

Life Cycles and Loopholes

Leehi Yona,* Catherine Rocchi,
Robert B. Jackson, and Katharine J. Mach

Plant-based fuels (or “biofuels”) are an increasingly touted climate solution, on the basis that they emit fewer greenhouse gases (GHGs) compared to fossil fuels. But do they? Biofuel emissions are currently undercounted in many climate policies which ignore the GHGs generated to produce them. In this Article, we aim to better understand how to address biofuel GHG accounting shortfalls at the subnational level. We focus on California, a state which used to account for certain biofuel GHGs but then excluded them. What factors influenced this decision? We answer the question by conducting research that includes interviews with stakeholders in biofuels emissions accounting to make sense of what might have played a role in the policy shift. We aim to understand how stakeholders on the ground viewed California’s decision, since it could provide useful findings about how rent-seeking works and about how GHG accounting is politicized. Our results suggest that while most practitioners agree that a life cycle analysis approach is the best practice to account for GHG emissions from biofuels, they disagree as to the system boundaries of this approach. Moreover, we develop a typology of biofuel GHG accounting perspectives where we suggest that policy decisions are determined by (1) whether actors think current biofuel GHG accounting approaches are accurate, and (2) whether actors think they matter for climate mitigation. This typology may inform how to better approach GHG accounting issues in policy and legal realms, and in California and beyond. Different perceptions of biofuel emissions accounting impact climate policies, and there are ways to address those deficiencies. Incorporating an understanding of the typologies of biofuel GHG accounting is important to help ensure successful climate mitigation.

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* Assistant Professor of Law and Gears & Russo Faculty Fellow of Environmental Law, Cornell Law School. Leehi Yona is the primary author of the Article, with guidance, advising, and input from Catherine Rocchi, Robert B. Jackson, and Katharine J. Mach. We thank Coco Sanabria for outstanding research assistance, and Michael Mastrandrea, Michael Wara, and Danny Cullenward for conversations that informed the Article. We thank William Boyd, Mike Dorf, Monika Ehrman, Valerie

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INTRODUCTION

Greenhouse gas (GHG) emissions inventories underpin local, national, and international climate change policies. Whenever a government or corporation pledges to reduce GHG emissions to address climate change, they use GHG inventories to demonstrate that they are indeed reducing their emissions. GHG inventories are thus critical mechanisms for accountability. Yet they are also vulnerable to manipulation or misrepresentation when accounting is incomplete:

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If an actor emits GHGs into the atmosphere but excludes them from inventories, the resulting shortfalls between inventoried and actual GHG emissions can undermine climate action.¹ These “emissions omissions” perpetuate false assumptions about the overall progress an actor is making towards mitigation, and may lead policymakers to misallocate resources to mitigation programs which are ultimately ineffective at reducing GHG emissions.

Accurate GHG accounting is particularly important for the land-use sector, where different classifications of emissions sources can lead to undercounting in GHG inventories.² Within this sector, proper accounting for biofuels—plant-based fuels such as corn ethanol³—is particularly critical to the effectiveness of climate policies which rely on biofuels for emissions reductions.⁴ When governments or corporations undercount their GHG emissions, they may claim that they are making more progress to address climate change than they are in reality.⁵ Studying GHG accounting is thus of value.

Greenhouse gas accounting is more than the quantitative exercise it may seem to be—it is a political activity that influences perceptions of climate progress.⁶ This Article fills an important gap in climate law and policy literature by identifying factors influencing biofuel GHG accounting. Using qualitative data, we examine a 2016 change to California’s state-level GHG inventory to exclude certain biofuel emissions from accounting, aiming to explore the possible factors that may have contributed to the change.

In so doing, we examine GHG accounting practices that may yield lessons for other subnational contexts in the United States, as well as assess possible mechanisms which may enable rent-seeking. “Rent-seeking” describes situations where actors leverage government regulations or policies to increase their own

1. Leehi Yona, *Emissions Omissions: Greenhouse Gas Accounting Gaps*, 49 HARV. ENV'T L. REV., 597, 619, 633 (2025) [hereinafter Yona, *Emissions Omissions*] (demonstrating the ways that GHG accounting laws and policies exclude important emissions sources which undermine efforts to address climate change).

2. Amy Luers, Leehi Yona, Christopher B. Field, Robert B. Jackson, Katharine J. Mach, Benjamin W. Cashore, Cynthia Elliott, Lauren Gifford, Colleen Honigsberg, Lena Klaassen, H. Damon Matthews, Andi Peng, Christian Stoll, Marian Van Pelt, Ross A. Virginia & Lucas Joppa, Comment, *Make Greenhouse-Gas Accounting Reliable: Build Interoperable Systems*, 607 NATURE 653, 654 (2022).

3. See, e.g., Melissa J. Scully, Gregory A. Norris, Tania M Alarcon Falconi & David L. MacIntosh, *Carbon Intensity of Corn Ethanol in the United States: State of the Science*, 16 ENV'T L. RSCH. LETTERS, Mar. 2021, at 1.

4. See generally Timothy D. Searchinger, Steven P. Hamburg, Jerry Melillo, William Chameides, Petr Havlik, Daniel M. Kammen, Gene E. Likens, Ruben N. Lubowski, Michael Obersteiner, Michael Oppenheimer, G. Philip Robertson, William H. Schlesinger & G. David Tillman, *Fixing a Critical Climate Accounting Error*, 326 SCI. 527 (2009) (arguing that sources of emissions from biofuels are excluded, such as emissions from land use change, which undercounts overall biofuel GHG emissions).

5. See Yona, *Emissions Omissions*, *supra* note 1, at 630–35.

6. *Id.* at 631–33.

self-interest or profits.⁷ In GHG accounting, rent-seeking can take place where actors might advocate for GHG accounting practices that benefit their own self-interest at the expense of climate goals.

This Article highlights different practitioner, decision-maker, and researcher assessments of effective biofuel GHG accounting findings which may inform legal and administrative interventions to effectively mitigate climate change. We examine GHG accounting because it has the power to shape climate policy.⁸ Moreover, biofuels are receiving ever-increasing attention by many GHG emitters as a viable large-scale climate solution.⁹ Considering these realities, better understanding the drivers and barriers for effective biofuel emissions accounting may foster powerful climate action.

This Article proceeds in five Parts. Part I describes GHG accounting as it relates to law and policy, with a specific focus on the biofuel sector. Next, Part II presents the California case study at the heart of our research, highlighting both the history of biofuel GHG accounting in the state as well as the policy change underlying the project's research question. Part III then presents research data, where we find that competing worldviews may influence biofuel emissions accounting policies. Part IV explores the implications of our results, particularly as they relate to biofuel accounting laws at subnational scales. A final Part concludes.

I. ACCOUNTING FOR BIOFUEL GREENHOUSE GAS EMISSIONS

Climate change is one of the most pressing issues of our time.¹⁰ It affects everyone and disproportionately harms poor communities who have both

7. See, e.g., Jonathan R. Macey, *Promoting Public-Regarding Legislation through Statutory Interpretation: An Interest Group Model*, 86 COLUM. L. REV. 223, 224 n.6 (1986) ("Rent-seeking refers to the attempt to obtain economic rents (i.e., payments for the use of an economic asset in excess of the market price) through government intervention in the market. A classic example of rent-seeking is a corporation's attempt to obtain monopolies granted by government. Such monopolies allow firms to raise prices above competitive levels. The increased income is economic rent from government regulation."); Christine Jolls, Cass R. Sunstein & Richard Thaler, *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471, 1508 (1998) (noting that laws benefitting "farmers and concentrated industries" are often explained as products of rent-seeking approaches).

8. See generally Yona, *Emissions Omissions*, *supra* note 1 (illustrating how GHG accounting influences climate change law and policy); Searchinger et al., *supra* note 4 (discussing how undercounting excluding emissions from biofuels, and therefore undercounting overall biofuel greenhouse gas emissions, impacts greenhouse gas regulations like cap-and-trade laws).

9. See, e.g., Max Bearak, Dionne Searcey & Mira Rojanasakul, *Airlines Race Toward a Future of Powering Their Jets With Corn*, N.Y. TIMES (Nov. 30, 2023), <https://www.nytimes.com/interactive/2023/11/30/climate/airlines-jet-fuel-ethanol-com.html> [<https://perma.cc/QC5T-JN92>] (biofuel-based jet fuels); CAL. AIR RES. BD., FREQUENTLY ASKED QUESTIONS: GREENHOUSE GAS EMISSIONS INVENTORY 3 (2022), https://ww2.arb.ca.gov/sites/default/files/2022-10/ghg_inventory_faq.pdf [<https://perma.cc/GQ5Y-8CRQ>] (suggesting that the increasing trend toward bio-diesel fuel use in the transportation sector is a measure of progress in "transportation-related climate programs").

10. See generally INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS (Thomas Stocker, Dahe Qin, Gian-Kasper Plattner, Melinda M. B. Tignor, Simon K. Allen, Judith Boschung, Alexander Nauels, Yu Xia, Vincent Bex & Pauline M.

contributed least to the problem and have the fewest resources to adapt to it.¹¹ In order to address climate change, global society must reduce its overall GHG emissions; however, we must count them in the first place to determine that emissions are decreasing. This is where GHG accounting comes in.¹²

A. *The Political Economy of Accounting*

In a governmental context, GHG emissions accounting is the process by which a particular jurisdiction discloses its GHG emissions and sinks.¹³ For instance, parties to the Paris Agreement, widely seen as the most significant and extensive global climate change treaty, submit GHG inventory reports to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat to attest to the progress they are making toward their Nationally Determined Contributions to tackle climate change.¹⁴ These governmental agencies apply an estimation methodology—typically one produced by the Intergovernmental Panel on Climate Change (IPCC)—to quantify emissions.¹⁵ The resulting GHG inventories substantiate governments’ contributions to climate change mitigation, since they are typically the information relied upon

Midgley eds., 2014) [hereinafter IPCC, CLIMATE CHANGE 2013], https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_all_final.pdf (synthesizing the most up to date impacts, physical science basis, and evidence for anthropogenic climate change); INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, GLOBAL WARMING OF 1.5°C (Valérie Masson-Delmotte, Panmao Zhai, Hans-Otto Pörtner, Debra Roberts, Jim Skea, Priyadarshi R. Shukla, Anna Pirani, Wilfran Moufouma-Okia, Clotilde Pean, Roz Pidcock, Sarah Connors, J. B. Robin Matthews, Yang Chen, Xiao Zhou, Melissa I. Gomis, Elisabeth Lonnoy, Tom Maycock, Melinda Tignor & Tim Waterfield eds., 2018) [hereinafter IPCC, GLOBAL WARMING], https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SR15_Full_Report_LR.pdf [https://perma.cc/9NWV-HR7B] (assessing the impacts of global warming to 1.5 degrees Celsius comprehensively and illustrating various policies and mitigation efforts required to limit warming to this threshold).

11. RACHEL MORELLO-FROSCH, MANUEL PASTOR, JAMES SADD & SETH B. SHONKOFF, THE CLIMATE GAP: INEQUALITIES IN HOW CLIMATE CHANGE HURTS AMERICANS & HOW TO CLOSE THE GAP 5 (2009), https://drive.google.com/file/d/1BcUBC9yIY11w_zCO2ynjDle_BHEv5fdg/view [https://perma.cc/56UC-UA5K].

12. Not only is accurate accounting a means to address climate change, but inaccurate GHG accounting itself can lead to environmental harms. See generally Leehi Yona, *Climate Injustice, Off the Books*, 73 UCLA L. REV. (forthcoming 2026) [hereinafter Yona, *Climate Injustice*] (demonstrating how inadequate GHG accounting can lead to environmental injustices).

13. Luers et al., *supra* note 2, at 653–54. The term GHG “sink” is used to describe processes by which GHGs are absorbed from the atmosphere and into land and water, thus reducing GHG concentrations in the atmosphere. E.g., T. F. Keenan & C. A. Williams, *The Terrestrial Carbon Sink*, 43 ANN. REV. ENV’T & RES. 219, 220 (2018).

14. Paris Agreement to the U.N. Framework Convention on Climate Change art. 4, Dec. 12, 2015, T.I.A.S. No. 16-1104.

15. Leehi Yona, Benjamin W. Cashore & Mark A. Bradford, *Factors Influencing the Development and Implementation of National Greenhouse Gas Inventory Methodologies*, 5 POL’Y DESIGN & PRAC. 197, 199 (2022) [hereinafter Yona et al., *Factors Influencing Development*]; see generally INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES (Simon Eggleston, Leandro Buendia, Kyoko Miwa, Todd Ngara & Kiyoto Tanabe eds., 2006), https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/0_Overview/V0_0_Cover.pdf [https://perma.cc/D3X9-LC2E] (outlining methodologies for national governments to use to estimate their greenhouse gas emissions and “removals by sinks”).

to assess any progress made toward mitigation pledges.¹⁶ Challenges arise when there are shortfalls between these policy GHG inventories and scientific estimates of the same GHG sources.¹⁷ Technically speaking, these shortfalls occur when governments measure and quantify GHG emissions (they “repor[t]” those emissions in policy documents) but do not take responsibility for those emissions or count them toward their mitigation commitments (they exclude those emissions from their “account[ing]”).¹⁸ These discrepancies—when governments “repor[t],” but do not “accoun[t]-for,” GHGs—can lead to governments underreporting their GHG emissions, creating “emissions omissions” which undermine climate progress.¹⁹

Indeed, there is a political economy to these disclosures, since GHG inventories are sources of legitimacy and credibility.²⁰ As indicators of GHG emissions, inventories shape behavior and perceptions of actors’ behavior.²¹ Because of inventories’ power, emitters may be influenced by incentives to misreport if it benefits their self-interest.²²

16. See, e.g., Lechi Yona, Benjamin Cashore, Robert B. Jackson, Jean Ometto & Mark A. Bradford, *Refining National Greenhouse Gas Inventories*, 49 AMBIO 1581, 1581–82 (2020).

17. See generally Searchinger et al., *supra* note 4 (discussing that counting biofuels as “carbon neutral” can lead to “large-scale land conversion for bioenergy regardless of the actual net emissions”); John Liggio, Shao-Meng Li, Ralf M. Staebler, Katherine Hayden, Andrea Darlingson, Richard L. Mittermeier, Jason O’Brien, Rober McLaren, Mengistu Wolde, Dough Worthy & Felix Vogel, *Measured Canadian Oil Sands CO₂ Emissions Are Higher than Estimates Made Using Internationally Recommended Methods*, 10 NATURE COMM’NS, Apr. 2019, at 5 (demonstrating that the reported emissions from Canadian oil sands are lower than the emissions which are actually measured, which can impact regulation of emissions and perceptions of progress toward emissions reductions).

18. Yona, *Emissions Omissions*, *supra* note 1, at 614–16 (“First, *measurable* GHG emissions are scientifically quantifiable. With measurable emissions, the process by which GHGs are emitted is known and informed by peer-reviewed evidence. Measurable GHGs emitted by a particular activity are generally quantifiable or estimated with a reasonable degree of scientific confidence. . . . Second, measured GHG emissions can be *reported*, meaning that they are documented by governments or other responsible actors in some form. Actors list these *reported* emissions in their aggregated GHG data. . . . Third, only *accounted-for* GHG emissions determine responsibility for emissions reductions (and thus, assess progress toward those pledged reductions). These are an actor’s formally recorded emissions for which they are liable.”).

19. See *id.* at 615–16, 632–33.

20. *Id.* at 630, 647 n.284. Additionally, there are environmental justice implications here. First, the burden of climate change disproportionately falls on communities (and countries) that contributed least to the problem. See, e.g., Glenn Althor, James E. M. Watson & Richard A. Fuller, *Global Mismatch Between Greenhouse Gas Emissions and the Burden of Climate Change*, 6 SCI. REPS., Feb. 2016, at 2–3. Second, incomplete GHG accounting can impose additional burdens on disadvantaged communities—poor communities and communities of color—who live near industries with unaccounted-for GHG emissions. See generally Yona, *Climate Injustice*, *supra* note 12 (highlighting how industries, such as airports and maritime ports, are disproportionately located near disadvantaged communities, which causes them to suffer negative local air pollution impacts).

21. Yona, *Emissions Omissions*, *supra* note 1, at 601, 621.

22. These perverse incentives can also impact marginalized or disadvantaged communities. See, e.g., Yona, *Climate Injustice*, *supra* note 12.

B. Biofuel Emissions Accounting

“Biofuel” is an umbrella term used to describe primarily plant-based fuels that can substitute for petroleum.²³ The Federal Energy Policy Act of 2005 defines biofuels as derived from:

- (A) any of the following forest-related resources: mill residues, precommercial thinnings, slash, and brush, or nonmerchantable material;
- (B) solid wood waste materials, including waste pallets, crates, dunnage, manufacturing and construction wood wastes (other than pressure-treated, chemically treated, or painted wood wastes), and landscape or right-of-way tree trimmings, but not including municipal solid waste (garbage), gas derived from the biodegradation of solid waste, or paper that is commonly recycled;
- (C) agriculture wastes, including orchard tree crops, vineyard, grain, legumes, sugar, and other crop by-products or residues, and livestock waste nutrients; or
- (D) a plant that is grown exclusively as a fuel for the production of electricity.²⁴

In the United States, cellulosic ethanol and biodiesel are the most common biofuels.²⁵ Producing and using biofuels involves different processes. For corn ethanol, the most common transportation biofuel,²⁶ these steps include farming and harvesting crops, transporting feedstocks, producing fuels, combusting fuel at the tailpipe, and the changing land uses that result from different agricultural practices.²⁷ These processes exchange carbon with the atmosphere when GHGs are emitted or absorbed by different activities. For example, crops sequester carbon from the air as they grow; trucks may emit carbon as they transport feedstocks; biofuel plants may run on natural gas; and biofuel-powered cars release tailpipe emissions.²⁸

23. See *Biofuel Basics*, U.S. DEP’T OF ENERGY, <https://www.energy.gov/eere/bioenergy/biofuels-energy-transportation> (last visited May 20, 2024) [<https://perma.cc/NKJ9-TTDE>]; Mingxin Guo, Weiping Song & Jeremy Buhain, *Bioenergy and Biofuels: History, Status, and Perspective*, 42 RENEWABLE & SUSTAINABLE ENERGY REVS. 712, 712 (2015).

24. Energy Policy Act of 2005, Pub. L. No. 109-58, § 203, 119 Stat. 594 (2005).

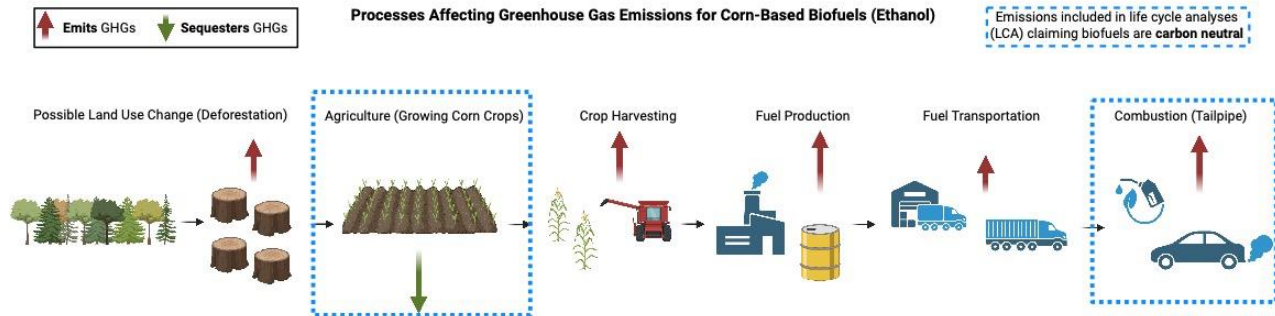
25. *Biofuel Basics*, U.S. DEP’T OF ENERGY, <https://www.energy.gov/eere/bioenergy/biofuels-energy-transportation> (last visited May 20, 2024) [<https://perma.cc/NKJ9-TTDE>].

26. Scully et al., *supra* note 3, at 1.

27. See *id.* at 1–2. Some of these indirect land use change (ILUC) impacts may be less GHG emission-intensive than others.

28. See Michael Wang, Jeongwoo Han, Jennifer B. Dunn, Hao Cai & Amgad Elgowainy, *Well-to-Wheels Energy Use and Greenhouse Gas Emissions of Ethanol from Corn, Sugarcane and Cellulosic Biomass for US Use*, 7 ENVT’L RSCH. LETTERS, Dec. 2012, at 3, 10; Liqiang He et al., *Tailpipe Emissions and Fuel Consumption of a Heavy-Duty Diesel Vehicle Using Palm Oil Biodiesel Blended Fuels*, 955 SCI. TOTAL ENV’T 177048, 177048 (2024).

Figure 1: Different Processes Throughout the Production of Biofuels (Corn Ethanol in Particular) and Their Associated Greenhouse Gas (GHG) Emissions Impacts, with Boundaries of Life Cycle Analysis for Carbon Neutral Claims



See Scully et al., *supra* note 3, at 2. Figure created in Biorender (publication permissions granted).

To estimate the net GHG emissions from biofuels, scientific studies apply a “life cycle analysis” (LCA) approach, an accounting methodology that considers every step of an energy source’s production. These studies evaluate GHG exchanges within the entire system of biofuel production, from crop growth to production to tailpipe emissions to indirect land-use change.²⁹ LCA studies suggest that net GHG emissions from biofuels may range from 86 percent less to 24 percent more than those of fossil fuels.³⁰ As part of its Renewable Fuel Standards program, the EPA has also undertaken LCA reviews of the net GHG

29. Some LCAs limit system boundaries to a single growth cycle, while others examine the increased soil carbon sequestration potential of many years of repeat growth cycles. See generally Zhangcai Qin, Jennifer B. Dunn, Hoyoung Kwon, Steffen Mueller & Michelle M. Wander, *Soil Carbon Sequestration and Land Use Change Associated with Biofuel Production: Empirical Evidence*, 8 GLOB. CHANGE BIOLOGY BIOENERGY 66 (2016) (limiting biofuel GHG system boundaries to a 30-year growth cycle, which is the time horizon used by EPA in its Renewable Fuel Standard since 2010 and which has subsequently been adopted in many studies); see also Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670, 14679, 14683 (Mar. 26, 2010) (to be codified at 40 C.F.R. pt. 80); Tyler J. Lark, Nathan P. Hendricks, Aaron Smith, Nicholas Pates, Seth A. Spawn-Lee, Matthew Bougie, Eric Booth, Christopher J. Kucharik & Holly K. Gibbs, *Supplementary Information for Environmental Outcomes of the US Renewable Fuel Standard*, 119 PROCS. NAT’L ACAD. SCIENCES, Feb. 2022 at 31; Michael Q. Wang, Jeongwoo Han, Zia Haq, Wallace E. Tyner, May Wu & Amgad Elgowainy, *Energy and Greenhouse Gas Emission Effects of Corn and Cellulosic Ethanol with Technology Improvements and Land Use Changes*, 35 BIOMASS & BIOENERGY 1885, 1894 (2011).

30. See, e.g., Wang et al., *supra* note 28, at 8–9; Scully et al., *supra* note 3, at 16; Tyler J. Lark, Nathan P. Hendricks, Aaron Smith, Nicholas Pates, Seth A. Spawn-Lee, Matthew Bougie, Eric Booth, Christopher J. Kucharik & Holly K. Gibbs, *Environmental Outcomes of the US Renewable Fuel Standard*, 119 PROCS. NAT’L ACAD. SCI., Feb. 2022, at 3; Hui Xu, Longwen Ou, Yuan Li, Troy R. Hawkins & Michael Wang, *Life Cycle Greenhouse Gas Emissions of Biodiesel and Renewable Diesel Production in the United States*, 56 ENV’T SCI. & TECH. 7512, 7517 (2022).

emissions of different biofuels, finding that emissions range from 129 percent lower (resulting in net carbon sequestration) to 19 percent higher than comparable petroleum fuel baselines depending on the type of fuel and feedstock.³¹ LCA is also particularly useful for distinguishing between different kinds of biofuels: For example, fuel derived from used cooking oil has a much smaller carbon footprint than biofuel crops that displace carbon-dense rainforests and peatlands.³²

Why does this matter? LCA boundaries determine whether biofuels are seen to be carbon neutral. Biofuel proponents argue that biofuels are carbon neutral because the carbon emitted to the atmosphere during fuel combustion was removed from the atmosphere during prior plant growth.³³ Some believe that biofuels can thus be “zero net emitters” of greenhouse gases.³⁴ This claim, however, rests on excluding “the processes used to grow and collect biomass, including any associated land-use change,”³⁵ from LCA.

Biofuel critics question this logic.³⁶ They argue biofuels are not carbon neutral when LCA emissions are calculated³⁷ and may indeed produce net GHG emissions comparable to gasoline.³⁸ Some argue that “incomplete accounting of [greenhouse gas] emissions risks undermining the climate change mitigation

31. *Lifecycle Greenhouse Gas Results*, EPA, <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/lifecycle-greenhouse-gas-results> (last updated May 29, 2025) [<https://perma.cc/N58H-G3QZ>]; EPA, LIFECYCLE GREENHOUSE GAS EMISSIONS FOR SELECT PATHWAYS 1–2 (2016), <https://www.epa.gov/sites/default/files/2016-07/documents/select-ghg-results-table-v1.pdf> [<https://perma.cc/7NKR-QWNR>]. Note that EPA conducts its LCA estimates on 30-year time horizons. See *Changes to Renewable Fuel Standard Program*, 75 Fed. Reg. at 14679, 14683.

32. Joseph Fargione, Jason Hill, David Tilman, Stephen Polasky & Peter Hawthorne, *Land Clearing and the Biofuel Carbon Debt*, 319 SCI. 1235, 1236 fig.1 (2008); Hui Xu et al., *Life Cycle Greenhouse Gas Emissions of Biodiesel and Renewable Diesel Production in the United States*, 56 ENV'T. SCI. TECHNOL. 7512, 7516 (2022).

33. See Eric Johnson, *Goodbye to Carbon Neutral: Getting Biomass Footprints Right*, 29 ENV'T'L IMPACT ASSESSMENT REV. 165, 165–66 (2009).

34. Piotr Bórawski, Aneta Beldycka-Bórawska, Elzbieta Jadwiga Szymańska, Krzysztof Józef Jankowski, Bogdan Dubis & James W. Dunn, *Development of Renewable Energy Sources Market and Biofuels in The European Union*, 228 J. CLEANER PROD. 467, 468 (2019).

35. NAT'L RSCH. COUNCIL, RENEWABLE FUEL STANDARD: POTENTIAL ECONOMIC AND ENVIRONMENTAL EFFECTS OF U.S. BIOFUEL POLICY 195 (Paula Tamapol Whitacre ed., 2011) (“Biomass, a biogenic source of carbon, is commonly assumed to be carbon neutral because the carbon emitted when burning had previously been removed from the atmosphere as CO₂ during plant growth. Although biomass itself can be treated as carbon neutral, the processes used to grow and collect biomass, including any associated land-use change, can incur GHG emissions.”).

36. See Mareike Lange, *The GHG Balance of Biofuels Taking into Account Land Use Change*, 39 ENERGY POL'Y 2373, 2373 (2011).

37. See *id.* at 2378 (analyzing land use change emissions for a variety of biofuels and concluding that most are not carbon neutral); Ana Meijide, Christina de la Rua, Thomas Guillaume, Alexander Röhl, Evelyn Hassler, Christian Stiegler, Aiyen Tjoa, Tania June, Marife D. Corre, Edzo Veldkamp & Alexander Knohl, *Measured Greenhouse Gas Budgets Challenge Emission Savings from Palm-Oil Biodiesel*, 11 NATURE COMM'NS, Feb. 2020, at 4 (studying the GHG emissions from palm-oil biodiesel and finding that emissions are not carbon neutral).

38. See Fargione et al., *supra* note 32, at 1237.

objective of policies seeking to promote biofuels.”³⁹ Finally, a push towards biofuel crops may, in some cases, contribute to deforestation and therefore to additional GHG emissions.⁴⁰

These competing views have consequential impacts for biofuels as a climate policy: Proponents of the “carbon neutral” approach see biofuels as a climate solution, whereas critics see biofuels as undermining climate policy by underperforming as a mitigation strategy.⁴¹ Indeed, the best available scientific evidence suggests that biofuels are not carbon neutral (though ongoing research is assessing the extent to which their emissions are higher or lower than fossil fuels).⁴²

Nonetheless, systematic reviews of scientific studies find that the median GHG emissions for all biofuels are higher than zero.⁴³ While some biofuel sources may produce fewer net GHG emissions than conventional fossil fuels, they are not carbon neutral fuel sources if the emissions associated with producing and transporting them are accounted for.⁴⁴ Incorrectly treating biofuels as carbon neutral thus establishes a false premise that (1) affects overall mitigation progress, and (2) uses mitigation resources on biofuels that might be more effectively spent elsewhere. A lack of regulatory instruments to measure biofuel emissions may impact this sector’s potential for climate change mitigation.⁴⁵ Absent a full accounting of their GHG emissions, biofuels therefore may underperform as climate solutions, failing to meet policymakers’ expectations.⁴⁶

II. CALIFORNIA CASE STUDY

In this Article, we aim to better understand how to address biofuel GHG accounting shortfalls at the subnational level. We focus on California, a state which *used* to account for certain biofuel GHGs but then excluded them in

39. Taotao Yue & Marjan Peeters, *Better Greenhouse Gas Emissions Accounting for Biofuels: A Key to Biofuels Sustainability*, 6 CLIMATE L. 279, 280 (2016).

40. Daniel A. Farber, *Indirect Land Use Change, Uncertainty, and Biofuels Policy*, 2011 U. ILL. L. REV. 381, 389–91 (2011).

41. Not to mention that biofuel refining has been found to have greater local air pollution than fossil fuel refining. See, e.g., Jason Hill, Stephen Polasky, Erik Nelson, David Tilman, Hong Huo, Lindsay Ludwig, James Neumann, Haochi Zheng & Diego Bonta, *Climate Change and Health Costs of Air Emissions from Biofuels and Gasoline*, 106 PROCS. NAT’L ACAD. SCIS. 2077, 2078 (2009).

42. See Anne Bouter, Sibylle Duval-Dachary & Romain Besseau, *Life Cycle Assessment of Liquid Biofuels: What Does the Scientific Literature Tell Us? A Statistical Environmental Review on Climate Change*, 190 BIOMASS & BIOENERGY, Oct. 2024, at 9 fig.3.

43. See *id.* at 4–6.

44. See *id.* at 5–6.

45. Seita Romppanen, *Regulating Better Biofuels for the European Union* 3, 6, 11 (Univ. E. Finl. Rsch. Papers, Paper No. 10, 2013); see *Decision COP X/37: Biofuels and Biodiversity*, CONVENTION ON BIOLOGICAL DIVERSITY, <https://www.cbd.int/decisions/cop/10/37> (last visited May 20, 2024) [<https://perma.cc/YRG6-C97P>] (requesting, among other things, increased resources to assess the GHG impacts of biofuels to inform policymaking for biofuel-related climate action).

46. See Johnson, *supra* note 33, at 166.

2016.⁴⁷ What factors influenced this decision? We answer this question by conducting research that includes interviews with stakeholders in the biofuels GHG accounting space—spanning local, state, and federal government, industry, non-governmental organizations, and academic researchers—to make sense of what might have played a role. We aim to understand how stakeholders on the ground viewed California’s decision, since it could provide useful findings about how rent-seeking works and how GHG accounting is politicized.

A. *The History of California’s Accounting*

For decades, the State of California has professed values of climate leadership and led on many aspects of climate policy.⁴⁸ The state’s government actively participates in United Nations climate negotiations and invited world leaders to its Global Climate Action Summit in 2018.⁴⁹ California has an important role to play in both reducing its own GHG emissions and in setting an example for effective climate policy.⁵⁰ As the fifth largest economy in the world,⁵¹ it is uniquely positioned among U.S. states in terms of both resources and international influence. Accurate GHG emissions accounting is required under the state’s signature climate policy—SB 32—which commits the state to reducing its GHG emissions to 40 percent below 1990 levels by 2030. The

47. CAL. AIR RES. BD., CALIFORNIA’S 2000-2014 GREENHOUSE GAS EMISSIONS INVENTORY, 2016 EDITION, INVENTORY UPDATES SINCE THE 2015 EDITION OF THE INVENTORY, SUPPLEMENT TO THE TECHNICAL SUPPORT DOCUMENT 10 (2016) [hereinafter CARB, INVENTORY UPDATES SINCE THE 2015 EDITION], https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/pubs/reports/2000_2014/ghg_inventory_00-14_method_update_document_20160617.pdf [https://perma.cc/2SGY-257W].

48. See, e.g., *California and China Sign Agreement on Climate and Cleantech*, UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (June 6, 2017), <https://unfccc.int/news/california-and-china-sign-agreement-on-climate-and-cleantech> [https://perma.cc/Z38D-2XPY]; Evan Halper, *Ambitious Climate Summit Gets Underway in San Francisco*, L.A. TIMES (Sept. 12, 2018), <https://www.latimes.com/politics/la-na-pol-climate-summit-starts-20180912-story.html> [https://perma.cc/T6UV-8PQV]; Erik Kirschbaum, *California Gov. Jerry Brown Delivers a Blunt Climate Change Message in Germany*, L.A. TIMES (Nov. 8, 2017), <https://www.latimes.com/world/europe/la-fg-germany-jerry-brown-climate-change-20171108-story.html> [https://perma.cc/MTJ3-G4L7]; CAL. HEALTH & SAFETY CODE §§ 38501(c) (“California has long been a national and international leader on energy conservation and environmental stewardship efforts, including the areas of air quality protections, energy efficiency requirements, renewable energy standards, natural resource conservation, and greenhouse gas emission standards for passenger vehicles”); CAL. AIR RES. BD., AB 32 GLOBAL WARMING SOLUTIONS ACT OF 2006 (Sept. 28, 2018), <https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006> [https://perma.cc/3MXE-6WTY?type=image]; CAL. AIR RES. BD., HISTORY, <https://ww2.arb.ca.gov/about/history> (last visited June 1, 2026) [https://perma.cc/B9CQ-BL57].

49. *California and China Sign Agreement on Climate and Cleantech*, *supra* note 48; Halper, *supra* note 48; Kirschbaum, *supra* note 48.

50. See Craig Holt Segall, *Networked Federalism: Subnational Governments in the Biden Era*, ECOLOGY L.Q. (Mar. 12, 2021), <https://www.ecologylawquarterly.org/currents/networkedfederalism/> [https://perma.cc/6JSB-JS9X].

51. *Best States for Business 2019: California*, FORBES, <https://www.forbes.com/places/ca/?sh=77f035963fef> (last updated Dec. 2019) [https://perma.cc/7WSH-KF8B].

California Air Resources Board (CARB), a state agency, is required by statute to produce annual GHG inventories.⁵²

Perhaps unsurprisingly considering this history, CARB used to account for GHG emissions from biofuels in its transportation sector. Yet, in 2016, the same year that then-Governor of California Jerry Brown signed SB 32 into law, CARB discontinued its practice of including on-road transportation biofuel emissions in its statewide GHG inventory (hereafter “2016 accounting change”).⁵³ The agency continues to *report* on-road transportation biofuel emissions in inventory documents, but no longer *accounts for* them in the statewide inventory total, instead delegating them to an excluded “biogenic emissions” category.⁵⁴ CARB releases information on the methodologies that it uses to calculate GHG emissions for each sector.⁵⁵ In its methods document, CARB stated that the 2016 accounting change was a response to Intergovernmental Panel on Climate Change (IPCC) guidelines for countries reporting their GHG inventories to the United Nations Framework Convention on Climate Change.⁵⁶

B. Comparing California’s Inventory to the Low Carbon Fuel Standard (LCFS)

CARB also manages a distinct GHG emissions program called the Low Carbon Fuel Standard (LCFS). The subject of much litigation, the LCFS is also one of the state’s most prominent climate policies.⁵⁷ It focuses on net life cycle

52. CAL. HEALTH & SAFETY CODE § 39607 (West 2024). Other state agencies may release additional emissions data. For example, Cal Fire releases (unaccounted-for) wildfire emissions data. CAL. AIR RES. BD., PUBLIC COMMENT DRAFT: GREENHOUSE GAS EMISSIONS OF CONTEMPORARY WILDFIRE, PRESCRIBED FIRE, AND FOREST MANAGEMENT ACTIVITIES i. fig.E-1 (2020) [hereinafter CARB, CONTEMPORARY WILDFIRE, PRESCRIBED FIRE, AND FOREST MANAGEMENT ACTIVITIES], https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/pubs/ca_ghg_wildfire_forestmanagement.pdf [https://perma.cc/2WXR-M7AT].

53. CARB, INVENTORY UPDATES SINCE THE 2015 EDITION, *supra* note 47, at 10. Similar changes also took place with the state’s Low Carbon Fuel Standard in 2015, where carbon intensity of biofuels was reduced, though the Low Carbon Fuel Standard program uses life cycle analysis to determine biofuel emissions. Amber Leland, S. Kent Hoekman & Xiaowei (Vivian) Liu, *Review of Modifications to Indirect Land Use Change Modeling and Resulting Carbon Intensity Values Within the California Low Carbon Fuel Standard Regulations*, 180 J. CLEANER PROD. 698, 698 (2018).

54. CARB, INVENTORY UPDATES SINCE THE 2015 EDITION, *supra* note 47, at 10.

55. See *GHG Inventory Data Archive*, CAL. AIR RES. BD., <https://ww2.arb.ca.gov/ghg-inventory-archive> (last visited Jan. 31, 2026) [https://perma.cc/9KBX-9QHC].

56. CAL. AIR RES. BD., CALIFORNIA’S 2000-2014 GREENHOUSE GAS EMISSIONS INVENTORY: TECHNICAL SUPPORT DOCUMENT 6–8 (2016) [hereinafter CARB, TECHNICAL SUPPORT DOCUMENT], https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/pubs/reports/2000_2014/ghg_inventory_00-14_technical_support_document.pdf [https://perma.cc/SA97-DPR7]. For a longer history of how these IPCC guidelines evolved and came to be, see generally Yona et al., *Factors Influencing Development*, *supra* note 15 (describing the technological constraints and political constraints that influenced the methodological guidelines for GHG accounting in the UNFCCC as well as the Paris Agreement).

57. See, e.g., *Rocky Mountain Farmers Union v. Corey*, 730 F.3d 1070, 1070 (9th Cir. 2013).

emissions from different fuels,⁵⁸ which are distinct from the tailpipe emissions in biofuel emissions accounting illustrated below in Figure 2. Under the LCFS approach, CARB includes emissions from every step of the production and consumption processes in its assessments for relative carbon intensity.⁵⁹

**Figure 2: Biofuel Transportation Emissions,
Reproduced from the California Air Resource Board's
2020 State Greenhouse Gas Inventory Report.**

The shaded emissions in yellow are measured but excluded from CARB's inventory—the specific GHG accounting used to determine California's progress toward its GHG emissions reductions goals.

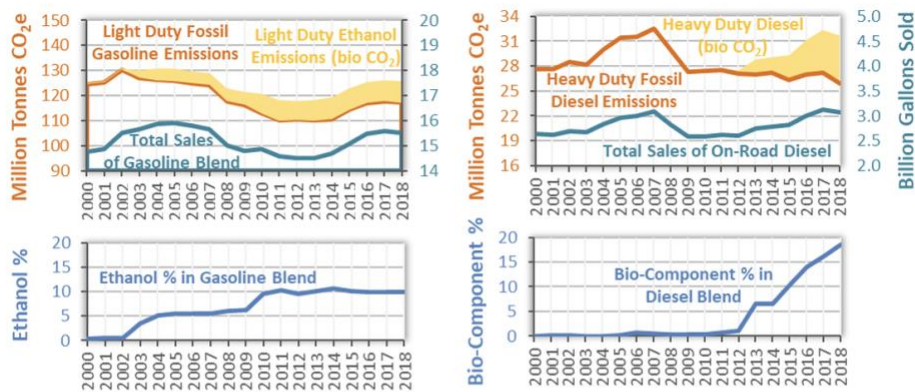


Figure 6. Trends in On-Road Light Duty Gasoline Emissions. In the top panel, the yellow shaded region represents CO₂ emissions from the ethanol-component of the gasoline fuel blend. The orange line includes all GHG emissions from the fossil gasoline component of the fuel blend, as well as the CH₄ and N₂O emissions from the ethanol-component of the fuel blend. "Total Sales of Gasoline Blend" includes gasoline used in any types of vehicles, 93% of which are used in light duty vehicles. The color of a trend line matches the color of its corresponding vertical axes label. The bottom panel shows the percent of gasoline blend that is ethanol.

Figure 7. Trends in On-Road Diesel Vehicle Emissions. In the top panel, the yellow shaded region represents CO₂ emissions from the bio-component (biodiesel and renewable diesel) of the diesel fuel blend. The orange line includes all GHG emissions from the fossil diesel component of the fuel blend, as well as the CH₄ and N₂O emissions from the bio-component of the fuel blend. "Total Sales of On-Road Diesel" includes diesel blends used in any types of vehicles, 97% of which are used in heavy duty vehicles. The color of a trend line matches the color of its corresponding vertical axes label. The bottom panel shows the percent of diesel blend that are biodiesel or renewable diesel.

Cal. Air Res. Bd., California Greenhouse Gas Emissions for 2000 to 2018 – Trends of Emissions and Other Indicators 8 figs. 6 & 7 (2020), https://ww2.arb.ca.gov/sites/default/files/classic/cc/ghg_inventory_trends_00-18.pdf.

58. Bram Devlies, *Ethanol as Mitigation Measure in the Transport Sector: Countervailing Perverse Effects of Uncoordinated Biofuel Standards in the U.S. and Brazil*, 38 ENERGY L.J. 213, 227 (2017).

59. See Kirk Tracy, *Rocky Mountain Farmers Union v. Goldstene: Low Carbon Fuel Standards, Life Cycle Greenhouse Gases, and California's Continued Struggle to Lead the Way*, 24 TUL. ENV'T L.J. 173, 173–74 (2010); *Low Carbon Fuel Standard: About*, CAL. AIR RES. BD., <https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/about> (last visited June 22, 2026) [<https://perma.cc/45KY-H9BQ>].

In *Rocky Mountain Farmers Union v. Corey*, plaintiff ethanol and petroleum industry associations argued that the LCFS's LCA violated the Dormant Commerce Clause—the prohibition, implicit in the Constitution of the United States, against states passing legislation that discriminates against interstate commerce.⁶⁰ Much of California's defense rested on the scientific underpinnings of LCA.⁶¹ In its opening brief, the state argued that LCA was “a neutral, widely accepted scientific methodology to assess GHG emissions.”⁶²

The state's arguments in *Rocky Mountain Farmers Union* conflict with CARB's 2016 accounting change. In the lawsuit, CARB accurately insisted that the LCFS aligned with the best available science—that is, with LCA.⁶³ But the agency's revised GHG methodologies exclude on-road transportation emissions,⁶⁴ which undercount net emissions under an LCA approach. The result is a discrepancy between not only biofuels emissions accounting and LCA science, but also between departments within CARB, which seem to draw different accounting system boundaries in determining how biofuels ought to be incorporated into the state's climate policies.⁶⁵

Drawing appropriate boundaries for the scope of California's GHG emissions is important. As noted previously, if a government is excluding GHG emissions from its accounting, it can underestimate its overall total emissions.⁶⁶ As one report, commissioned for Communities for a Better Environment (a non-profit environmental organization in the state), explains:

Inconsistent system boundaries can lead to false conclusions about pathways' climate impacts. For example, import/export emissions associated with oil refined in-state increased by a greater amount (≈ 20 Mt/yr) than those associated with electricity used in the state decreased (≈ 16 Mt/yr) from 2013–2017. By excluding these oil emissions while including these electricity emissions in their GHG Inventory, state officials could wrongly conclude that their current path is shrinking the global carbon footprint of energy systems here when, in fact, it could be expanding.⁶⁷

60. *Rocky Mountain Farmers Union*, 730 F.3d at 1077.

61. Appellees' Answering Brief at 5, *Rocky Mountain Farmers Union v. Corey*, 913 F.3d 940 (9th Cir. 2019) (No. 17-16881), 2018 U.S. 9th Cir. Briefs LEXIS 5918, at *5.

62. Appellants' Opening Brief at 1, *Rocky Mountain Farmers Union v. Corey*, 730 F.3d 1070 (9th Cir. 2013) (Nos. 12-15131, 12-15135), 2012 U.S. 9th Cir. Briefs LEXIS 1674, at *2.

63. *Id.* at *1–2.

64. CARB, CONTEMPORARY WILDFIRE, PRESCRIBED FIRE, AND FOREST MANAGEMENT ACTIVITIES, *supra* note 52, at 4.

65. Moreover, there have also been studies suggesting that even the LCFS model undercounts GHG emissions. See generally Chris Malins, Richard Plevin & Robert Edwards, *How Robust Are Reductions in Modeled Estimates from GTAP-BIO of the Indirect Land Use Change Induced by Conventional Biofuels?*, 258 J. CLEANER PROD., June 2020 (suggesting there are shortcomings in the GHG accounting model the LCFS uses); CAL. CODE REGS. tit. 17, § 95481(a)(74).

66. See *supra* notes 18–19 and accompanying text.

67. GREG KARRAS, DECOMMISSIONING CALIFORNIA REFINERIES: CLIMATE AND HEALTH RISKS IN AN OIL STATE 92 (2020).

The system boundaries that CARB applies to biofuels could create the impression that California's transportation policy is successfully decreasing GHG emissions, when absolute transportation emissions may in fact be increasing over time (see Figure 2).

III. COMPETING PARADIGMS WHICH SHAPE LEGAL AND POLICY OUTCOMES

Our analysis shows that perceptions of the accuracy and importance of biofuel emissions accounting influence how the accounting is seen and utilized in climate policy. These perceptions matter because accurate biofuel emissions accounting is essential to addressing climate change.

A. Methodology

This qualitative study examines the drivers of transportation biofuel GHG emissions accounting policy in California. We implemented an iterative approach, combining document analysis with interview data guided by our research questions. Our results draw upon two sources of data: publicly available agency documents and semi-structured interviews (N = 22) with key stakeholders (N = 25) from academia, civil society, industry, and government agencies. We drew themes⁶⁸ regarding biofuel GHG accounting from our data, which then served as the basis to inductively develop a typology⁶⁹ of biofuel GHG accounting perspectives (Figure 3).⁷⁰ That typology informed a subsequent analysis of interviewees' perspectives of GHG accounting compared to CARB's approach, which may enable rent-seeking.⁷¹ In addition to focusing on biofuel GHG accounting in California at large, this research also examines CARB's specific change to biofuel GHG accounting for on-road transportation emissions, which was the subject of the 2016 accounting change. A Methodological Appendix⁷² includes supplementary information on our research design.

B. Fuzzy Life Cycle Analysis (LCA) System Boundaries

The majority of interviewees generally agreed that applying a life cycle analysis (LCA) approach would be the best practice to account for biofuel GHG emissions inventories (N = 20).⁷³ The majority of interviewees (N = 18) also

68. *Infra* Part III.B.

69. See generally Rosalind Donald, Camila Young & Katharine J. Mach, *The Role of Local Narratives in Emerging Climate Governance*, 1 ENV'T'L RSCH.: CLIMATE, JULY 2022; Emily Boyd, Rachel A. James, Richard G. Jones, Hannah R. Young & Friederike E.L. Otto, *A Typology of Loss and Damage Perspectives*, 7 NATURE CLIMATE CHANGE 723 (2017) (describing methodologies which develop typologies, or paradigms, around different climate policies).

70. *Infra* Part III.C.

71. *Infra* Part III.D.

72. The Appendix is on file with *ELQ*, available at <https://perma.cc/8UXW-JSVJ>.

73. One outlier stated, "this is a stock and flow problem. We need to be treating it using systems dynamics methods, not LCA" (Interviewee 21). An additional interviewee specifically named the LCFS program as the best practice in biofuel GHG emissions accounting (Interviewee 12).

agreed that such an approach ought to be grounded in scientific evidence.⁷⁴ However, despite this broad agreement, many interviewees disagreed about what an LCA analysis would actually *entail*.

For example, a majority of interviewees (N = 14) stated that it was essential to draw appropriate LCA system boundaries but diverged on what those boundaries ought to be. An additional interviewee directly highlighted these disagreements (Interviewee 4). Some argued that a “true” LCA analysis would encompass all GHG emissions, including those from indirect land-use change (ILUC) (e.g., Interviewees 1, 8, 15, 19, 20), while others (e.g., Interviewees 13, 23, 24) believed that LCA system boundaries are already too broad. While some argued that a “whole footprint” approach must be taken to account for biofuel GHG emissions (Interviewee 25), others argued that this approach would lead to double counting (Interviewee 18). Still others argued that “the key thing is equivalent system boundaries with whatever you’re assessing, so what you’re assessing for biofuels should be assessed for fossil fuels” (Interviewee 8), implying that the boundaries of fossil fuel GHG emissions accounting systems ought to be broadened to match those applied to biofuels.

However, some interviewees took issue with CARB’s different biofuel emissions accounting approaches between its LCFS and GHG inventory, saying, “[a] GHG system where you have inconsistent accounting being used at different programs, it creates a lot of challenges” (Interviewee 6). Specifically, some NGO interviewees viewed CARB as politicized rather than based solely on objective technical expertise (Interviewee 19, Interviewee 22). Others argued that such a system of multiple accounting methodologies was a strength of CARB’s approach in that the agency “develop[s] supplemental types of accounting that were very useful in each program” (Interviewee 20).⁷⁵

Whether to include ILUC emissions was a particular point of disagreement. Some stakeholders argued that ILUC is “just [an] insane wild card” that is too

74. As one interviewee noted, it’s important to “use real data [...] you trust the science [...] and you include that in the renewable fuel life cycle analysis, the LCA, you have a model that has peer reviewed data and you keep it updated, you have a public process to have the model reflect real world conditions, including [...] indirect land-use change that’s applied to the biofuel LCA” (Interviewee 8).

75. This interviewee continued: “The cap and trade program’s built almost completely around the Mandatory Reporting Rule, but the Low Carbon Fuel Standard is an entirely separate set of accounting, because it is so biofuel-focused, and because for biofuels, it’s important to look at how they’re produced, and you know, how they’re moved to end markets and etc., right, and even knock-on effects or you know sort of general equilibrium effects associated with how crops are grown and stuff like that right, and what that does to land-use and things like the Low Carbon Fuel Standard has its own set of accounting, but that has to still you know sort of interface with the inventory a little bit, so that CARB can still speak to how biofuels are making an impact or whatever right, so it’s almost like keeping two sets of books, you know, like the inventory sort of says, ‘Here’s the total gallons of liquid biofuels used of different types and the simplified treatment there is, you know carbon neutrality right in line with IPCC requirements.’ And then the LCFS puts an overlay on top of that, and says, you know if you actually want to sell biofuel in the state, you have to demonstrate its low carbon value on a life cycle basis.” (Interviewee 20).

complex to appropriately measure (Interviewee 19) and needs more scientific research (Interviewee 7). Yet another argued that:

You have to absolutely include indirect land-use change as much as possible [in GHG accounting], even though it's difficult, there's no good way to quantitatively do it, you have to sort of accept that [...] you can quantitatively get into the ballpark. And then you have to make some value decisions about how you're going to actually square the circle and bring that approximate value into what is otherwise a fairly precise quantitative exercise. (Interviewee 15)

Despite some of the challenges with estimating ILUC emissions, concerns around leakage outweigh this complexity:

You know, if there [were] programs everywhere where every country, for example, is going to commit to meeting a certain target and [...] we believe that that was going to be strictly enforced, we wouldn't need to model the indirect effects of our policies on land-use change in Brazil and Indonesia, because that would be controlled there. It's big, it's because there's like *this leakage from our system* that we have to try to account for [...] it *sounds like it would be double counting* if that were the case, if everyone was producing their own inventories, *but they aren't*. (Interviewee 4)

Highlighting leakage concerns, one interviewee said that in CARB's current approach of excluding biogenic on-road transportation GHG emissions from its inventory, California might miss accounting for carbon impacts beyond the biofuel produced:

Most of the carbon embodied in the biofuel may or may not be counted [...] in any biological system there's going to be a carbon impact beyond just the product that comes out [...] if you are changing agricultural practices in order to maximize yields, or to try to increase soil carbon [...] if you're not fully accounting for that, there's a chance you're missing really significant carbon impacts. (Interviewee 15)

These distinctions illustrate how boundary setting in LCAs can make biofuels appear to be a net sink or source of emissions. What's more, the lack of consensus among stakeholders in government, industry, and NGOs creates a gray area that can be easily manipulated according to a stakeholder's strategic goal (for example, a biofuel company that is incentivized to promote their product, or a government agency seeking to demonstrate emissions reductions to constituents). One interviewee highlighted the impacts of these exclusions on incentives:

When you do accounting that omits biogenic carbon in energy sectors, so therefore treats corn ethanol as having zero emissions at the tailpipe, and yeah, look at the production and stuff, you've relieved the fuel producer and by extension, the agricultural producer, of the burden of proof that they've actually—their product, the production of their product—has created a net offset. (Interviewee 21)

Another called the approach a “biomass loophole argument” (Interviewee 6). These findings are illustrative examples of how rent-seeking related to climate disclosures can take place.

C. A Typology of Competing Paradigms

Below, we describe a typology through which to understand how perceptions of biofuel GHG emissions accounting may influence policy decisions, building on our interview data. We reviewed all of our interview responses and developed two characteristics that could describe the different stakeholder perspectives. This typology centers on two criteria (Table 1): perceptions of the accuracy of biofuel GHG accounting approaches, as well as the importance of accounting for biofuel GHG emissions for mitigation. By examining the impact of biofuel emissions accounting on climate policies and resulting mitigation, this typology can advance how to better approach GHG accounting issues in California and beyond.

Table 1: Criteria for the Typology

Criterion	Definition	Illustrative Interview and Document Quotes
Accuracy	Whether the biofuel GHG accounting approach is accurately estimating emissions; i.e., whether the approach is aligned with the best available scientific evidence and/or consensus. Perceptions of accuracy may depend on the methodologies the actor considers to be most accurate, including, but not limited to, Life Cycle Assessment (LCA) and where to draw biofuel GHG emissions accounting system boundaries (e.g., whether they believe treating life cycle GHG emissions from biofuels as zero is accurate).	“I think the decision to exclude biofuels from the GHG inventory was scientifically correct.” (Interviewee 15) “Consistent with the IPCC Guidelines for National GHG Inventories [...] the biofuel components of fuel combustion CO₂ emissions are classified as ‘biogenic CO₂’ and are tracked as informational items, separate from the rest of the emissions in the inventory (that are classified as ‘included’ emissions).” (2017 GHG Inventory)⁷⁶ [illustrating changing system boundaries]
Importance for Climate Mitigation	Specifically looking at whether the actor perceives that <i>biofuel GHG emissions accounting</i> meaningfully impacts climate mitigation. “Mitigation” includes the understanding of current total GHG emissions, perceived emissions targets needed to address climate change, and any progress made toward those targets. Within this criterion, an actor may have different reasons why they	“If you don’t know what you’re actually emitting, it’s hard to figure out what to actually regulate.” (Interviewee 13) “On a global level, governments and organizations at all levels have begun to adopt regulations to reduce greenhouse gases (AB 32, 2006; United

76. CAL. AIR RES. BD., CALIFORNIA GREENHOUSE GAS EMISSIONS FOR 2000 TO 2015 – TRENDS OF EMISSIONS AND OTHER INDICATORS 7 (2017), https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/pubs/reports/2000_2017/ghg_inventory_trends_00-17.pdf [<https://perma.cc/XZ2M-JVH3>].

	perceive that biofuel GHG accounting is unimportant for climate mitigation, such as believing that GHG accounting generally is unimportant or that biofuels specifically form such a small percentage of overall emissions that accounting for them is a de minimis activity.	Nations, 1998). Central to all of these regulations is the generation of an emissions baseline year and an updated emission inventory to track greenhouse gas emissions and monitor reductions.” (2011 GHG Inventory) ⁷⁷
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Four perceptions emerge along these factors. The paradigms are: “Inaccurate but Unimportant,” “Accurate and Important,” “Accurate and Unimportant,” and “Inaccurate and Important.” Of these, only one perspective finds California’s current biofuel GHG inventorying practices concerning: “Inaccurate and Important.” Below, we describe these perspectives, grounding them in our interview data as well as CARB documents. Table 2 outlines the four perceptions and highlights illustrative interview quotes of each.

Table 2: A Typology of Biofuel GHG Accounting Paradigms

Paradigms	Concern?	Description	Illustrative Quote(s)
<i>“Inaccurate but Unimportant”</i>	No	There are flaws in how California treats biofuel GHG emissions in its GHG inventory, but these inaccuracies are trivial; other policy mechanisms—such as the state’s Low Carbon Fuel Standard (LCFS)—are accurate and are more determinative in impacting climate mitigation.	“Why is accounting so important anyway? It’s important because it’s the basis for powers and regulations and incentives. So, if you have some kind of policy mechanism to deal with it—in this case LCFS—unless you think the LCFS is distorting investments and business activities, then you wouldn’t care what the total number is. It doesn’t really mean anything, except as a baseline, as you know, to measure progress. Isn’t progress more important than accurate accounting? Isn’t consistency more important than accuracy?” (Interviewee 3) “In terms of the overall inventory, [transportation biofuels] may not make a lot of difference. It may not be 100 percent accurate, let’s say they’re wrong by 20 percent, so now you’re at 20 percent of 9.7 percent of the total emissions inventory. In terms of the extent of the problem that we’re looking at, it may not make a lot of difference. [...] You know you always want to be as accurate as you can, but if the accuracy is not gonna affect the outcome in any way, shape, or form, maybe it’s not worth sort of nitpicking, yeah that makes sense. [...] When it reaches 20 percent of the inventory here in the state that might be a different question. But back in 2016, 2019, [...] it was 0.05 percent

77. CAL. AIR RES. BD., CALIFORNIA GREENHOUSE GAS EMISSIONS INVENTORY: 2000-2009 5 (2011), https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/pubs/reports/2000_2009/ghg_inventory_00-09_report.pdf [<https://perma.cc/RPB2-DCZG>].

			of the inventory or something. Who cares? [...] You always want to be as accurate as you can, but if the accuracy is not gonna affect the outcome in any way, shape, or form, maybe it's not worth nitpicking." (Interviewee 10)
<i>"Accurate and Important"</i>	No	How California accounts for biofuels in its GHG inventory is important for climate mitigation, and the current methodologies the state applies in its inventory are accurate.	"You know, if you go to a party and you're driving and then get pulled over and the officer is like, 'How many beers did you have?' and you're like, 'Five non-alcoholic beers,' that's zero beers. That's what it should be." (Interviewee 8)
<i>"Accurate and Unimportant"</i>	No	California's GHG inventory accurately accounts for biofuel GHG emissions, but even if it didn't, any inaccuracies would be insignificant for climate law and mitigation.	"I think liquid biofuels aren't that important to California's overall climate goals." (Interviewee 19)
<i>"Inaccurate and Important"</i>	Yes	California's GHG inventory is both important for climate mitigation and its treatment of biofuel GHG emissions accounting deviates from scientific evidence to a determinative extent. This is the only perspective concluding that current biofuel GHG accounting practices negatively impact the state's climate action efforts.	"Biofuels are an integral component of reduction in carbon emissions [...] By not including the tailpipe emissions, it's really reducing what [their] environmental impacts are and [...] makes biofuels look cleaner than they actually are." (Interviewee 2) "The more bespoke the accounting gets—the more it relies on pathway-specific calculations that are customized and full of exceptions—the harder it is to see your way to a zero-carbon future." (Interviewee 17)

These four perceptions influence whether GHG accounting is worthy of attention. Some interviewees agreed that California's biofuel GHG accounting was inaccurate but argued that biofuels form such a small portion of the state's overall emissions that these inaccuracies were irrelevant ("Inaccurate but Unimportant"). Other interviewees expressed views that California's biofuel GHG inventory was accurate, or "scientifically correct" (Interviewee 15). Within this perspective, stakeholders argued that even if it *was* inaccurate, California's biofuel GHG inventory was inconsequential ("Accurate and Unimportant"). Other interviewees saw California's biofuel GHG accounting as important but saw no issue with CARB's approach, believing that excluding on-road transportation biofuel GHG emissions was accurate ("Accurate and Important"). Finally, the last portion of interviewees saw inaccuracies in CARB's approach while also believing that inventories were important for mitigation ("Inaccurate and Important"). The four perceptions are visualized in Figure 3 below.

Figure 3: Conceptual Representation of the Typology of Biofuel Greenhouse Gas Emissions Inventories Accounting Perspectives

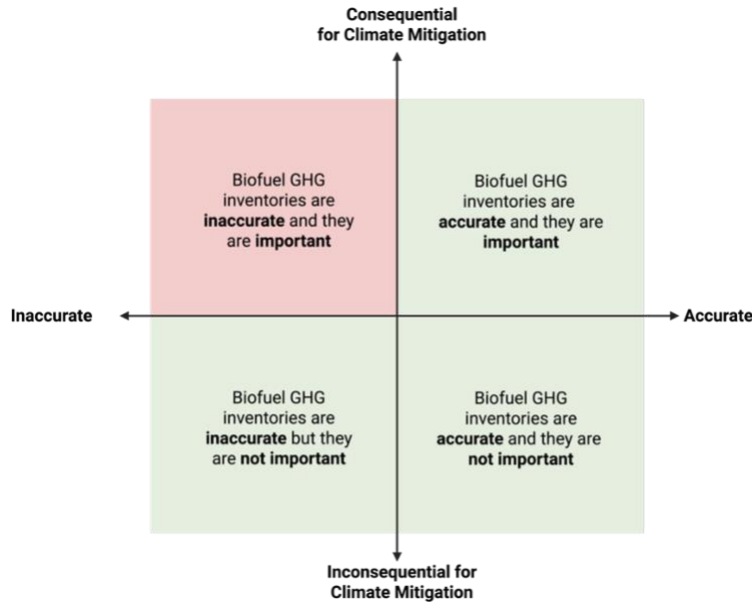


Figure created in Biorender (publication permissions granted).

Many of these perceptions hinged on different perspectives among interviewees about what constitute accurate system boundaries for life cycle GHG emissions accounting for biofuels. Those who believed in narrower boundary setting for biofuel GHG accounting thought CARB was accurate in its approach of treating net life cycle biofuel GHG emissions as zero, while those who believed that more expansive LCA boundaries were accurate saw issues in CARB's approach. We propose that competing paradigms can lead to GHG accounting exclusions, because governments either (1) misunderstand the science by thinking biofuel GHGs are accurately carbon neutral *or* (2) underestimate the impact of biofuel GHG accounting on climate policy overall.

These perceptions about biofuel GHG accounting also impact whether interviewees believed that external stakeholders ought to be engaged in biofuel GHG accounting and inventorying processes: If biofuel GHG inventories are seen as inconsequential to climate mitigation, as accurate, or as both inconsequential as well as accurate, then public participation⁷⁸ in inventorying processes may be deprioritized by policymakers and agencies. If, on the other

78. "Public participation" here describes the transparency and accessibility of GHG accounting to members of the general public, which of course includes researchers and academics with technical expertise to improve accuracy.

hand, biofuel GHG inventories are inaccurate and impact climate mitigation, then public participation is crucial.

D. Dissonances Between Interviewees' Perceptions of Biofuel GHG Accounting Best Practices and CARB's Approach

Interestingly, some interviewees in the “Accurate and Important” as well as “Accurate and Unimportant” paradigms also described LCA as the best practice for biofuel GHG accounting, even though CARB does not apply this approach for on-road biofuel transportation emissions in its inventory. Some interviewees who described LCA as the best practice for GHG accounting also agreed with CARB’s contradictory decision to exclude on-road biofuel transportation emissions from its GHG inventory. As one explanation for this dissonance, some interviewees stated that different accounting practices may be appropriate for different contexts: “[T]he greenhouse gas accounting that’s done in the Low Carbon Fuel Standard is accounted for differently than the inventory, so CARB basically has two separate sets of books that they agree on” (Interviewee 23). Another interviewee mentioned that CARB’s approach made sense to them in light of how difficult it is to reduce uncertainties in biofuel land-use GHG estimates (Interviewee 4).⁷⁹

Some interviewees disagreed as to whether it is appropriate to treat biofuels as carbon neutral in GHG inventories. Several interviewees expressed views in support of the carbon neutrality argument, believing that “biomass is carbon neutral” (Interviewee 8), or that treating biofuel tailpipe emissions as zero would be simpler and easier than estimating emissions (Interviewee 18). Furthermore, some argued that treating biofuels as carbon neutral is beneficial because it incentivizes biofuels over fossil fuels, and “for every gallon sold of biofuel it’s better than selling a gallon of conventional fuel” (Interviewee 20). Another stated, “when you consider the kind of factual fate of biomass either being landfilled or decomposing or being burned in a burn pile, it allows us to credit them as very low carbon fuels” (Interviewee 11).

Others disagreed, arguing that the production of biofuels itself is a carbon-intensive process: “It just doesn’t make sense to say that biogenic carbon is carbon neutral, because you don’t know what the impact is on that landscape” (Interviewee 7). One interviewee explained that while biofuels in theory are carbon neutral, current accounting systems are inconsistent in practice to address leakage and boundary setting concerns: “[T]he field is in flux, and people have come to appreciate the shortcomings of what has been the conventional approach

79. “There’s variation in how geographically, and from farmer to farmer, about how they’re doing things and there’s some attempts to estimate like how different farming practices might affect emissions, but [...] I think the science on that is not very developed and just a lot of uncertainties in how much those practices actually matter and if and how permanent are some of them [...] there’s a lot of talk now about soil practices to increase soil carbon sequestration, but [...] the whole land-use change discussion [...] it’s very hard to reduce the uncertainties.” (Interviewee 4).

of treating biogenic carbon as inherently carbon neutral in energy sectors, under the assumption that a consistent global accounting occurs” (Interviewee 21).⁸⁰ Finally, in response to statements about the benefits of biofuels over fossil fuels, others argued that the carbon intensities of different types of biofuels vary, which can impact the extent of their overall emissions reductions (Interviewees 2 and 23).

These dissonances and divergences highlight a possible tension between GHG accounting in theory versus accounting in practice. When biofuels are viewed as carbon neutral, it may lead to incentives to promote or adopt more biofuels—but also might overstate their benefits and allow for governments to actually do less to achieve climate mitigation results. Of course, claiming biofuel carbon neutrality benefits governments by allowing them to claim emissions reductions on paper (and possibly enabling them to sustain any related economic interests). This approach enables rent-seeking on the ground while maintaining the theoretical appearance of scientific credibility.

IV. IMPLICATIONS AND RECOMMENDATIONS

A. *Evaluating the IPCC Approach in Subnational Inventories*

Our respondents agreed that alignment with IPCC guidelines was at least one factor in CARB’s 2016 accounting change,⁸¹ which the agency also cited as a justification in its methodology documents.⁸² Yet many respondents also stated that while alignment with the IPCC approach may have been the *justification* for the change, it might not have been the primary (or only) factor motivating CARB. “It could have been more or less an excuse for the state to make the change,” one interviewee suggested (Interviewee 1).

Moreover, the advantages of the simpler IPCC approach may not apply to a subnational context. The IPCC inventory guidelines were designed for use around the globe, including in countries that lack primary data.⁸³ Although the IPCC guidelines permit resource-constrained countries to use default values in their inventories, its tiered approach aims to encourage nations to adopt more

80. An additional interviewee stated: “There are no carbon neutral biofuels, or basically no biofuels that have a clear and obvious pathway to get to zero outside of coupling carbon sequestration to it” (Interviewee 15).

81. One governmental interviewee stated: “The methodology is aligned with the IPCC process and other inventories at the national level and other subnationals. And when it came to the Low Carbon Fuel Standard, there was discussion about the embedded carbon along the entire chain, from well to wheel, of emissions, and so there was a full public process about what that scope should look like. [...] Because we were going to incentivize the displacement of transportation fuels that were fossil with other fuels that would be of a biofuel nature, it was important for us to make sure that as part of that full accounting, it was clear what the net difference was between the emissions on a life cycle basis, so that was a very targeted decision” (Interviewee 13).

82. CARB, TECHNICAL SUPPORT DOCUMENT, *supra* note 56, at 5–6.

83. Yona et al., *Factors Influencing Development*, *supra* note 15, at 201, 209.

accurate emissions accounting methodologies.⁸⁴ The IPCC guidelines state that inventory compilers “should also consider the relative importance of [...] international transportation and biomass burning to ensure that the calculations for these items are adequately addressed when designing improvement activities.”⁸⁵ Moreover, higher tiers of the IPCC methodologies encourage governments to use the primary and local level data available to them.⁸⁶

While EPA’s National Inventory Report excludes transportation biofuels,⁸⁷ there is no reason why California cannot set a higher standard for its own inventory. CARB does not face prohibitive resource or information constraints in this regard: The agency already *reports* (but excludes from its emissions responsibilities) the life cycle emissions associated with transportation biofuels.⁸⁸ Moreover, the IPCC guidelines are explicitly designed to set a minimum standard, “not . . . a roof”—countries are encouraged to adopt more robust accounting approaches if possible.⁸⁹ In subnational contexts, there is a risk that the IPCC guidelines serve as a useful justification for accounting decisions that may otherwise be influenced by special interests, such as particular industries or constituents.

B. *Rent-Seeking on the Ground*

While our interview data cannot definitively answer what exactly motivated CARB’s 2016 accounting change, the interviews nonetheless shed light on how space and discretion can be created for inadequate GHG accounting—whether or not it is done in bad faith. Our goal is to understand how this change could have taken place in California, gleaning any learnings that may be applicable to other subnational contexts. We aim to understand the political economy of the 2016 accounting change in the absence of a definitive determination of its cause. The typology we developed in this Article demonstrates how differing perspectives of GHG accounting can enable public policy manipulation. Interested stakeholders can leverage these differing perspectives to advocate for biofuels as a climate change solution while overclaiming their mitigation benefits.

This typology can help us identify problems in GHG accounting in the land-use/agricultural sector, which can also help us deal with these problems, by (1)

84. *Id.* at 209.

85. Justin Goodwin, Newton Paciornik & Michael Gillenwater, *Methodological Choice and Identification of Key Categories*, in 2019 REFINEMENT TO THE 2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES 4.1, 4.7 (Dario Gómez & William Irving eds., 2019), https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/1_Volume1/19R_V1_Ch04_MethodChoice.pdf [<https://perma.cc/M98L-UYZE>].

86. *Id.*

87. See EPA, EPA 430-R-23-002, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2021 3-121 (2023), <https://www.epa.gov/system/files/documents/2023-04/US-GHG-Inventory-2023-Main-Text.pdf> [<https://perma.cc/S4K4-NU6L>].

88. CARB, INVENTORY UPDATES SINCE THE 2015 EDITION, *supra* note 47, at 8.

89. See Yona et al., *Factors Influencing Development*, *supra* note 15, at 209.

creating structures/safeguards to mitigate this rent-seeking, or (2) simply putting it “out in the open.” While many respondents indicated that CARB’s 2016 accounting change rendered the transportation sector of the statewide GHG inventory inaccurate if assuming LCA system boundaries, fewer believed that this discrepancy was a problem. Two interviewees stated that California’s inventory was unimportant because CARB’s LCFS, which assigns carbon tariffs to different biofuels proportionate to emissions factors, is the more important policy mechanism. Within the typology illustrated in Figure 3, only those respondents in Quadrant II—those who believed that biofuel GHG inventories are important and that California’s inventory is inaccurate—believed that CARB’s methodology change threatened the integrity of California’s emissions reduction program. This finding is important because such a paradigm may enable rent-seeking: Poor accounting risks overstating the progress governments are making toward their mitigation goals and downplaying the importance of GHG accounting, which creates opportunities to misreport.

Proper accounting is tied to creating incentives to reduce GHGs; as one interviewee expressed, “they [CARB officials] want to demonstrate progress” on climate change mitigation (Interviewee 20). Accounting can also influence policy choices, as another interviewee noted: “[A] lot of discussion around the LCFS is, ‘can it help with the effort to produce electric vehicles?’” (Interviewee 21).

Our findings thus extend beyond CARB’s 2016 accounting decision. They highlight the importance of paying attention to GHG accounting and how a focus on quantitative techniques may obscure its political economy. Incorporating the best available scientific evidence is essential to the efficacy of biofuel climate policies.

C. Biofuel Accounting Best Practices

In addition to LCA as a general approach, interviewees highlighted other factors to consider for effective biofuel GHG emissions accounting that may be broadly applicable to other subnational contexts. Traceability was important, with high value placed on “a combination of full life cycle assessment combined with some sort of traceability approach that gives you [. . .] a chain of custody of the feedstock all the way back to the source” (Interviewee 1). Similar emphasis was placed on inventory transparency (Interviewee 13) and consistency (Interviewee 16).⁹⁰ Some interviewees pointed to third-party verification as an essential cornerstone of biofuel GHG accounting best practices (Interviewees 13, 14, 15). Others discussed the importance of improving and revising accounting methodologies in line with emerging scientific evidence:

You want to [...] know where the science is going to evolve [and] have a process for how the science evolves and how you’re going to make

90. “It’s important to be consistent across time” (Interviewee 16).

sure that's clear and transparent. Beyond that you need to have regular reviews and regular opportunities to go [and say], "here's what our long-term goal is and we're going to keep course correcting as time goes by, to make sure we get to this long-term goal" (Interviewee 15).

Finally, stakeholder engagement was a best practice voiced by some: "I think the best practice is a full life cycle accounting that uses a framework that's been well vetted and that a lot of stakeholder dialogue has occurred around" (Interviewee 20).⁹¹ All of these factors could conceivably inform efforts to successfully use biofuels as a climate mitigation strategy.

Legislative intent around GHG accounting in California is clear, focusing on the importance of accurate accounting for climate policies:

The Legislature hereby finds and declares that it is in the interests of the state that air quality plans be based on accurate emission inventories. Inaccurate inventories that do not reflect the actual emissions into the air can lead to misdirected air quality control measures, resulting in delayed attainment of standards and unnecessary and significant costs.⁹²

Yet current state-level GHG inventorying may undermine these goals when biofuel GHG emissions may be undercounted under narrower life cycle system boundaries.

D. Possible Administrative and Legal Approaches to Account for Life Cycle Greenhouse Gas Emissions from Biofuels in California's Statewide Inventory

There are possible pathways to revise CARB's biofuel GHG accounting guidelines to better serve the State Legislature's GHG inventorying purposes. While the following Subpart does not exhaustively assess all such possibilities, it highlights two in particular: (1) revising formal CARB GHG inventory procedure and (2) updating CARB's GHG inventory methodologies to incorporate scientific evidence as it becomes available. These two interventions are compelling because they may mitigate potential political incentives to underreport GHG emissions that interviewees expressed may have contributed to CARB's decision to exclude biofuel transportation GHG emissions. Administrative and legal opportunities to constrain these incentives can help improve how effective the state's climate policies will be.

1. Applying Formal Rulemaking Procedure to California's GHG Inventories

One possibility to improve biofuel GHG emissions accounting is to revise the formal rulemaking procedure around CARB's GHG inventory so that future changes undergo public consultation. CARB's 2016 change to transportation biogenic GHG emissions accounting did not go through formal rulemaking

91. Katrina Fisher Kuh often outlines examples of how stakeholder engagement can be powerful in developing transparent environmental regulations. See, e.g., Katrina Fischer Kuh, *Informational Regulation, the Environment, and the Public*, 105 MARQ. L. REV. 603, 660 (2022).

92. CAL. HEALTH & SAFETY CODE § 39607.3(d).

processes as outlined by the California Administrative Procedure Act (APA).⁹³ In other words, the agency announced the change via a technical document and without a public comment process.⁹⁴ Presumably, CARB did so because the accounting change was seen as a “non-substantive” amendment (Interviewee 24) which ostensibly did not meet the threshold of a “regulation” as defined by the California APA, therefore exempting the agency from engaging in a formal rulemaking process.⁹⁵ As one interviewee described, GHG inventories are not seen as regulatory documents themselves, but as appendices to those regulations:

If you were to want to look up a document and find the [GHG] inventory, you would not find a regulatory document that just has an inventory. Typically, the inventory would be an attachment to a regulation [...] you will find the inventory as an attachment, if you will, to the regulatory document (Interviewee 12).

And in the words of a governmental interviewee, “We have an obligation to make sure we’re transparent and we’re clear as to how [inventories] are calculated, but those are not driving a specific action by a specific actor out there, and so they do not require the same legal requirements for board action” (Interviewee 13). Inherent to these statements is an assumption that California’s GHG inventory or the biofuel sector within the GHG inventory is minor and therefore unimpactful, a perspective which reflects the “Accurate / Inaccurate and Unimportant” typologies mentioned above.

However, changes like the one CARB made in excluding biogenic transportation GHG emissions arguably meet the definition for a regulation pursuant to the California APA. The State Legislature’s expressed intent around the importance of accurate GHG inventories,⁹⁶ as well as the impact that the decision has on influencing climate policies, would support this viewpoint. Document analysis also supports this argument: While the Global Warming Solutions Act of 2006 specified that *voluntary* GHG emissions inventories were exempt from California APA requirements,⁹⁷ it is silent on any exemptions for the mandated statewide GHG inventory.⁹⁸

Although CARB provided a brief explanation for its 2016 accounting change,⁹⁹ our interviews suggest that multiple factors may have played a role in the agency’s decision. Clarifying what, how, and why GHG accounting decisions are made would enable the public to engage with GHG accounting policies and

93. CAL. GOV’T CODE §§ 11340–11361.

94. See CARB, INVENTORY UPDATES SINCE THE 2015 EDITION, *supra* note 47, at 2–3.

95. “‘Regulation’ means every rule, regulation, order, or standard of general application or the amendment, supplement, or revision of any rule, regulation, order, or standard adopted by any state agency to implement, interpret, or make specific the law enforced or administered by it, or to govern its procedure.” CAL. GOV’T CODE § 11342.600.

96. CAL. HEALTH & SAFETY CODE § 39607.3(d).

97. CAL. HEALTH & SAFETY CODE § 38571.

98. In fact, a text search of our CARB inventory document repository for either the terms “APA” or “Administrative Procedure Act” returned only one result: this language for voluntary reporting.

99. CARB, TECHNICAL SUPPORT DOCUMENT, *supra* note 56, at 5–6.

provide opportunities to examine the environmental justice implications.¹⁰⁰ Increased transparency would also set an example for governments worldwide, many of which look to California as a model for climate leadership.¹⁰¹ “Ever since I’ve been involved in renewables,” one interviewee stated, “‘What is California doing?’ is at the top of everyone’s mind, because it really is one of the most important jurisdictions for North American renewable fuels” (Interviewee 8). It is arguably appropriate for CARB to undergo formal rulemaking processes for changes to its GHG inventory that may have an impact on policy, such as in the case of biofuel emissions accounting. In fact, EPA makes its National Inventory Reports¹⁰² similarly available for public comment.¹⁰³ In theory, a successful underground regulation petition¹⁰⁴ filed with the California Office of Administrative Law (OAL) could require CARB to undergo formal rulemaking procedures if the OAL determines the 2016 accounting change constituted a regulation.¹⁰⁵

2. Bridging Greenhouse Gas Inventory Methodologies and Emerging, Rigorous Scientific Expertise

Greenhouse gas inventories are inherently political.¹⁰⁶ Governments face political incentives to include optional carbon sinks but exclude optional sources of emissions, because doing so inflates a jurisdiction’s perceived progress toward emissions reduction goals. In California, a state that prides itself on ambitious climate policy, these incentives may be particularly acute.

One way to counteract these pressures could be to strengthen connections between shared knowledge, relationships, strategies, and decision-making in government.¹⁰⁷ This approach would emphasize transparency, mandating that government agencies clarify the decision-making and deliberation processes around which GHG emissions sinks and sources they include in inventory

100. See Yona, *Climate Injustice*, *supra* note 12 (manuscript at 39–43) (Cornell Legal Stud. Rsch. Paper No. 25-23).

101. See, e.g., Halper, *supra* note 48; Kirschbaum, *supra* note 48; Segall, *supra* note 50.

102. INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2021, *supra* note 87, at ES-1 to -2.

103. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022, 89 Fed. Reg. 11275, 11275 (Feb. 14, 2024). The comment period for this National Inventory Report closed on March 15, 2024. *Id.*

104. *Underground Regulations*, OFF. OF ADMIN. L., https://oal.ca.gov/underground_regulations (last visited May 20, 2024) [<https://perma.cc/HJ7C-SG75>]. Of course, such claims must be brought within any relevant statutes of limitations.

105. *OAL’s Role Concerning Underground Regulation Petitions*, OFF. OF ADMIN. L., https://oal.ca.gov/underground_regulations/role-in-underground-regulations (last visited Nov. 15, 2025) [<https://perma.cc/A5HV-7GM8>].

106. See HEATHER LOVELL, THEREZA SALES DE AGUIAR, JAN BEBBINGTON & CARLOS LARRINAGA-GONZALEZ, ASS’N OF CHARTERED CERTIFIED ACCOUNTANTS, ACCOUNTING FOR CARBON 7 (2010); see, e.g., Yona et al., *Factors Influencing Development*, *supra* note 15, at 209–10.

107. See Mark Lubell & Tiffany H. Morrison, *Institutional Navigation for Polycentric Sustainability Governance*, 4 NATURE SUSTAINABILITY 664, 665 (2021).

reports. Transparency around emissions accounting methodologies may only be a first step, but it is an important one. “The narrowness of this field is an issue,” one interviewee from the non-governmental sector explained:

There’s a perception that it’s this closed, elite space that keeps others out because it’s so technical. I think that if we could do away with that or open things up . . . we might see a fostering of more possible approaches, and also maybe a convergence about how to resolve some of these longstanding issues. (Interviewee 1)

Several interviewees indicated that grounding CARB’s GHG inventorying methods in the best available science would be particularly important for biofuels: “[S]cientific exactness is important in accounting for environmental protection schemes in energy policy. The exactness in science is a means to provide more concrete legal solutions to environmental threats and energy challenges.”¹⁰⁸

Scientific literature suggests that, though some biofuels generate fewer GHG emissions than fossil fuels, they are not carbon neutral under an LCA approach.¹⁰⁹ As one interviewee explained, “Now that we’re more aware of how badly things have gone awry when you omit biogenic carbon from the accounting, we may, I would hope, move towards something that does count biogenic carbon [...] instead of just assuming that [biomass] uptake automatically is neutralizing the combustion of the biogenic carbon” (Interviewee 21). Grounding GHG inventory methodologies in LCA can also help provide “some confidence that [inventory compilers] are not going too far wrong with [their] policy” by providing more robust emissions estimates (Interviewee 7).

For example, California’s Climate Corporate Data Accountability Act of 2023 is an informative model of how to incorporate best available GHG accounting methodologies into climate policies.¹¹⁰ In particular, it expressly stipulates that CARB may assess existing GHG accounting methodologies every five years and adopt any alternative standards it deems “would more effectively further the goals” of the Act.¹¹¹ A similar approach to CARB’s statewide GHG inventory can help ensure that it is effective in representing the state’s GHG emissions.

108. Nadia B. Ahmad, *Blood Biofuels*, 27 DUKE ENV’T L. & POL’Y F. 265, 274 (2017) (outlining the various environmental justice and equity challenges associated with the production and consumption of biofuel energy sources).

109. See, e.g., Lange, *supra* note 36, at 2378 (finding that land use change emissions for most biofuels studied were not carbon neutral); Meijide et al., *supra* note 37, at 4.

110. See CAL. HEALTH & SAFETY CODE § 38532.

111. *Id.* § 38532(c)(2)(A)(iv)(I).

E. Limitations and Further Research

This Article examines a subset of the drivers of and barriers to effective biofuel GHG emissions accounting. While our results may not be completely replicable due to our heavy reliance on interview data, this study may inform methodologies for future projects examining a sector of GHG inventories in a subnational context. Additionally, while we aimed to capture a diversity of views in our research interviews, subsequent studies may conduct larger-scale interviews to obtain a more representative sample (this research involved 22 interviews). Furthermore, additional work may explore other opportunities to improve GHG inventories, such as through legislative decisions.

Future work can also explore the environmental justice and equity concerns in biofuels emissions accounting. As Nadia Ahmad writes, “While a shift away from hydrocarbon fossil fuels through the use of biofuels is laudable, renewable energy policy does not account for the full scale of environmental externalities associated with varying forms of renewables.”¹¹² For climate policies to be successful, they must take into account harms and costs that may be disproportionately affecting poor communities of color.¹¹³ These environmental justice concerns are further compounded for the biofuels sector, because this energy source involves significant land-use and potential land type conversion.¹¹⁴

These concerns are both local and global in scale. On a global level, the impact of shifting crops from food sources to biofuels may increase prices and lead to food insecurity.¹¹⁵ Water demand in biofuel production¹¹⁶ could also exacerbate water shortages in drought-prone California. From a broader climate justice perspective, any policy that undermines the success of climate mitigation strategies will have repercussions in furthering sea level rise, extreme weather events, and other climatic changes which disproportionately impact already disadvantaged communities.¹¹⁷ Applying an environmental and climate justice lens to biofuels emissions accounting would help ensure that the renewable energy transition is indeed a just transition.¹¹⁸

112. Ahmad, *supra* note 108, at 273.

113. See generally Alice Kaswan, *Environmental Justice: Bridging the Gap Between Environmental Laws and “Justice”*, 47 AM. U.L. REV. 221 (1997) (summarizing the importance of centering environmental justice when developing environmental laws and policies).

114. See Ahmad, *supra* note 108, at 274.

115. *Id.* at 284.

116. *Id.* at 314.

117. See generally IPCC, CLIMATE CHANGE 2013, *supra* note 10 (synthesizing the most up to date impacts, physical science bases, and evidence for anthropogenic climate change); IPCC, GLOBAL WARMING, *supra* note 10 (assessing the impacts of global warming to 1.5 degrees Celsius comprehensively, and illustrating various policies and mitigation efforts required to limit warming to this threshold).

118. See generally Uma Outka, *Fairness in the Low-Carbon Shift: Learning from Environmental Justice*, 82 BROOK. L. REV. 789 (2017) (illustrating the need for fairness, justice, and equity in the United

CONCLUSION

Greenhouse gas emissions accounting is a political process that can influence the climate mitigation policies that decision-makers may choose to implement. Biofuels are a particularly important industry where GHG accounting can have an impact: Incomplete system boundaries can undercount overall life cycle GHG emissions, distorting the benefits of biofuel-based climate policies.

These distortions may undermine climate mitigation efforts, overpromising the reductions that biofuels can deliver. This study examines opportunities for improved GHG emissions accounting for biofuels in a subnational context. In this Article, we sought to better understand the factors driving CARB's decision to exclude certain biofuel emissions from California's GHG inventory. Through document analysis and research interviews, we uncovered themes underpinning biofuel GHG emissions accounting, developing a typology of different biofuel GHG accounting perspectives which impact climate policies.

Incorporating an understanding of the typologies of biofuel GHG accounting is important to help ensure successful climate mitigation and to prevent the rent-seeking which can undermine climate action. Increasing transparency and public engagement, as well as better integrating the best available scientific information in governmental inventorying, can help support this goal. GHG inventories have a clear impact on climate action and deserve our attention. By scrutinizing agencies' approaches to GHG accounting, researchers can encourage state and national agencies to ground their GHG inventories in accurate and robust scientific methodologies.

States' transition to a renewable energy society and highlighting how past injustices have led to further harm and unsuccessful environmental policies).

We welcome responses to this Article. If you are interested in submitting a response for our online journal, *Ecology Law Currents*, please contact cse.elq@law.berkeley.edu. Responses to articles may be viewed at our website, <http://www.ecologylawquarterly.org>.