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

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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 decades[2]—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

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1. *Forest Bioenergy, Carbon Capture & storage, & Carbon Dioxide Removal: An Update*, EUR. ACADS. SCI. ADVISORY COUNCIL 2 (2019), https://easac.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 COMMC'N 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 1.2ºC 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 2ºC above pre-industrial levels.[8] At the same

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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 1.5ºC 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 $GtCO_2eq\ yr^{-1}$ in 2030, and half of available pathways fall within the 25–30 $GtCO_2eq\ yr^{-1}$ 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 (CO_2) 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 CO_2 from fuel in use, e_u, shall be taken to be zero for biomass fuels. Emissions of non-CO_2 greenhouse gases (CH_4 and N_2O) from the fuel in use shall be included in the e_u 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 rénmín 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 $GtCO_2$/year to 85 $GtCO_2$/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 1.5ºC or 2ºC often rely on BECCS.[22] The IPCC notes that 1.5ºC-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 CO_2 ($GtCO_2$) annually by 2050.[23] For reference, in 2019 the United States emitted over 5 billion tons of CO_2.[24] Despite these models, BECCS is not necessary to achieve the Paris Agreement's goals. The IPCC's 2018 *Special*

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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 1.5ºC highlights a 1.5ºC-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 CO_2 emissions, are necessary to stay within the 1.5ºC threshold.[28] This includes reducing CO_2 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 1.5ºC 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

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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 SLCF 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 Unites 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 disproportionally feel the effects of climate change).

deaths—especially for low-income communities and communities of color.[33] The IPCC estimates that limiting warming to 1.5ºC rather than 2ºC 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 1.5ºC of warming rather than 2ºC.[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 1.5ºC goal. Meeting this target requires fast action this decade on the way to net-

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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 2ºC and 4ºC 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 CO_2 levels for decades.[44] Burning forest biomass for power generation emits more CO_2 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

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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]

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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 Langaniere 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.

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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 CO_2 removal is necessary to stay within the 1.5ºC 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 2ºC target.[67] For BECCS specifically, there were only five BECCS facilities in operation in 2019, collectively

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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 CO_2 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 CO_2 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 CO_2 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 CO_2, 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 CO_2.[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

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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. ENVT'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]

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76. Thomas Ranius et al., *supra* note 75, at 414; Juha Siitonen, *Threatened Saproxylic 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 $GtCO_2$ 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]

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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; Grunwald, *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; Grunwald, *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 CO_2 footprint.[99] The RED assumes zero combustion emissions of CO_2 for forest biomass; it requires only that biomass-fired plants report the CO_2 from fossil

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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 CO_2 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. GUIDELINS 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-CO_2 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 CO_2.

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 CO_2, 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.; Palahí, 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 CO_2 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 CO_2 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]

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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 1.5ºC.[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

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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 Chine to reduce GHGs by encouraging processes like clean energy).

125. EPA, Policy Statement, EPA'S TREATMENT OF BIOGENIC CARBON DIOXIDE (CO_2) 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 1.5ºC 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

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Explicit Analysis Identifies Significant Potential for Bioenergy with Carbon Capture and Storage in China, NATURE COMMC'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

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132. EPA, EPA'S TREATMENT OF BIOGENIC CARBON DIOXIDE (CO_2) 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 generation[144] and the industrial sector[145] 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]

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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 LEGISTURES (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 qualifying[152] 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

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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

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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

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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

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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 CO_2 and non-CO_2 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.

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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 1.5ºC 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

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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,

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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]

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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.

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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).