wet years, the Valley has not been able to make gains on restoration because everyone uses the extra water.²¹⁰

Furthermore, even if users were able to conserve extra water, the Valley cannot rely on wet years to restore the aquifer. The southwest is experiencing a general drying and warming trend.²¹¹ Dry and warm could possibly become the new normal. If that is the future, what is the Valley to do?

Combining economics with behavior and the climate makes for a potent combination. The combination makes conserving groundwater in the Valley particularly challenging. From the behavioral side, all these efforts to conserve water can seem in vain when the weather does not cooperate, and not everyone participates in efforts to conserve the resource.

This creates a death spiral of sorts. As efforts appear futile, more and more subdistrict participants might choose not to follow the rules. Or, participants not yet in subdistricts may decide not to form one at all. Valley residents are legally obligated to participate in a subdistrict, fallow their fields, or develop an *aug plan*, which requires well users to replace the water they consume.²¹² Yet without enforcement, residents are not easily made to participate in these options.

204. Bowlin, *supra* note 144.

205. Coleman, *supra* note 140.

206. Bowlin, *supra* note 144.

207. *Id.*

208. Carswell, *supra* note 32.

209. Bowlin, *supra* note 144.

210. *Id.*

211. *Climate Change Indicators*, *supra* note 1.

212. Carswell, *supra* note 32; Paddock, *supra* note 44, at 333.

As more users choose not to participate in conservation, it begins to seem pointless. This, in turn, makes it harder to conserve the resource because fewer and fewer users are helping.

While a total lack of participation has not happened yet, if the drought becomes worse and agriculture becomes less profitable, it is entirely possible to achieve full participation. For many Valley residents, the reason they keep up the thankless work of trying to use less water is because of their love for the community, area, and farming.²¹³ It is hard to predict when or if the breaking point of that love will come.

Given the challenges that the Valley is facing, some might ask why bother? Especially given the realities of climate change, why not give up farming in the Valley entirely? In response, people in the Valley say their lives and livelihoods are worth just as much as anyone else.²¹⁴ “People who live here aren’t any more special than people anywhere else . . . but they also aren’t any less special than anyone else.”²¹⁵

The people in the Valley are afraid of a complete well shut off.²¹⁶ A complete well shut off will ruin lives.²¹⁷ In 2020, the Colorado State Engineer said, “we’ll see in the next couple of years if we can turn around this trick.”²¹⁸ Given how dry the winter of 2021 has been, the threat seems imminent.²¹⁹ While residents of the Valley knew this threat was always looming in the background, greater institutional accountability was needed to prevent it. An example would be mandatory water restrictions. The subdistricts had a lot of potential to solve water issues in the Valley. However, considering climate change, they needed something more—they needed enforcement authority.

No one wants to be the person who says no. No one wants to be the one to say “enough.” While the people of the Valley thought voluntary and market measures would be enough to conserve their groundwater, they have not been. Economics, behavior, and the weather have proved them wrong.²²⁰ Unfortunately, someone or something has to step in at some point and stop or limit groundwater pumping. That someone might be the Colorado State Engineer in the next couple of years. But it could have been Subdistrict 1 if it had been granted enforcement authority.

213. See Bowlin, *supra* note 144 (detailing interviews with community members about their love of agriculture and the community).

214. *Id.*

215. *Id.*

216. *Id.*

217. *Id.*

218. *Hundreds of Farm Wells at Risk*, *supra* note 140.

219. Bollinger & Freeman, *supra* note 5.

220. Bowlin, *supra* note 144.

Either way, greater institutional accountability is required in order to conserve groundwater resources in the future. The Valley has proven that voluntary conservation efforts are not enough. Climate change is hard on farmers and businesses whose work depends on water use. People have to make a living and survive somehow. No one likes to address consequences, but a line must be drawn if we want to conserve a resource. Otherwise, there will always be those who will try to maximize the resource to the fullest extent possible.

Unfortunately, if institutions continue to follow the current law in the Valley, senior users will be prioritized over junior users. That means plenty of users will suffer. It is possible the Valley's attempts to conserve groundwater could still work if the Valley could make decisions on its own and enforce that. However, it may be too late to find out.

III. PART III

Greater institutional accountability is required to manage groundwater, regardless of what is known or unknown about the hydrology of certain groundwater resources. The lack of information regarding the future of climate change is often used as an excuse for inaction. The unknowns and fear of reprisal paralyze decision makers. This section will argue that decision makers in the Valley cannot wait for more scientific knowledge to decide how to conserve their resources. If decision makers continue to wait, it may be too late to rescue groundwater in the Valley.

In a place like the Valley and in general, waiting for more science in order to make a decision is no longer an option. As discussed earlier, the climate of the Valley is already changing. The changing climate is part of the megadrought gripping the Southwest.²²¹

No one knows for certain what will happen to the Southwest climate as our climate changes. However, scientists already know “[s]treamflow totals in . . . the Rio Grande . . . were 5% to 37% lower between 2001 and 2010 than the 20th century average flows.”²²² Parts of Colorado are already 3.6°F warmer than they were a century ago.²²³

While it may be harder to argue against the science of climate change, some might also point to the hydrology of the Valley and reliability of the

221. Freedman & Fears, *supra* note 6.

222. *Southwest*, NAT'L CLIMATE ASSESSMENT, <https://nca2014.globalchange.gov/report/regions/southwest> (last visited Nov. 12, 2021).

223. Mufson et al., 2°C: *Beyond the Limit*, WASH. POST (Aug. 13, 2019), <https://www.washingtonpost.com/graphics/2019/national/climate-environment/climate-change-america/>.

RGDSS Groundwater Model as a reason for inaction. The RGDSS Groundwater Model is the Rio Grande Decision Support System.²²⁴ Decision Support Systems are computer based systems that use data and computer models to help decision makers solve unstructured problems. Colorado has developed a decision support system for every major water basin in the state.²²⁵

The hydrology of the Valley is complex.²²⁶ Initial hydrologic studies of the Valley during the 1960s and 1970s.²²⁷ These studies were conducted in order to implement the 1969 Act.²²⁸ The passage of HB 98-1011 mandated the most recent research into understanding the hydrology of the Valley, spurring the creation of RGDSS Groundwater Model.²²⁹

HB 98-1011 was passed in 1998 after efforts to export water out of the Valley.²³⁰ “[W]ater users in the Valley sought help from the State of Colorado to undertake the scientific investigations needed to determine if and how further groundwater development could occur in the Valley without injury to vested water rights or interference with the state’s obligations under the Compact.”²³¹ Much was unknown about the confined aquifer, “its hydrologic connections to the overlying unconfined aquifer and surface waters (including the Rio Grande), [or] its sources of recharge and their interannual variability.”²³²

In 2004 the RGDSS Groundwater Model was challenged as unreliable and inadequate.²³³ The Colorado Supreme Court rejected this challenge and new data continues to improve RGDSS Groundwater Model.²³⁴ However, without regular and continuous updates to the Model, “the Model will cease to be reliable and can no longer serve as a reasonable basis for groundwater administration in the San Luis Valley.”²³⁵

224. Paddock, *supra* note 44, at 294.

225. *About Us*, COLORADO’S DECISION SUPPORT SYSTEMS, <https://cdss.colorado.gov/about-us> (last visited Jan. 29, 2022).

226. *Id.* at 250; Cody et al., *supra* note 114, at 407.

227. *See generally* P.A. EMERY ET AL., HYDROLOGY OF THE SAN LUIS VALLEY, SOUTH-CENTRAL COLORADO, U.S. DEP’T OF THE INTERIOR GEOLOGICAL SURV. (1969) (providing a study report from 1969); *See* P.A. EMERY ET AL., HYDROLOGY OF THE SAN LUIS VALLEY IN SOUTH-CENTRAL COLORADO: HYDROLOGIC INVESTIGATIONS ATLAS HA-381, U.S. DEP’T OF THE INTERIOR (1971) (geological survey).

228. Paddock, *supra* note 44, at 292.

229. *Id.* at 294.

230. *Id.* at 293.

231. *Id.*

232. Miller et al., *supra* note 38, at 751.

233. Paddock, *supra* note 44, at 301.

234. *Id.* at 302.

235. *Id.* at 334-35.

With the newer information provided by the RGDSS Groundwater Model, the Valley is still trying to collect more information about the hydrology of the area.²³⁶ A large part of this stems from the fact that the Colorado Revised Statutes require “maintenance of artesian pressure while allowing pressure fluctuations within the ranges that occurred during the period of 1978 through 2000.”²³⁷ But no one knows what the pressure was during that time period because no one was collecting that data at that time.²³⁸ To make up for the lack of historical information, the Valley hopes that new information can fill in some of these gaps.²³⁹

Defining the standard for a sustainable aquifer water supply is also difficult “[when there] is [a] lack of comprehensive data on the relationships between basin scale hydrologic conditions and the resulting artesian pressure in the confined aquifer.”²⁴⁰ To achieve this goal, the Valley continues to collect more data.²⁴¹

While it is important for the Valley to continue collecting data to better understand the hydrology of the Valley for statutory and management reasons, a lack of a complete understanding of the hydrology of the Valley should not be an excuse for inaction. Valley residents and the State of Colorado recognize that changes in groundwater pumping have an effect on surface water availability and how much water is available in the aquifer.²⁴² So, while it may not be known precisely how much water is left in the Valley or how exactly everything is interconnected, that is no reason to delay enforcement or institutional accountability. The Colorado State Engineer has said that if it ever becomes clear the Valley cannot “reach a sustainable level by the year 2031, then, yes, . . . his office would shut off irrigation for a substantial part of the area.”²⁴³

However, if the State Engineer waits that long, given how little is understood about the hydrology of the Valley, then it might be too late. If someone does not hold Valley residents accountable sooner, rather than later, users will continue to deplete the resource. The only thing that seems to scare Valley residents is the threat of a well shut-off.²⁴⁴ When subdistricts were

236. *Id.* at 335.

237. COLO. REV. STAT. 37-92-501(4)(a)(III) (2019).

238. Paddock, *supra* note 44, at 335.

239. *Id.*

240. *Id.* at 327.

241. *Id.*

242. Bowlin, *supra* note 144.

243. *Id.*

244. *Id.*

created, the Valley thought they would be sufficient.²⁴⁵ Yet, the Valley “could not account for the realities of a changing climate, and [Subdistrict 1] has proven unable to discourage enough farmers from pumping.”²⁴⁶

No one ever wants to be the one to say enough. But without greater institutional enforcement, whether local or from the state, the aquifer cannot be saved. By not stepping in to limit pumping earlier, the Valley, perhaps this year, will face an even uglier reality than it already does.

CONCLUSION

Who cares if the Valley runs out of water? Who cares if the self-governance experiment does not work out in the Valley? Users of groundwater across the nation, particularly in the Southwest, should care. The Valley is a canary in the coalmine right now. Despite their best efforts, users in the Valley have been unable to conserve enough water in the face of climate change.

Conjunctive management is difficult. One often hears about how groundwater resources are overtaxed,²⁴⁷ yet they are a resource that seems to keep lasting beyond anyone’s expectations. The science keeps changing, extending the expected lifespan of groundwater resources. It is unclear how much humans can, or will, curb their behavior to conserve such resources.

But climate change is changing all that. Climate change has made it increasingly difficult to conserve enough water.²⁴⁸ Voluntary measures are not enough to conserve water in light of the challenges climate change presents. Under the pressure of climate change, voluntary measures are not sufficient due to a combination of behavior and economics.

When there are no mandatory water restrictions in the Valley, users are unlikely to limit their water consumption. Some users only care about themselves and not the community as a whole. Other users, particularly small farms, are struggling with expensive bills.²⁴⁹ Other users who can afford higher prices are outcompeting those who cannot.²⁵⁰ Depending on the year, users either cannot afford to fallow fields, or it is not economically worth it

245. *Id.*

246. *Id.*

247. Lucas Bessire, *The Next Disaster Coming to the Great Plains*, THE ATLANTIC (Dec. 26, 2021), <https://www.theatlantic.com/ideas/archive/2021/12/kansas-aquifer-ogallala-water-crisis-drought/621007/>; Jonathan Thompson, *As Temperatures Rise, Arizona Sinks*, HIGH COUNTRY NEWS (Apr. 1, 2020), <https://www.hcn.org/issues/52.4/infographic-water-as-temperatures-rise-arizona-sinks>.

248. Bowlin, *supra* note 144.

249. *Id.*

250. *Id.*

to fallow fields.²⁵¹ Currently, there is more water leaving the aquifers in the Valley than entering them.²⁵² The megadrought, combined with the economics of water pumping, has exposed flaws in the system.

Water managers, politicians, and users in the Valley are aware of this.²⁵³ Many are aware that a painful future is looming. Despite their best efforts, they have not been able to do enough. The inability to conserve water without the threat of a well shut-off in the Valley should serve as a lesson. The biggest takeaway by far is that without institutional accountability, other efforts will not be enough to conserve groundwater.

Water users in the Valley are human. But, as demonstrated earlier, they will not stop pumping water until forced.²⁵⁴ People need someone to come in and enforce limits on water. Otherwise, as the Valley has shown us, even in the face of a dire future, economics and human behavior will always keep some users pumping water to the detriment of others.²⁵⁵ Enforcement of mandatory measures, such as limits or restrictions, is the only way forward to conserve groundwater in the face of climate change.

251. Carswell, *supra* note 32.

252. Bowlin, *supra* note 144 (infographic).

253. Bowlin, *supra* note 144.

254. *See supra* Part II (discussing ineffectiveness of self-governance measures without enforcement power).

255. Jane Braxton Little, *The Ogallala Aquifer: Saving a Vital U.S. Water Source*, SCI. AM. (Mar. 1, 2009), <https://www.scientificamerican.com/article/the-ogallala-aquifer/>.