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Please see attached comments

Additional submitted attachment is included below.

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California Energy Commission
Docket Unit, MS-4
Docket No. 25-IEPR-04
715 P Street
Sacramento, California 95814-5512

Re: Integrated Energy Policy Report Commissioner Workshop on Firm Zero-Carbon Resources and Hydrogen

The Center for Biological Diversity submits these comments in response to the California Energy Commission's July 29, 2025, Integrated Energy Policy Report ("IEPR") workshop. The proposed focus of the 2025 IEPR is to advance clean energy deployment, including an assessment of the "value proposition of using biogenic materials such as agricultural and forest biomass resources as fuel," the potential for hydrogen under Senate Bill 1075, and an analysis of firm, zero-carbon resources. Bills such as SB 423, which requires the CEC to incorporate "firm zero-carbon resources" into the IEPR, and SB 1075, which requires an analysis of hydrogen's role in decarbonizing transportation and electrical sectors, are intended to steer California's path in achieving its climate goals.

We urge the CEC to use this opportunity to conduct a robust scientific assessment of using woody biomass to make bioenergy such as hydrogen, electricity, methane, and bio-oil, including the wide-ranging impacts to the climate, public health, environmental justice, and forest ecosystems. A large body of published scientific research shows that converting forest and agricultural biomass into energy using combustion, gasification, and pyrolysis emits significant greenhouse gas emissions that worsen the climate crisis, releases air pollution that harms public health often in environmental justice communities, industrializes and depletes forests, and burdens taxpayers with high costs. We are concerned that the IEPR workshop discusses energy production from woody biomass feedstocks as if on par with proven clean, renewable energy resources, namely solar and wind energy, when in fact woody biomass energy is highly polluting and cannot be part of a clean, renewable energy future.

We urge the CEC to acknowledge that the assertion that biomethane constitutes a "firm zero-carbon resource" is based upon faulty premises. We also request the CEC to recognize the shortcomings of using biomass and biomethane feedstocks in the production of hydrogen.

Hydrogen is oft-discussed as being a fuel source essential to our decarbonization goals. However, hydrogen should play only a limited role in a carbon-free future given the risks it carries and the availability of viable alternatives like direct electrification. Insofar as hydrogen is needed at all, it should be produced via electrolysis powered by clean, renewable solar and wind energy using the three pillars—the only carbon neutral, climate friendly method to make hydrogen.

We discuss these concerns and recommendations in detail below, citing extensive scientific evidence.

I. Bioenergy production using forest and agricultural biomass is polluting and expensive.

One of the proposed purposes of the 2025 IEPR is to assess the "value proposition of using biogenic materials such as agricultural and forest biomass resources as fuel." A robust body of scientific evidence clearly shows that making bioenergy—such as electricity, hydrogen, methane, and bio-oil—using agricultural and forest biomass as fuel is polluting and expensive across the lifecycle. The main processes used—biomass combustion, gasification and pyrolysis—emit significant amounts of carbon dioxide and air pollution. Biomass gasification and pyrolysis processes to produce energy and fuels are technically difficult and expensive. On top of this, biomass extraction, transport, processing, and storage emit substantial additional upstream climate and air pollution. In short, making energy from woody biomass worsens the climate crisis, harms public health, often in environmental justice communities, industrializes and depletes forests, and burdens taxpayers because these products are so costly.[1]

A. Bioenergy production using woody biomass is carbon-emitting, not carbon neutral.

Bioenergy proponents falsely claim that making bioenergy using woody biomass is carbon neutral, asserting these processes lead to no net increase of CO_2 to the atmosphere. This incorrect claim is non-sensical on its face and has been repeatedly debunked by scientific experts and assessments,[2] including the Environmental Protection Agency's Science Advisory Board and Intergovernmental Panel on Climate Change (IPCC).[3] Making energy and fuels using woody

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[1] Center for Biological Diversity, Forest Biomass Energy is a False Solution (2021), https://www.biologicaldiversity.org/campaigns/debunking_the_biomass_myth/pdfs/Forest-Bioenergy-Briefing-Book-March-2021.pdf

[2] Mackey, B.G. et al., Burning forest biomass is not an effective climate mitigation response and conflicts with biodiversity adaptation, 4 Climate Resilience and Sustainability e70015 (2025), https://doi.org/10.1002/cli2.70015

[3] Letter from John Beddington, et al. to EU Parliament regarding forest biomass (Jan. 9, 2018), http://empowerplants.files.wordpress.com/2018/01/scientist-letter-on-eu-forest-biomass-796-signatories-as-of-january-16-2018.pdf; Letter from Michael Honeycutt, U.S. EPA Sci. Advisory Bd., to Andrew Wheeler, U.S. EPA Administrator, SAB Review of Framework for Assessing Biogenic CO2 Emissions from Stationary Sources (Mar. 5, 2019), https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=539269&Lab=OAP at 2 ("not all biogenic emissions are carbon neutral nor net additional to the atmosphere, and assuming so is inconsistent with the underlying science"); IPCC, Frequently Asked Questions, Intergovernmental Panel on Climate Change (IPCC) Task Force on National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/faq/faq.html at Q2-10 ("The IPCC

biomass is polluting across the lifecycle, resulting in decreased forest carbon sequestration; substantial upstream emissions from biomass extraction, transport, processing, and storage; and significant downstream emissions from combustion, gasification, and pyrolysis.

The CEC must fully account for all these sources of emissions in assessing the climate impacts of bioenergy made from forest biomass and woody agricultural biomass in the IEPR:

Decreased forest carbon sequestration: Cutting down trees ends their carbon sequestration. Because a tree's carbon sequestration rate increases with size, large trees capture carbon more efficiently than smaller trees.[4] Therefore, it takes many years for trees that grow back after logging/thinning to become large enough to draw down the same amount of carbon as the trees that were cut, resulting in decreased forest carbon sequestration.

Substantial upstream emissions are released during cutting, extraction, transport, and processing of woody biomass in preparation for making bioenergy and fuels. Climate and air pollution is released from the use of heavy machinery to cut and extract trees from forests; the use of fertilizers and pesticides after cutting; transporting biomass often long distances in diesel trucks; and processing biomass through chipping and drying.[5] For example, the biomass-to-methane pilot project proposed by PG&E and West Biofuels involved estimated truck deliveries of biomass averaging 2,700 vehicle miles per year and a maximum of 9,000 vehicle miles per year,[6] releasing an estimated 3.79 to 12.65 metric tons of CO_2 per year.[7] The Public Utilities Commission rejected this pilot proposal because the PG&E failed to demonstrate that it would reduce greenhouse gas emissions.[8]

Methane emissions from wood chip storage piles and log landings: The wood chip storage piles and log landings at biomass facilities release substantial methane emissions that can be large enough to significantly add to the overall climate impact of bioenergy production.[9] One

Guidelines do not automatically consider biomass used for energy as 'carbon neutral,' even if the biomass is thought to be produced sustainably)

[4] Stephenson, N.L. et al., Rate of tree carbon accumulation increases continuously with tree size; 507 Nature 90 (2014), https://www.nature.com/articles/nature12914; Moomaw, William R. et al., Focus on the role of forests and soils in meeting climate change mitigation goals: summary, 15 Environmental Research Letters 045009 (2020), https://iopscience.iop.org/article/10.1088/1748-9326/ab6b38

[5] Roder, Mirjam et al., How certain are greenhouse gas reductions from bioenergy? Life cycle assessment and uncertainty analysis of wood pellet-to-electricity supply chains from forest residues, 79 Biomass and Bioenergy 50 (2015), DOI: 10.1016/j.biombioe.2015.03.030.

[6] Application 23-06-023, Testimony on Pacific Gas and Electric Company's Application for Approval of the Woody Biomass to Renewable Natural Gas Pilot Project (Feb. 16, 2023), https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M529/K871/529871040.PDF (page 4).

[7] *Id.* at 5.

[8] CPUC Decision 25-05-003 (May 21, 2025), https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M566/K975/566975547.PDF.

[9] Wihersaari, M., Evaluation of greenhouse gas emission risks from storage of wood residue, 28 Biomass and Bioenergy 444 (2005); Whittaker, C. et al., Dry matter losses and methane emissions during wood chip storage: the impacts on full life cycle greenhouse gas savings of short rotation coppice willow for heat, 9 Bioenergy Research 820 (2016); Vantellingen, J. & S.C. Thomas, Log landings are methane emissions hotspots in managed forests, 51 Canadian Journal of Forest Research 1916 (2021).

study reported that wood chip piles can cause "remarkable" methane emissions as well as nitrous oxide (N_2O) emissions, and that "greenhouse gas emissions from storage [in wood chip piles] can, in some cases, be much greater than emissions from the rest of the biofuel production and transportation chain."[10]

Significant downstream emissions: The main processes used to turn woody biomass into energy and fuels—combustion, gasification and pyrolysis—are dirty processes that emit significant climate and air pollution.[11] Combusting woody biomass to make electricity is more carbon-polluting at the smokestack than coal per unit of energy produced.[12] Biomass gasification and pyrolysis are similarly dirty. Gasification and pyrolysis heat biomass to high temperatures using water and a controlled oxygen stream (or no oxygen in the case of pyrolysis) to produce a "syngas" that contains large amounts of CO_2, as well as the climate super-pollutant methane (CH_4).[13]

Bioenergy production—including using "residues"—is not carbon neutral. Bioenergy proponents incorrectly claim that bioenergy production is carbon neutral by (1) ignoring upstream emissions and foregone carbon sequestration and (2) taking credit for future forest growth, ignoring the time lags and uncertainty in that growth. Specifically, bioenergy proponents immediately offset the CO_2 emissions released from logging and biomass combustion, gasification and pyrolysis by taking credit for the CO_2 that will be absorbed by future tree growth.[14] This is misleading because forest growth takes time and is uncertain—there is no requirement that cut forests will be allowed to grow back or that forests won't be converted to other land uses. Once trees are cut, numerous studies show it takes many decades to more than a century—if ever—for forests to regrow and drawdown the CO_2 emissions that were released when they were cut and turned into energy or fuels.[15]

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[10] Wihersaari, M., Evaluation of greenhouse gas emission risks from storage of wood residue, 28 Biomass and Bioenergy 444 (2005).

[11] Center for Biological Diversity, Don't Be Fooled by Biomass Energy, https://biologicaldiversity.org/programs/climate_law_institute/energy_and_global_warming/pdfs/Don't-Be-Fooled-by-Biomass-False-Solutions-fact-sheet-CBD.pdf

[12] Sterman, John et al., Does replacing coal with wood lower CO2 emissions? Dynamic lifecycle analysis of wood bioenergy, 13 Env't Rsch. Letters 015007 (2018), https://iopscience.iop.org/article/10.1088/1748-9326/aaa512; Sterman, John et al., Does wood bioenergy help or harm the climate?, 78 Bulletin of the Atomic Scientists 128 (2022), https://doi.org/10.1080/00963402.2022.2062933

[13] Partnership for Policy Integrity, Air pollution from biomass energy, https://www.pfpi.net/air-pollution-2/; Liu, Wu-Jun et al., Fates of chemical elements in biomass during its pyrolysis, 117 Chemical Reviews 6367 (2017), https://pubs.acs.org/doi/10.1021/acs.chemrev.6b00647; Pang, Yoong Xin et al., Analysis of environmental impacts and energy derivation potential of biomass pyrolysis via piper diagram, 154 Journal of Analytical and Applied Pyrolysis 104995 (2021), https://doi.org/10.1016/j.jaap.2020.104995

[14] John Sterman et al., Does wood bioenergy help or harm the climate?, 78 Bulletin of the Atomic Scientists 128 (2022), https://doi.org/10.1080/00963402.2022.2062933

[15] Manomet Ctr. for Conservation Scis., Massachusetts Biomass Sustainability and Carbon Policy Study: Report to the Commonwealth of Massachusetts Department of Energy Resources (2010), https://www.mass.gov/doc/manometbiomassreportfullhirezpdf/download; Hudiburg et al. T.W., Regional carbon dioxide implications of forest bioenergy production, 1 Nature Climate Change 419 (2011), https://doi.org/10.1038/nclimate1264; Law, B.E. & M.E. Harmon, Forest sector carbon management, measurement and verification, and discussion of policy related to climate change, 2 Carbon Mgmt. 73 (2011),

Importantly, research shows that making bioenergy using forest "residues" or "waste" feedstocks—referring to biomass that would otherwise be disposed of—is also not carbon neutral. The combustion or gasification of forest residues leads to a *net increase* of carbon emissions in the atmosphere for decades.[16] One study found that combusting all wood types, including forest residues (defined as branches, tree tops and bark) and fire-killed trees, to generate electricity increases carbon emissions in the atmosphere for more than a century compared to generating that electricity with fossil gas.[17] These conclusions would be similar for gasification and pyrolysis since CO_2 is a primary product.

As summarized in a recent review by Mackey et al. (2025), "burning forest biomass for energy is not carbon neutral or beneficial":

> We found that models used to evaluate bioenergy rely on key assumptions that are in themselves capable of delivering results supportive of bioenergy as an effective strategy. Yet there is abundant evidence that these assumptions are invalid and that burning forest biomass for energy is not carbon neutral or beneficial. From our assessment, we concluded that burning forest biomass, including logging residues, increases atmospheric CO_2 concentration; land sector reporting using net greenhouse gas inventories obscures the impact of forest harvesting on ecosystem carbon stocks; and biomass energy will most likely displace other renewable energy, rather than fossil fuels.[18]

In short, making fuels and energy using woody biomass, including residues, is carbon-polluting, resulting in foregone forest carbon sequestration and significant upstream and downstream carbon emissions.

B. Bioenergy production with CCS (BECCS/BiCRS) is carbon-emitting, not "carbon negative."

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https://doi.org/10.4155/cmt.10.40; Mitchell, S.R. et al., Carbon debt and carbon sequestration parity in forest bioenergy production, 4 Global Change Biology Bioenergy 818 (2012), https://doi.org/10.1111/j.1757-1707.2012.01173.x; Schulze, E.D. et al., Large-scale bioenergy from additional harvest of forest biomass is neither sustainable nor greenhouse gas neutral, 4 Global Change Biology Bioenergy 611 (2012), DOI:10.1111/j.1757-1707.2012.01169.x; Holtsmark, Bjart, The outcome is in the assumptions: Analyzing the effects on atmospheric CO_2 levels of increased use of bioenergy from forest biomass, 5 GCB Bioenergy 467 (2013), https://doi.org/10.1111/gcbb.12015; Sterman, John et al., Does replacing coal with wood lower CO_2 emissions? Dynamic lifecycle analysis of wood bioenergy, 13 Env't Rsch. Letters 015007 (2018), https://doi.org/10.1088/1748-9326/aaa512.

[16] Booth, Mary S. Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy, 13 Env't Rsch. Letters 035001 (2018), https://doi.org/10.1088/1748-9326/aaac88; Sterman, John et al., Does wood bioenergy help or harm the climate?, 78 Bulletin of the Atomic Scientists 128 (2022), https://doi.org/10.1080/00963402.2022.2062933.

[17] Laganiere, Jerome et al., Range and uncertainties in estimating delays in greenhouse gas mitigation potential of forest bioenergy sourced from Canadian forests, 9 GCB Bioenergy 358 (2017), https://doi.org/10.1111/gcbb.12327.

[18] Mackey, B.G. et al., Burning forest biomass is not an effective climate mitigation response and conflicts with biodiversity adaptation, 4 Climate Resilience and Sustainability e70015 (2025), https://doi.org/10.1002/cli2.70015

Bioenergy proponents incorrectly claim that putting CCS equipment on bioenergy facilities will make bioenergy production "carbon negative," meaning it will lead to a net removal of CO_2 from the atmosphere. This is demonstrably false.[19] Because bioenergy production is not "carbon neutral," adding CCS will not make it "carbon negative."[20] Instead, bioenergy production with CCS will increase CO_2 in the atmosphere in several ways: (1) cutting trees decreases forest carbon sequestration; (2) upstream emissions are not captured; and (3) CCS has proven to be ineffective in capturing downstream emissions from smokestacks and risks inevitable leaks and blowouts, as detailed below.

CCS has consistently proven to be exceptionally ineffective, unsafe, expensive, and unjust, targeting communities of color and low-income communities.[21] Putting CCS equipment on biomass combustion, gasification, and pyrolysis facilities ("BECCS" or "BiCRS") would still lead to significant CO_2 and co-pollutants emissions and add new health and safety risks, endangering communities and the climate.

Real-world data demonstrates that CCS has proven to be ineffective and inefficient in practice, despite decades of development and billions of dollars of investment. BECCS/BiCRS proponents often assume an idealized 90% to 95% carbon capture rate at the smokestack for CCS projects. However, real-world data shows that CCS projects around the world are not meeting these carbon capture targets, often by large margins. According to one estimate, nearly 90% of proposed CCS capacity in the power sector has either failed during implementation or has otherwise been suspended early.[22] An example is the billion-dollar Petra Nova carbon capture facility in Texas which was shuttered after only 4 years. Though it promised a CO_2 capture rate of 90%, when factoring in emissions from the gas-fired combustion turbine used to power the facility, it substantially underperformed this benchmark.[23] Meanwhile, internationally, Chevron, operator of Australia's only commercial-scale CCS project, admitted that it failed to meet its five-year capture target of 80% CO_2 and faced the ire of regulators for allowing millions more tons of CO_2 to be emitted than promised.[24] In short, evidence shows that idealized carbon capture rates are not realistic and substantially under-estimate the carbon emissions from CCS projects.

[19] Booth, Mary, Once you see it, you can't unsee it: "negative emissions" from BECCS is a scam, Partnership for Policy Integrity, July 2025, https://www.pfpi.net/2025/07/once-you-see-it-you-cant-unsee-it-negative-emissions-from-beccs-is-a-scam/
[20] https://www.biofuelwatch.org.uk/wp-content/uploads/BECCS-letter-by-scientists-and-economists-1.pdf.
[21] Center for Biological Diversity, Carbon Capture and Storage is a False Solution for the Climate and Our Communities (2022), https://biologicaldiversity.org/campaigns/carbon-capture-and-storage/pdfs/CCS-explainer.pdf.
[22] IEEFA, The carbon capture crux: Lessons learned (Sept. 2022), https://ieefa.org/resources/carbon-capture-crux-lessons-learned.
[23] Mattei, S. and Schlissel, D. The ill-fated Petra Nova CCS project: NRG Energy throws in the towel, IEEFA (October 5, 2022), https://ieefa.org/resources/ill-fated-petra-nova-ccs-project-nrg-energy-throws-towel; IEEFA, The carbon capture crux: Lessons learned (Sept. 2022), https://ieefa.org/resources/carbon-capture-crux-lessons-learned.
[24] Adam Morton, The Guardian, "'A shocking failure': Chevron criticized for missing carbon capture target at WA gas project" (Jul. 2021), https://www.theguardian.com/environment/2021/jul/20/a-shocking-failure-chevron-criticised-for-missing-carbon-capture-target-at-wa-gas-project.

In fact, studies show that when the lifecycle greenhouse gas emissions of CCS projects are taken into account, the purported climate benefits of CCS evaporate.[25] For one, CCS operations are very energy-intensive given the high energy requirements needed to separate, compress, transport, and inject CO_2—typically requiring at least 15-25% more energy, which results in increased greenhouse gas and air pollution emissions.[26] Analysis from the Institute for Energy Economics and Financial Analysis found that the energy required to capture, transport, and inject carbon underground "materially reduces its net benefit."[27] A lifecycle analysis of the Petra Nova CCS project found that "the [CCS] equipment captured the equivalent of only 10-11% of the emissions they produced, averaged over 20 years."[28]

There is also the inevitable risk that captured CO_2 transported via pipeline, rail, or truck, and then stored underground, will leak back to the atmosphere. CO_2 pipelines have a history of rupturing which not only releases captured CO_2 to the atmosphere but poses serious public health and safety risks.[29] In 2020, for example, residents of rural Satartia, Mississippi experienced a CO_2 pipeline rupture that resulted in more than 300 residents being evacuated and 46 hospitalized, with victims found gasping for breath, nauseated, foaming at the mouth, and rendered unconscious. Months later, residents continued to suffer from mental fogginess, lung dysfunction, chronic fatigue, and stomach disorders.[30] Such risks are unwarranted for the sake of an unsafe and unproven technology. Carbon capture projects similarly have a history of leakage. For instance, an ethanol CCS project in Decatur, Illinois, run by the Archer Daniels Midland agribusiness company, was found to be leaking because of the monitoring wells' corrosion-prone

[25] Jacobson, M.Z., The health and climate impacts of carbon capture and direct air capture, 12 Energy Environ Sci 3567 (2019), https://web.stanford.edu/group/efmh/jacobson/Articles/Others/19-CCS-DAC.pdf; Howarth, R.W. & M.Z. Jacobson, How green is blue hydrogen? 9 Energy Science & Engineering 1676 (2021), https://doi.org/10.1002/ese3.956; Grubert, E. & F. Sawyer, US power sector carbon capture and storage under the Inflation Reduction Act could be costly with limited or negative abatement potential, 3 Environmental Research: Infrastructure and Sustainability 015008 (2023), https://iopscience.iop.org/article/10.1088/2634-4505/acbed9 ; Jacobson, M.Z. et al., Energy, health, and climate costs of carbon-capture and direct-air-capture versus 100%-wind-water-solar climate policies in 149 countries, 59 Environ Sci Technol 3034 (2025), https://pubs.acs.org/doi/10.1021/acs.est.4c10686

[26] Climate Action Network International, Position: Carbon Capture, Storage, and Utilisation (January 2021), https://climatenetwork.org/resource/can-position-carbon-capture-storage-and-utilisation/; IEEFA, The carbon capture crux: Lessons learned (Sept. 2022), https://ieefa.org/resources/carbon-capture-crux-lessons-learned.

[27] Clark Butler, IEEFA, "Carbon Capture and Storage Is About Reputation, Not Economics" at 4 (2020), https://ieefa.org/wp-content/uploads/2020/07/CCS-Is-About-Reputation-Not-Economics_July-2020.pdf.

[28] Jacobson, M.Z, The health and climate impacts of carbon capture and direct air capture, 12 Energy Environ Sci 3567 (2019).

[29] Pipeline Safety Trust, Regulatory and Knowledge Gaps in the Safe Transportation of Carbon Dioxide by Pipeline (2022), https://pstrust.org/wp-content/uploads/2022/10/CO2-Regulatory-and-Knowledge-Gaps-1.pdf; Dan Zegert, Huffington Post, "The Gassing of Satartia" (Aug. 2021), https://www.huffpost.com/entry/gassing-satartia-mississippi-co2-pipeline_n_60ddea9fe4b0ddef8b0ddc8f; Sarah Fowler, 'Foaming at the mouth': First responders describe scene after pipeline rupture, gas leak, The Clarion-Ledger (February 27, 2020), https://www.clarionledger.com/story/news/local/2020/02/27/yazoo-county-pipe-rupture-co-2-gas-leak-first-responders-rescues/4871726002/.

[30] Dan Zegert, Huffington Post, "The Gassing of Satartia" (Aug. 2021), https://www.huffpost.com/entry/gassing-satartia-mississippi-co2-pipeline_n_60ddea9fe4b0ddef8b0ddc8f.

steel lining.[31] This is on top of the project already proving to be inefficient, only storing half the emissions the company projected,[32] amounting to a mere 10-12% of the facility's annual emissions.[33]

C. Bioenergy production using woody biomass emits health-harming air pollution, has high water usage, targets environmental justice communities, and harms forest ecosystems.

The IEPR must thoroughly account for the air pollution and health harms, high water usage, environmental justice harms, and forest ecosystem harms from biomass gasification and pyrolysis projects to produce bioenergy.

Biomass gasification and pyrolysis produce a wide array of health-harming co-pollutants that must be accounted for. Gasification of biomass at high temperatures (800-1200°C) produces a "syngas" containing large amounts of CO_2, as well as methane (CH_4), carbon monoxide (CO), and hydrogen (H_2), in addition to liquid hydrocarbons and tar, solid char and ash residues, and a wide array of air pollutants.[34] Pyrolysis heats biomass to temperatures of 350-600°C without oxygen and produces similar products to gasification, including large amounts of CO_2, with the addition of pyrolytic oil and larger quantities of char. Heath-harming pollutants from biomass gasification and pyrolysis include fine particulate matter, NOx, SOx, benzene, toluene and xylenes (BTEX), tars and soot, and persistent organic pollutants such as polycyclic aromatic hydrocarbons (PAHs) (e.g., naphthalene), polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs).[35] Fine particulate matter (PM 2.5) can penetrate deeply into the lungs, even enter the bloodstream, and cause serious health problems. The formation of liquid tar is an inherent

[31] Annie Snider & Ben Lefebvre, E&E News, "Carbon storage projects hit a hurdle: Corroding steel (Oct. 2024), https://subscriber.politicopro.com/article/eenews/2024/10/09/carbon-storage-projects-hit-a-hurdle-corroding-steel-ee-00182889.

[32] Jonathan Hettinger, Investigate Midwest, "Despite hundreds of millions in tax dollars, ADM's carbon capture program still hasn't met promised goals (Nov. 2020), https://investigatemidwest.org/2020/11/19/despite-hundreds-of-millions-in-tax-dollars-adms-carbon-capture-program-still-hasnt-met-promised-goals/.

[33] Brendan Gibbons, Oil & Gas Watch, "In Illinois, a massive taxpayer-funded carbon capture project fails to capture about 90 percent of plant's emissions (Apr. 2024), https://news.oilandgaswatch.org/post/in-illinois-a-massive-taxpayer-funded-carbon-capture-project-fails-to-capture-about-90-percent-of-plants-emissions

[34] Shayan, E. et al., Hydrogen production from biomass gasification; a theoretical comparison of using different gasification agents, 159 Energy Conversion and Management 30 (2018), https://doi.org/10.1016/j.enconman.2017.12.096.

[35] Partnership for Policy Integrity, Air pollution from biomass energy, https://www.pfpi.net/air-pollution-2/; Liu, Wu-Jun et al., Fates of chemical elements in biomass during its pyrolysis, 117 Chemical Reviews 6367 (2017), https://pubs.acs.org/doi/10.1021/acs.chemrev.6b00647; Yao, Zhiyi et al., Particulate emissions from the gasification and pyrolysis of biomass: Concentration, size distributions, respiratory deposition-based control measure evaluation, 242 Envtl. Pollution 1108 (2018), https://doi.org/10.1016/j.envpol.2018.07.126; Saxe, Jennie Perey et al., Just or bust? Energy justice and the impacts of siting solar pyrolysis biochar production facilities, 58 Energy Research & Social Sci. 101259 (2019) https://doi.org/10.1016/j.erss.2019.101259; Pang, Yoong Xin et al., Analysis of environmental impacts and energy derivation potential of biomass pyrolysis via piper diagram, 154 J. of Analytical and Applied Pyrolysis 104995 (2021), https://doi.org/10.1016/j.jaap.2020.104995; Li, Simeng, Reviewing Air Pollutants Generated during the Pyrolysis of Solid Waste for Biofuel and Biochar Production: Toward Cleaner Production Practices, 16 Sustainability 1169 (2024), https://doi.org/10.3390/su16031169.

problem in biomass gasification. Tar contains toxic substances such as benzene, toluene, and naphthalene, while tar build-up also lowers energy efficiency, interrupts continuous operation, and increases maintenance costs of gasification processes.[36] Methods to clean tar from equipment would create large amounts of toxic wastewater, with resulting environmental and community harms.[37]

Biomass gasification to make hydrogen has extremely high water usage. One recent study estimated that biomass gasification uses 306 kg water per kg of H_2 produced, which is orders of magnitude more than electrolysis production pathways estimated at 9 to 18 kg water per kg H_2.[38] This would put extra stress on water supplies in areas already suffering from climate crisis-charged drought.

Proposals to produce energy from woody biomass frequently target environmental justice communities already overburdened with pollution. For example, in California's Central Valley—which has some of nation's worst air pollution—idled bioenergy facilities in or near communities, such as the Madera biomass facility, are being proposed for conversion to biomass gasification or pyrolysis facilities to produce hydrogen, threatening to worsen environmental injustice for these communities.[39] Another recent proposal envisions a massive build-out of 50 to 100 biomass processing facilities—many of them biomass gasification and pyrolysis facilities—that would be concentrated in the Central Valley, paired with a polluting network of CO_2 pipelines, railcars, and trucking, and the injection of 100 million tons of CO_2 underground each year,[40] with inevitable harms from air pollution, water pollution, noise pollution, CO_2 leakage, earthquake risks, and ecosystem damage.

Incentivizing the production and commodification of bioenergy from woody biomass will drive an increase in forest logging and thinning, harming forest ecosystems and their carbon storage. Logging/thinning forests degrades wildlife habitat and results in a net loss of carbon storage and sequestration from forests, at a time when we must reduce deforestation and protect forest carbon stores.[41] A recent review concluded that "the use of bioenergy results in major

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[36] He, Quing et al., Soot formation during biomass gasification: A critical review, 139 Renewable and Sustainable Energy Reviews 110710 (2021), https://doi.org/10.1016/j.rser.2021.110710.
[37] Luo, Xiang et al., "Biomass gasification: an overview of technological barriers and socio-environmental impact" in Gasification for Low-Grade Feedstock 1-15 (2018), https://www.intechopen.com/chapters/59423.
[38] Mehmeti, Andi et al., Life cycle assessment and water footprint of hydrogen production methods: from conventional to emerging technologies, 5 Environments 24 (2018).
[39] Clean Energy Systems, Clean Energy Systems Enters Into An Agreement to Acquire the Madera Biomass Power Plant (Jul. 12, 2022), https://www.cleanenergysystems.com/clean-energy-systems-enters-into-an-agreement-to-acquire-the-madera-biomass-power-plant.
[40] LLNL and DOE, Getting to Neutral: Options for Negative Carbon Emissions in California (2019), available at https://livermorelabfoundation.org/2019/12/19/getting-to-neutral/.
[41] Moomaw, William R. et al., Intact Forests in the United States: Proforestation mitigates climate change and serves the greatest good, Frontiers in Forests and Global Change (2019), https://doi.org/10.3389/ffgc.2019.00027;

negative cascading impacts for forest ecosystem integrity and consequently a reduction in the resilience and natural adaptive capacity of species in the face of climate change impacts."[42]

Logging and thinning forests and using those trees for bioenergy production would: 1) increase overall carbon emissions, 2) reduce the forest carbon sink, 3) lower forest ecosystem resilience; and 4) require massive public subsidies, reducing resources for truly low-carbon solar and wind energy.

D. Bioenergy projects using woody biomass are justified based on false claims.

The evidence is clear that making bioenergy from woody biomass releases large amounts of planet-heating CO_2 and toxic air pollutants, targets communities of color and low-income communities already suffering from high pollution burdens, depletes forests, and is extremely expensive, relying on massive public subsidies. Bioenergy proponents deploy a suite of inaccurate claims to justify these dirty projects:

1. Bioenergy proponents incorrectly claim that thinning forests for bioenergy will prevent wildfires and reduce carbon emissions.

Contrary to bioenergy proponents' claims, forest logging and thinning projects do not typically stop fires or reduce the amount of area burned.[43] Forest thinning projects can even increase fire intensity and rate of spread by creating hotter, drier, windier conditions and introducing invasive fire-prone grasses.[44] One comprehensive study covering three decades and 1,500 fires in the western US, including California, found that forests with the most protection from logging/thinning burned with the lowest intensities.[45] Instead, the amount of forest area burned is primarily influenced by weather and climate and has little relationship to the amount of forest area treated. [46] Regardless of logging/thinning, forests are burning in extreme fire weather conditions—periods of high temperatures, low humidity, and strong winds—which are becoming more prevalent due to anthropogenic climate change. Anthropogenic climate change has been

[42] Mackey, B.G. et al., Burning forest biomass is not an effective climate mitigation response and conflicts with biodiversity adaptation, 4 Climate Resilience and Sustainability e70015 (2025), https://doi.org/10.1002/cli2.70015
[43] Schoennagel, Tania et al., Adapt to more wildfire in western North American forests as climate changes, 114 PNAS 4582 (2017); Law, Beverly E. at al., Creating strategic reserves to protect forest carbon and reduce biodiversity losses in the United States, 11 Land 721 (2022).
[44] Lesmeister, D.B., et al., Mixed-severity wildfire and habitat of an old-forest obligate, 10 Ecosphere Article e02696 (2019); Lesmeister, D.B., et al., Northern spotted owl nesting forests as fire refugia: a 30-year synthesis of large wildfires, 17 Fire Ecology Article 32 (2021); DellaSala, D, et al., Have Western USA fire suppression and megafire active management approaches become a contemporary Sisyphus? 268 Biological Conservation 109499 (2022).
[45] Bradley, C.M. et al., Does increased forest protection correspond to higher fire severity in frequent-fire forests of the western United States? 7 Ecosphere e01492 (2016).
[46] Schoennagel, Tania et al., Adapt to more wildfire in western North American forests as climate changes, 114 PNAS 4582 (2017); Law, Beverly E. at al., Creating strategic reserves to protect forest carbon and reduce biodiversity losses in the United States, 11 Land 721 (2022), https://doi.org/10.3390/land11050721; Reilly, M.J., et al., Cascadia Burning: The historic, but not historically unprecedented, 2020 wildfires in the Pacific Northwest, USA, 13 Ecosphere e4070 (2022).

identified as the primary driver of the increases in area burned, extreme fire weather, and community wildfire destruction in California in recent decades.[47]

Biomass proponents often claim that logging/thinning will reduce the amount of area burned and lead to a decrease in wildfire emissions, but this is not supported. Instead, numerous studies have demonstrated that broad-scale thinning for wildfire management leads to more carbon emissions than it prevents from being released in a wildfire, and results in a net increase of carbon emissions to the atmosphere and net decrease in forest carbon storage.[48] This is primarily because the carbon loss from forest thinning followed by wildfire is greater than the carbon loss from wildfire in un-thinned stands, when cumulative tree mortality is accounted for. In other words, thinning kills more trees than it prevents from being killed in wildfires.[49]

In contrast to thinning, wildfire consumes a small percentage of forest carbon while improving availability of key nutrients and stimulating rapid forest regeneration. Research from California shows that even very severe fires combust less than 2% of living tree biomass on average.[50] Most of what is combusted is small material such as needles, twigs and small branches. Dead trees left standing in the forest after intense fires provide critical carbon storage by retaining the vast majority of their carbon and undergoing subsequent slow decay.[51] Dead

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[47] Abatzoglou, J.T. and Williams, A.P., Impact of anthropogenic climate change on wildfire across western US forests, 113 Proceedings of the National Academy of Sciences 11770 (2016); Westerling, A.L.R., Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring, 371 Phil. Trans. R. Soc. B 20150178 (2016); Williams, A., et al., Observed impacts of anthropogenic climate change on wildfire in California, 7 Earth's Future 892 (2019), https://doi.org/10.1029/2019EF001210; Goss, M. et al., Climate change is increasing the likelihood of extreme autumn wildfire conditions across California, 5 Environmental Research Letters 1094016 (2020), https://doi.org/10.1088/1748-9326/ab83a7; Zhuang, Y. et al., Quantifying contributions of anthropogenic forcings on increased fire weather risk over the western United States, 118 PNAS e2111875118 (2021), https://doi.org/10.1073/pnas.2111875118; Hawkins, L.R. et al., Anthropogenic influence on recent severe autumn fire weather in the west coast of the United States, 49 Geophysical Research Letters e2021GL095496 (2022), https://doi.org/10.1029/2021GL095496; Jain, P. et al., Observed increases in extreme fire weather driven by atmospheric humidity and temperature, 12 Nature Climate Change 63 (2022), https://doi.org/10.1038/s41558-021-01224-1; Turco, M. et al., Anthropogenic climate change impacts exacerbate summer forest fires in California, 120 PNAS e2213815120 (2023), https://doi.org/10.1073/pnas.2213815120

[48] Mitchell, S.R. et al., Forest fuel reduction alters fire severity and long-term carbon storage in three Pacific Northwest ecosystems, 19 Ecological Applications 643 (2009); Campbell, J.L. et al., Can fuel-reduction treatments really increase forest carbon storage in the western US by reducing future fire emissions? 10 Frontiers in Ecology and Environment 83 (2012); Bartowitz, Kristina J. et al., Forest carbon emission sources are not equal: putting fire, harvest, and fossil fuel emissions in context, 5 Frontiers in Forests and Global Change 867112 (2022), https://doi.org/10.3389/ffgc.2022.867112; Law, Beverly E. at al., Creating strategic reserves to protect forest carbon and reduce biodiversity losses in the United States, 11 Land 721 (2022), https://doi.org/10.3390/land11050721.

[49] Hanson, Chad, Cumulative severity of thinned and unthinned forests in a large California wildfire, 11 Land 373 (2022); Baker, B.C. and C.T. Hanson, Cumulative tree mortality from commercial thinning and a large wildfire in the Sierra Nevada, California, 11 Land 995 (2022).

[50] Harmon, M.E. et al., Combustion of aboveground wood from live trees in mega-fires, CA, USA, 13 Forests 391 (2022).

[51] Most combustion during wildfire comes from needles and small branches less than 2 centimeters in diameter. See, e.g., Campbell, John et al., Pyrogenic carbon emission from a large wildfire in Oregon, United States, 112 Journal of Geophysical Research Biogeosciences G04014 (2007), https://doi.org/10.1029/2007JG000451; Meigs, Garrett W. et al., Forest fire impacts on carbon uptake, storage, and emission: The role of burn severity in the Eastern Cascades, Oregon, 12 Ecosystems 1246 (2009), https://doi.org/10.1007/s10021-009-9285-x; Stenzel, Jeffrey E. et al., Fixing a

trees do not increase wildfire risk, including no increase in fire severity, rate of spread, or extent,[52] and do not need to be removed from the forest. Instead, dead trees—standing or fallen—provide numerous ecological benefits such as wildlife habitat, soil stabilization, water quality, and carbon storage.[53] In short, logging/thinning is the largest cause of carbon loss from California (and U.S.) forests—rather than wildfire.[54]

2. Bioenergy proponents incorrectly claim that thinning forests for bioenergy is needed for community wildfire safety.

A large body of research and on-the-ground experience demonstrates that the most effective way to protect communities from wildfires is to reduce the ignitability of structures themselves through proven "home hardening" retrofits paired with vegetation trimming within 60 to 100 feet of homes and other structures—not logging/thinning forests.[55] California-focused studies have found that vegetation management beyond 100 feet from homes and other structures provide *no additional benefit* for protecting those structures from burning.[56]

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snag in carbon emissions estimates from wildfires, 25 Global Change Biology 3985 (2019), https://doi.org/10.1111/gcb.14716 at Table 1; Harmon, M.E. et al., Combustion of aboveground wood from live trees in mega-fires, CA, USA, 13 Forests 391 (2022), https://doi.org/10.3390/f13030391.

[52] Bond, M.L. et al., Influence of pre-fire tree mortality on fire severity in conifer forests of the San Bernardino Mountains, California, 2 The Open Forest Science J. 41 (2009), http://dx.doi.org/10.2174/1874398600902010041; Hart, Sarah J. et al., Area burned in the western United States is unaffected by recent mountain pine beetle outbreaks, 112 PNAS 4375 (2015), https://doi.org/10.1073/pnas.1424037112; Meigs, Garrett W. et al., Do insect outbreaks reduce the severity of subsequent forest fires?, 11 Env't Rsch. Letters 045008 (2016), DOI: 10.1088/1748-9326/11/4/045008; Hart, Sarah J. & D.L. Preston, Fire weather drives daily area burned and observations of fire behavior in mountain pine beetle affected landscapes, 15 Env't Rsch. Letters 054007 (2020), DOI 10.1088/1748-9326/ab7953.

[53] Swanson, M.E. et al., The forgotten stage of forest succession: early-successional ecosystems on forested sites, 9 Frontiers in Ecology and Environment 117 (2011); DellaSala, D.A. et al., Complex early seral forests of the Sierra Nevada: what are they and how can they be managed for ecological integrity? 34 Natural Areas Journal 310 (2014); Hutto, R.L. et al., Toward a more ecologically informed view of severe forest fires, 7 Ecosphere e01255 (2016).

[54] Depro, B.M., et al., Public land, timber harvests, and climate mitigation: Quantifying carbon sequestration potential on U.S. public timberlands, 255 Forest Ecology and Management 1122 (2008); Harris, N.L. et al., Attribution of net carbon change by disturbance type across forest lands of the conterminous United States, 11 Carbon Balance and Management 24 (2016)); Law, B.E. et al., Land use strategies to mitigate climate change in carbon dense temperate forests, 115 Proceedings of the National Academy of Sciences of the United States of America 3663 (2018); Erb, Karl-Heinz et al., Unexpectedly large impact of forest management and grazing on global vegetation biomass, 553 Nature 73 (2018); Hudiburg, Tara W. et al., Meeting GHG reduction targets requires accounting for all forest sector emissions, 14 Environmental Research Letters 095005 (2019); Peng, Liqing et al., The carbon costs of global wood harvests, 620 Nature 110 (2023), https://doi.org/10.1038/s41586-023-06187-1.

[55] Cohen, J.D., Preventing disaster: home ignitability in the Wildland-Urban Interface, 98 Journal of Forestry 15 (2000); Cohen, J.D. and R.D. Stratton, Home destruction examination: Grass Valley Fire, U.S. Forest Service Technical Paper R5-TP-026b (2008); Gibbons, P. et al., Land management practices associated with house loss in wildfires, 7 PLoS ONE e29212 (2012); Scott, J.H. et al., Examining alternative fuel management strategies and the relative contribution of National Forest System land to wildfire risk to adjacent homes – A pilot assessment on the Sierra National Forest, California, USA, 362 Forest Ecology and Management 29 (2016); Knapp, E. et al., Housing arrangement and vegetation factors associated with single-family home survival in the 2018 Camp Fire, 17 Fire Ecology (2021); Calkin, David E. et al., Wildland-urban fire disasters aren't actually a wildfire problem, 120 PNAS e2315797120 (2023).

[56] Syphard, A.D. et al., The role of defensible space for residential structure protection during wildfires, 23 International Journal of Wildland Fire 1165 (2014).

A 2023 study co-authored by U.S. Forest Service scientists concluded that "[t]he best way to make existing wildfire-vulnerable developments ignition resistant is to work within the limited area of the 'home ignition zone'—a home and its surroundings within 100 feet (which may include neighboring homes)."[57] The scientists emphasized that addressing the community wildfire destruction crisis will require changing from a "focus on the wildlands to one centered on the structure and its immediate surroundings," highlighting that the current approach "primarily directed toward fuel treatments in natural areas" is ineffective and insufficient.

Similarly, Calkin et al. (2014) emphasized that treating wildland fuels does not "measurably impact the susceptibility of homes to ignition and subsequent destruction."[58] The study highlighted that home losses are increasing despite enormous investments in modifying wildland fuels because home susceptibility to wildfire is a direct function of their ignitability, which is dependent of the small area of the "home ignition zone" which "is independent of fire behavior in the nearby wildlands." According to the study, "research demonstrates a home's characteristics in relation to its immediate surroundings principally determine home ignition potential during extreme wildfires." The scientists emphasized that "[o]vercoming perceptions of wildland-urban interface fire disasters as a wildfire control problem rather than a home ignition problem, determined by home ignition conditions, will reduce home loss."

In a California-focused study, Syphard et al. (2014) found that structures were more likely to survive a fire if the vegetation was treated in the defensible space immediately adjacent to them.[59] These scientists reported that "[t]he most effective treatment distance varied between 5 and 20 m (16–58 ft) from the structure, *but distances larger than 30 m (100 ft) did not provide additional protection*, even for structures located on steep slopes. The most effective actions were reducing woody cover up to 40% immediately adjacent to structures and ensuring that vegetation does not overhang or touch the structure." Subsequent studies have re-affirmed the important role of defensible space adjacent to structures.[60]

3. Bioenergy proponents present a false choice between pile burning forest biomass or making bioenergy.

Bioenergy proponents often claim that converting cut trees into bioenergy is cleaner than pile burning them, but this is a false choice. There are alternative methods of managing forest residues that do not require making dirty bioenergy or pile burning. The most beneficial

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[57] Calkin, David E. et al., Wildland-urban fire disasters aren't actually a wildfire problem, 120 PNAS e2315797120 (2023).
[58] Calkin, David E. et al., How risk management can prevent future wildfire disasters in the wildland-urban interface, 111 PNAS 746 (2014).
[59] Syphard, A.D. et al., The role of defensible space for residential structure protection during wildfires, 23 International Journal of Wildland Fire 1165 (2014).
[60] Syphard, Alexandra D. et al., The importance of building construction materials relative to other factors affecting structure survival during wildfire, 21 International Journal of Disaster Risk Reduction 140 (2017); Syphard, Alexandra D. et al., The relative influence of climate and housing development on current and projected future fire patterns and structure loss across three California landscapes, 56 Global Environmental Change 41 (2019).

management practice for forest biomass residues is leaving these materials in the forest to maintain soil organic carbon, retain vital nutrients in the ecosystem, and support wildlife habitat.[61] Forest residues break down over time, releasing nutrients that stimulate forest growth and adding to forest soil carbon, which keeps carbon circulating in forest ecosystems. Coarse woody debris and downed logs provide important wildlife habitat.[62] Forest materials can be broken down into large pieces and scattered in a way that maintains their contact with the forest floor, often called "lop and scatter," or masticated or chipped into smaller pieces and scattered across the forest floor. Research indicates that chipping, mastication, and "lop and scatter" of materials in the forest do not appear to increase wildfire intensity.[63] When forest residues are scattered across the forest floor, without creating deep layers or piles of material, they are unlikely to produce methane emissions, in contrast to the significant methane emissions that are released by the log landings and wood chip piles that are part of bioenergy production.

Furthermore, the Springsteen et al. (2011) study[64] that bioenergy proponents rely on to assert that bioenergy production is cleaner than pile burning is a now outdated, limited study that has significant data omissions and should be updated. To name a few problems, the study (1) failed to account for the large range and uncertainty in pile burning emissions factors that could significantly affect the study's conclusions; (2) failed to account for methane emissions from wood chip storage piles at bioenergy facilities; and (3) used emissions factors to represent biomass boilers based on a single facility, the SPI cogeneration plant in Lincoln, using industry data that likely fails to represent the chronic emissions exceedances and violations committed by bioenergy facilities. For example, our review of records obtained from air districts revealed at least 2,034 cases of excess emissions recorded across 18 California biomass plants between 2015 and 2021, including repeated exceedances of NOx, CO, and PM.

4. Bioenergy proponents present a false choice between pile burning agricultural materials or making bioenergy.

For agricultural biomass, there are far more sustainable alternatives for utilizing agricultural waste than using it to make bioenergy or pile burning. Alternatives such as mulching, and chipping and reincorporation, have been shown to promote soil health, increase

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[61] Walmsley, J.D. et al., Whole tree harvesting can reduce second rotation forest productivity, 257 Forest Ecology and Management 1104 (2009); Buccholz, Thomas et al., Mineral soil carbon fluxes in forests and implications for carbon balance assessments, 6 GCB Bioenergy 305 (2014); Achat, David et al., Forest soil carbon is threatened by intensive biomass harvesting, 5 Scientific Reports 15991 (2015), https://www.nature.com/articles/srep15991; Achat, David et al., Quantifying consequences of removing harvesting residues on forest soils and tree growth – A meta-analysis, 348 Forest Ecology Management 124 (2015).

[62] Harmon, M.E. et al., Ecology of coarse woody debris in temperature ecosystem, 34 Advances in Ecological Resources 59 (2004).

[63] Jesse K. Kreye et. al., Fire behavior in masticated fuels: a review, 314 Forest Ecology and Mgmt. 193 (2014), http://dx.doi.org/10.1016/j.foreco.2013.11.035; Jacobson, Kyle W. & Christopher A. Dicus, Effects of lop and scatter slash treatment on potential fire behavior and soil erosion following a selection harvest in a coast redwood forest, Natural Resources Management (2006), https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1041&context=nrm_fac.

[64] Springsteen, Bruce et al., Emission reductions from woody biomass waste for energy as an alternative to open burning, 61 Journal of the Air & Waste Management Association (2011)

crop yields, create agricultural drought resistance, and sequester carbon in soils for the long-term.[65]

Whole orchard recycling is a chipping and reincorporation practice used in California with perennial crops like almonds. When an agricultural operation is ready to replant an orchard, the old orchard biomass is ground and shredded using land clearing equipment, and the resulting chips are reincorporated into the soil in preparation for new tree plantings. Following whole orchard recycling, studies have found that trees grew more, trees were more productive, trees were more efficient in irrigated water usage, soil nutrient content was greater, soils were able to hold more water, and the carbon sequestered in the soil was greater — out to nine years following the start of the study.[66]

Mulching, or simply leaving agricultural waste on the ground, even without actively reincorporating it into soils, has also been shown to have numerous benefits: controlling erosion, conserving soil moisture, reducing soil compaction, removing harmful heavy metals, reducing weed growth and minimizing the need for pesticides and herbicides, and regulating soil temperature, which will be increasingly beneficial in a heating climate.[67]

Using agricultural waste for mulching or chipping and reincorporation can provide notable climate benefits. These methods enable carbon to be incorporated into soils or plants as the waste decomposes, leading to additional carbon storage. Using agricultural waste in place of nitrogen-based fertilizers has also been shown to reduce nitrous oxide emissions from soils, leading to climate benefits. The combination of improving soil health and carbon storage makes techniques of agricultural waste management such as mulching and chipping and reincorporation more beneficial than using them for bioenergy production.

II. The assertion that biomethane constitutes a "firm zero-carbon resource" is based upon a faulty premise.

[65] Andrews, S.S., Crop residue removal for biomass energy production: Effects on soils and recommendations (2006), https://www.nrcs.usda.gov/sites/default/files/2022-10/Crop_Residue_Removal_for_Biomass_Energy_Production.pdf; Central Valley Air Quality Coalition, Sustainable Alternatives to Biomass Incineration in the San Joaquin Valley (2019), http://www.calcleanair.org/wp-content/uploads/2019/03/biomass-handout-legislators.pdf; Jahanzad, E. et al., Orchard recycling improves climate change adaptation and mitigation potential of almond production systems, 15 PLoS ONE (2020), https://doi.org/10.1371/journal.pone.0229588; Iqbal, R. et al., Potential agricultural and environmental benefits of mulches—a review, 44 Bulletin of the National Research Centre (2020),https://doi.org/10.1186/s42269-020-00290-3

[66] Central Valley Air Quality Coalition, Sustainable Alternatives to Biomass Incineration in the San Joaquin Valley (2019), http://www.calcleanair.org/wp-content/uploads/2019/03/biomass-handout-legislators.pdf; Jahanzad, E. et al., Orchard recycling improves climate change adaptation and mitigation potential of almond production systems, 15 PLoS ONE (2020).

[67] Andrews, S.S., Crop residue removal for biomass energy production: Effects on soils and recommendations (2006); Xu, H. et al., A global meta-analysis of soil organic carbon response to corn stover removal, 11 Global Change Bioenergy 1215 (2019); Iqbal, R. et al., Potential agricultural and environmental benefits of mulches—a review, 44 Bulletin of the National Research Centre (2020).

In the workshop, CEC uplifts biomethane (e.g., biomethane derived from anaerobic digestion at dairies) as a firm zero-carbon resource,[68] or an energy source that does not yield greenhouse gas emissions. This conclusion is based on the assertion that biomethane can be carbon negative when compared to the alternative of methane from degrading waste escaping to the atmosphere.[69] This assertion presumes produced methane is unavoidable, which need not be the case. For example, much of the manure methane emissions that come from dairies results from the choice to intentionally liquify manure, though that is only one of multiple available manure management methods. Only the liquified manure management method produces the methane gas that is so lucrative under California's Low Carbon Fuel Standard (LCFS) incentives.[70] Evidence suggests other viable manure management methods (e.g., solid-liquid separation, scrape and vacuum collection of manure, composting, and pasture-based practices) are preferable to open-air lagoons and liquid manure for their cost-effective methane emissions reductions, and other environmental and health benefits. [71]

Biomethane is also uplifted as a feedstock for hydrogen production. This, however, will likely lead to unsustainable reliance upon (and will incentivize the production of) this resource from dairies, landfills, and wastewater facilities. Further, increased methane use to produce hydrogen increases the risks for methane leakage. A study of biogas plants found that leaked methane can be as high as 14.9% of total methane production.[72] Another study found that renewable natural gas from intentionally produced methane — as is the case with dairy methane — is always a net greenhouse gas emitter, unless total system leakage is zero.[73] The utilization of 'waste' methane does not guarantee an overall reduction in methane emissions. The only sure way to reduce methane emissions is to eliminate them at the source, such as through reformed agricultural practices and, at the wider scale, the rapid phase out of fossil fuels. To reduce emissions from waste, our focus should be to reduce waste, not to create a profitable market for waste-based biogenic sources, where incentives will likely increase their production and resultant pollution.

Relying upon waste streams for energy feedstocks risks hindering crucial efforts to reduce waste and reuse, recycle, and compost.[74] Incentivizing profit in waste pollution

[68] California Energy Commission, Presentation – SB 423 Fire Zero-carbon Resources Update, Slide 5 (July 28, 2025).

[69] Analysis of Hydrogen in California for Senate Bill 1075 Report, E3 presentation to CARB, February 25, 2025.

[70] Animal Agriculture in the U.S. – Trends in Production and Manure Management, Livestock and Poultry Env't Learning Cmty (2019), available at https://lpelc.org/animal-agriculture-in-the-u-s-trends-in-production-and-manure-management/.

[71] CAL. AIR RES. BD., Findings and Recommendations: Subgroup 1: Fostering Markets for Non-digester Projects, Senate Bill 1383 Dairy and Livestock Working Group 3 (Oct. 12, 2018), available at https://ww2.arb.ca.gov/sites/default/files/2020-11/dsg1_final_recommendations_11-26-18.pdf.

[72] Scheutz, Charlotte & Anders M. Fredenslund, Total methane emission rates and losses from 23 gas plants, 97 Waste Mgmt. 38-46 (2019), https://doi.org/10.1016/j.wasman.2019.07.029.

[73] Grubert, Emily, At scale, renewable natural gas systems could be climate intensive: the influence of methane feedstock and leakage rates, 15 Envtl. Research Letters 8 (2020), https://iopscience.iop.org/article/10.1088/1748-9326/ab9335.

[74] Waste reduction is the preferred management method in the Environmental Protection Agency's waste management hierarchy for decision-making. Env't Prot. Agency, Waste Management Hierarchy and Homeland

incentivizes its production. We can regulate and otherwise reduce methane emissions without commodifying them (as CARB has been directed to do, per SB 1383 (2016)[75]). Utilizing biomethane for hydrogen production runs directly counter to this aim.

Because the purported benefits of using biomethane for hydrogen production come from a comparison to business-as-usual management practices, the potential emissions benefits are overestimated. If biomethane use were instead compared to a regime of management that encouraged the reduction in biomethane production at the source (e.g., livestock/dairy operations), purported benefits would likely be greatly reduced if not outright eliminated.

III. Insofar as hydrogen is needed at all, the only carbon neutral method to produce it is using electrolysis powered by clean, renewable solar and wind energy.

Though various hydrogen production pathways are discussed in the IEPR workshop,[76] including the problematic use fossil gas, biomass, and biomethane as feedstocks, the current best science makes clear the cleanest way to produce hydrogen, without drawing much needed renewables from other uses, is to employ the three pillars — hourly matching, deliverability, and additionality — in the process of renewable-fueled electrolysis.[77] When hydrogen production proceeds where hydrogen generators are powered by *new* sources of zero-emissions electricity (additionality) that directly supply the grid electrolyzers are connected to (deliverability), within the same hour that generators are running (hourly matching), it is proven to be the cleanest production method. Further, it does not draw much needed renewables from other uses. With the three pillars, electrolysis-produced hydrogen clearly outperforms other forms of production in terms of overall GHG-emissions avoided.

Yet, even hydrogen produced using clean, renewable energy (i.e., excluding biomass and biogas, and adhering to the three pillars) should play only a limited role in a carbon-free future, given the risks it carries. First, hydrogen is a potent, indirect greenhouse gas with 100 times the warming power of CO_2 over a 10-year period and 33 times over 20 years.[78] As a small molecule, hydrogen is more leakage-prone than methane, posing climate risks across the production and supply chains. Also, transporting hydrogen through pipelines is more dangerous than transporting methane: it is more likely to explode, burns hotter, and is more corrosive to

Security Incidents, https://www.epa.gov/homeland-security-waste/waste-management-hierarchy-and-homeland-security-incidents.

[75] SB 1383 (2016), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB1383.

[76] California Energy Commission, Presentation- Hydrogen Potential – Electric Generation and Transportation (2025 IEPR), Slide 11 (July 28, 2025).

[77] Ricks, Jenkins, The Cost of Clean Hydrogen with Robust Emission Standards: A Comparison Across Studies, Princeton University Zero-carbon Energy Systems Research and Optimization Laboratory (2023), available at https://subscriber.politicopro.com/f/?id=00000187-9bb4-daaa-a5e7-bfbfff120000; Dan Esposito et al., Smart Design of 45V Hydrogen Production Tax Credit Will Reduce Emissions and Grow the Industry, Energy Innovation Policy & Technology (2023); and Ben Haley, Jeremy Hargreaves, Three-Pillars Accounting Impact Analysis, Evolved Energy Research (2023), available at https://www.evolved.energy/post/45v-three-pillars-impact-analysis,

[78] Ocko, I.B. and Hamburg, S. P., Climate consequences of hydrogen emissions, 22 Atmos. Chem. Phys. 9349 (2022).

pipelines.[79] And all forms of hydrogen production use massive amounts of water — much more than solar and wind per unit of energy produced — which will put extra stress on water supplies in areas already suffering from climate crisis-charged drought.[80]

Thus, the use of hydrogen should be limited to those sectors without a viable present-day alternative, such as replacing existing dirty gray fossil-based hydrogen, crude oil refineries, or steel manufacturing.[81] Whenever direct electrification can be used instead of hydrogen, such as in the transportation and power sectors, it is the demonstrably better choice. Electricity made from solar and wind is more efficient, lower cost, lower in CO_2 emissions, and a mature energy resource, and should be incentivized over hydrogen in pursuit of a carbon-free future.[82]

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Thank you for the opportunity to provide these comments. We would appreciate meeting with California Energy Commission staff to discuss these issues further.

Sincerely,

Shaye Wolf

Shaye Wolf, Ph.D.
Climate Science Director
Center for Biological Diversity
415-385-5746
swolf@biologicaldiversity.org

John Fleming, Ph.D.
Climate Senior Scientist
Center for Biological Diversity
310-405-1532
jfleming@biologicaldiversity.org

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[79] Pipeline Safety Trust, Hydrogen Pipeline Safety, Summary for Policymakers (2023), https://pstrust.org/wp-content/uploads/2023/01/hydrogen_pipeline_safety_summary_1_18_23.pdf.
[80] DiFelice, M. and Murray, B., Exposing a New Threat to Our Water: Hydrogen Power, Food & Water Watch (2023), https://www.foodandwaterwatch.org/2023/02/07/hydrogen-water-use/.
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