BRIEFING

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Setting a lipids fuel cap under the California Low Carbon Fuel Standard

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California's Low Carbon Fuel Standard (LCFS) has transformed its liquid fuels market and led to significant growth in biodiesel and renewable diesel consumption. Together, these two diesel-substitutes comprise the broader category of "biomass-based diesel" (BBD). Under the LCFS, BBD fuel producers generate credits based on the greenhouse gas (GHG) intensity of their fuel relative to annual GHG reduction targets. On the whole, the LCFS mandates a 20% reduction in the average GHG intensity of fuels supplied to California's road sector.

Over the last decade, BBD fuels have grown from 0.4% of California's diesel blend in 2011 to 32% in 2021 and this growth is poised to accelerate in coming years. Vegetable oil, waste oil, and animal fats are lipid compounds that can be readily converted to BBD. Although BBD can also be produced from cellulosic feedstocks such as agricultural and forestry residues, lipid-based feedstocks are the primary materials used to produce fuel for the state's BBD market. These feedstocks will be increasingly drawn from the rest of the United States and the world to meet growing demand. Increased consumption of lipid-based biofuels raises food prices, sustainability issues, and fraud concerns and could undermine the efficacy of the LCFS.

Until 2020, most of the BBD consumed in California was produced from waste fats and oils, such as used cooking oil (UCO) and animal fats. A long-standing reliance on waste-based BBD has shifted toward other feedstocks such as vegetable oils due to the limited supply of these resources and growing demand for BBD fuel. In the coming years, we expect that large-scale oil refinery conversions concentrated in California

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will pull feedstock away from fuel producers distributed across the country and shift it to the California market.[1] Producers of BBD fuel have taken particular interest in renewable diesel capacity expansion because it can be "dropped in" to conventional diesel engines and generates lower quantities of criteria air pollutants than biodiesel.[2] Renewable diesel is also produced from the same product slate as sustainable aviation fuel (SAF), a rapidly growing domestic fuel market.[3]

In 2021, 600,000 metric tons (MT) of soybean oil were used to produce BBD for the California market, and evidence shows that the scale of vegetable oil-based fuel in California could soon skyrocket. Scaling up the use of vegetable oil for fuel contributes to food price spikes and deforestation; therefore, a policy safeguard is urgently required to limit the impact of LCFS on the markets for vegetable oil and other lipids such as UCO that are linked through trade.

Although the federal Renewable Fuel Standard (RFS) volume mandates remain the largest driver of BBD consumption nationally,[4] the combined effects of federal and California state policies could lead to unintended environmental consequences. Capping the use of lipid feedstocks used for BBD would be a simple and effective way to mitigate the sustainability risks unique to BBD fuels and ensure the LCFS remains an effective tool to support California's transportation decarbonization goals. We recommend that California Air Resources Board (CARB) set a cap on the volume of lipid feedstocks used for fuel based on an analysis of feedstock availability and competing demands for vegetable oil, waste oil, and animal fats for food and other uses. We also recommend that growth in feedstock availability be scaled proportionally with California's share of the national distillate fuel market for an equitable distribution of BBD resources.[5]

Setting a lipid cap would also ensure that the LCFS supports a balanced portfolio of low carbon transportation fuels including alternatives such as battery and hydrogen fuel cell electric vehicles, as well as liquid fuels derived from cellulosic biomass. It would also prevent California's BBD market shifting from one that is primarily waste-oil based to one increasingly reliant on food-based fuels with the highest sustainability risks. With a reasonable cap on lipid fuels, California's LCFS will remain a model that works for other states and the federal government, encouraging efficiency in the production and use of existing credit-generating fuels while supporting innovation in novel fuels. This is especially important given the uncertainty of federal biofuels policy beyond 2022.[6]

Below we summarize three primary arguments for setting a lipids cap under the LCFS program: to support a balanced portfolio of low carbon technologies; to ensure that California uses a reasonable share of sustainably available lipid feedstocks; and

1 U.S. Energy Information Administration, "EIA Projects U.S. Renewable Diesel Supply to Surpass Biodiesel in AEO2022," March 24, 2022, https://www.eia.gov/todayinenergy/detail.php?id=51778.

2 Neste, "What Is the Difference between Renewable Diesel and Traditional Biodiesel - If Any?," September 26, 2016, https://www.neste.com/what-difference-between-renewable-diesel-and-traditional-biodiesel-if-any.

3 Kristi Moriarty and Allison Kvien, "U.S. Airport Infrastructure and Sustainable Aviation Fuel," Technical report, U.S. Department of Energy, Office of Scientific and Technical Information, February 1, 2021, https://doi.org/10.2172/1768316.

4 Chris Malins and Cato Sandford, "Animal, Vegetable or Mineral (Oil)? Exploring the Potential Impacts of New Renewable Diesel Capacity on Oil and Fat Markets in the United States" (Washington, D.C.: Cerulogy, January 17, 2022), https://theicct.org/publication/impact-renewable-diesel-us-jan22/.

5 U.S. Energy Information Administration, "Table F5: Distillate Fuel Oil Consumption Estimates, 2020," accessed June 14, 2022, https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_fuel/html/fuel_use_df.html&sid=US.

6 Congressional Research Service, "The Renewable Fuel Standard (RFS): An Overview," January 31, 2022, https://sgp.fas.org/crs/misc/R43325.pdf.

to avoid global displacement of vegetable oils that would contribute to food price impacts and deforestation. We also describe the sustainability and market risks of failing to implement a cap and their implications on global food and feed markets, cropland expansion, greenhouse gas emissions, and biodiversity loss. Finally, we provide a more detailed example of how a cap could be implemented within the structure of existing policy.

LIMITING LCFS COMPLIANCE FROM LIPID FUELS WOULD SUPPORT A MORE BALANCED PORTFOLIO OF LOW-CARBON, COST-EFFECTIVE TECHNOLOGIES

The growth of California's alternative fuels market over the last decade has not been evenly distributed across feedstocks and technologies. When the LCFS program began in 2011, corn ethanol accounted for more than 90% of alternative fuel used in California. Although the level of ethanol consumption has remained stable, its share of the market has fallen while other alternative fuel use has grown. Since 2011, the volume of BBD has grown more than 80-fold and, in 2021, BBD accounted for 50% of alternative fuel volumes and 45% of LCFS program credits.[7] This share is disproportionate to the volume of conventional diesel fuel consumed in California. According to LCFS credit data, diesel blended fuel made up 21% of liquid fuel volumes consumed in California in 2021 while gasoline blends made up 79% of liquid fuel volumes.[8] Technologies with low market penetration and a high opportunity for scaleup, including battery and hydrogen fuel cell electric vehicles, and second-generation biofuels made from waste and residue feedstocks, can deliver the greatest carbon savings but currently make up less than a quarter of annual program credits and 5% of total volumes. The annual volume of liquid biofuels used to generate LCFS credits by fuel and feedstock type is shown in Figure 1. Volumes are reported by CARB and standardized on a gasoline gallon equivalent (GGE) basis.

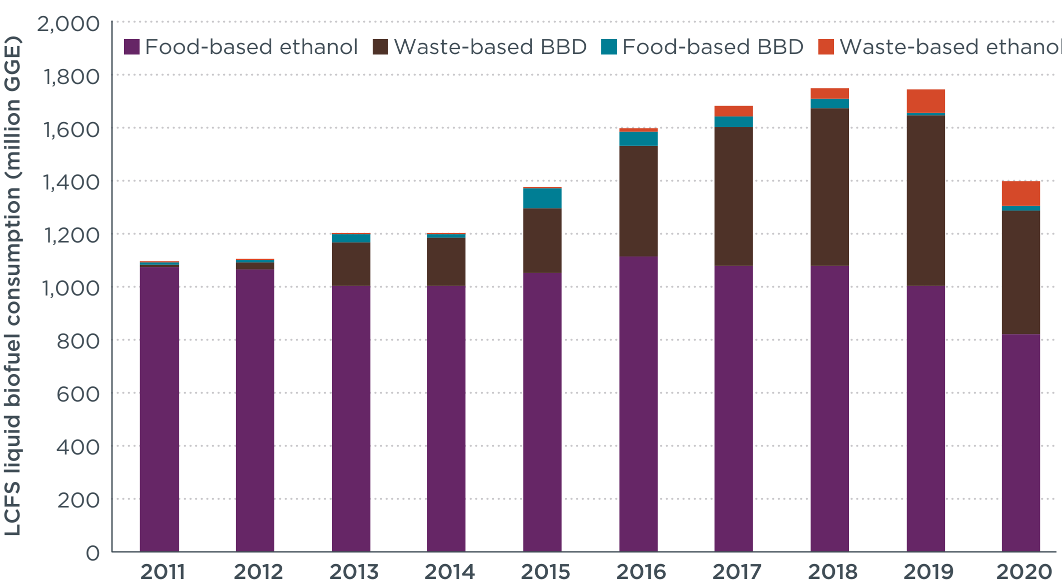

Figure 1. LCFS liquid biofuel volumes by fuel and feedstock type (million GGE). Source: California Air Resources Board, "LCFS Data Dashboard."

7 California Air Resources Board, "LCFS Data Dashboard," accessed April 30, 2022, https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm.

8 California Air Resources Board, "LCFS Data Dashboard."

Food-based BBD has made a slower entry into the California market but is used widely across the United States today. Its consumption is subsidized via the federal BBD tax credits and market incentives from federal and state clean fuel policies.[9] These include renewable identification numbers (RINs), tradeable credits used for compliance in the federal RFS program, as well as LCFS credits for fuel sold in the California fuel market.

In the absence of substantial policy support, the process of converting vegetable oil feedstocks into BBD is not cost effective, nor is it a strategic technology for scaleup. The cost of soybean or other vegetable oil required to produce a gallon of BBD routinely exceeds the wholesale cost of diesel fuel, even before the capital and operating costs of conversion to fuel are considered. Figure 2 displays the average wholesale cost of U.S. diesel and the contribution of soy oil to the cost of soy biodiesel after taking into account conversion yield.[10] These two price points track each other closely, and soy oil feedstock prices are on average 35% more expensive than diesel over the last 20 years. We assume a conversion yield of one gallon of biodiesel per 7.4 pounds of soybean oil using industry data from the Greenhouse Gases, Regulated Emissions, and Energy Use in Technology (GREET) model.

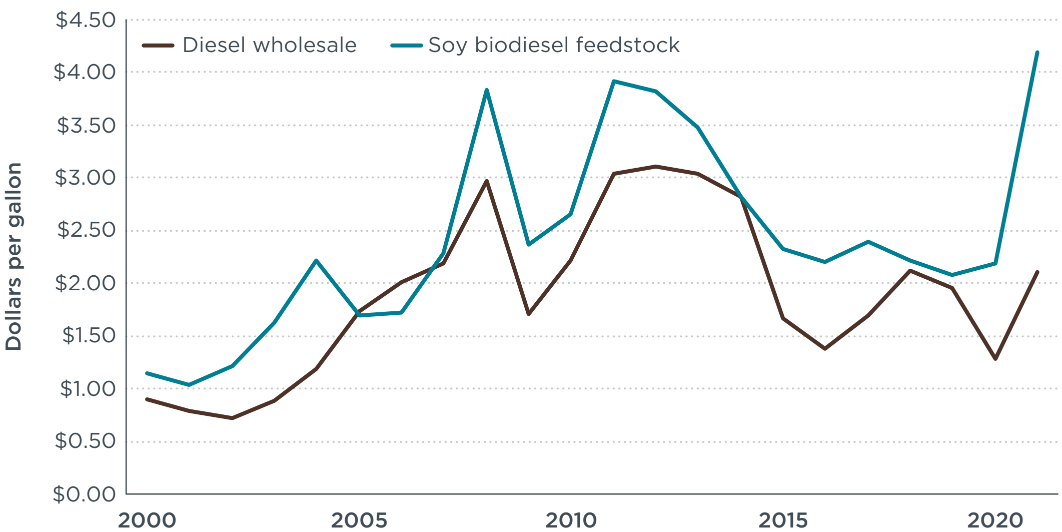

Figure 2. Wholesale cost comparison of conventional diesel and soy biodiesel feedstock adjusted by conversion yield. Market year data adjusted to year-end date.

Policy support for low carbon technology may be justified to help scale up innovative or immature technologies, with the assumption that costs will come down over time. However, soybean oil production is a mature technology with a well-established supply chain; soybean oil comprises two thirds of U.S. production of edible fats and oils and 29% of global vegetable oil production.[11] Thus, it is unlikely that scaling up the

9 U.S. Energy Information Administration, "U.S. Biomass-Based Diesel Tax Credit Renewed through 2022 in Government Spending Bill," January 28, 2020, https://www.eia.gov/todayinenergy/detail.php?id=42616.

10 U.S. Energy Information Administration, "U.S. No 2 Diesel Wholesale/Resale Price by Refiners (Dollars per Gallon)," accessed June 14, 2022, https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMA_EPD2D_PWG_NUS_DPG&f=M; U.S. Department of Agriculture Economic Research Service, "USDA ERS - Oil Crops Yearbook," accessed January 24, 2022, https://www.ers.usda.gov/data-products/oil-crops-yearbook/oil-crops-yearbook/#Soy%20and%20Soybean%20Products.

11 U.S. Department of Agriculture Economic Research Service, "USDA ERS - Oil Crops Yearbook," accessed January 24, 2022, https://www.ers.usda.gov/data-products/oil-crops-yearbook/oil-crops-yearbook/#Soy%20and%20Soybean%20Products.

use of vegetable oil for fuel will improve the efficiency of vegetable oil production. The production costs for BBD are driven primarily by the cost of vegetable oil inputs. Between 2009 and 2012, the International Renewable Energy Agency estimated that soybean oil accounted for 86% of biodiesel production costs while capital and operating costs made up the remainder.[12] This trend was similar for other food-based feedstocks including palm, jatropha, and rapeseed oil. Likewise, within the renewable diesel market, the process of converting lipids to hydrocarbon fuels utilizes a technologically mature oil refinery processes and is unlikely to have substantial cost reductions over time.

U.S. CONSUMPTION OF LIPID-BASED BBD IS RAPIDLY SHIFTING TO CALIFORNIA AMIDST LIMITED AVAILABILITY OF WASTE AND OIL FEEDSTOCKS

The supply of U.S. vegetable oils and fats is increasingly being diverted from other states to California, with limited benefits to California from this shuffling. Diversion of feedstock from the rest of the country still may not be enough to meet California's targets, given limitations in U.S. production of vegetable oils and fats. While BBD feedstock production is increasing nationally, it is not increasing fast enough to supply the industry's planned increases in BBD production capacity.

Growth of BBD is led by California, at the expense of other U.S. states. California is the most lucrative place in the U.S. to sell lower-carbon fuels because producers can stack federal and state policy incentives. For example, while a UCO renewable diesel producer would receive approximately $2.32 per GGE in incentives selling their fuel in New York, that same producer would receive $3.81 per GGE in incentives selling an equivalent volume of fuel in California, based on average 2021 RINs and LCFS credit prices.[13] In the 2016 to 2021 timeframe, the share of renewable content in diesel fuel in California rose from 10% in 2016 to 32% in 2021 while falling from 5% to 3% in the rest of the United States. Blending rates of BBD would be consistent across all states under a scenario where BBD resources were equally allocated. Considering that California consumes roughly 7% of the U.S. distillate fuel market, its fair share of BBD fuel consumption is also 7%. We compare the absolute volumes of biodiesel (BD) and renewable diesel (RD) consumed in California with the rest of the United States in Figure 3. Volumes are converted to diesel gallon equivalent (DGE). Over the last ten years, California's share of national BBD consumption (illustrated by the green line) has increased rapidly, growing from 2% in 2011 to 44% in 2021. Most of this growth is attributed to RD markets; however, biodiesel consumption in the state also increased more than twenty-fold.

12 International Renewable Energy Agency, "Road Transport: The Cost of Renewable Solutions," June 2013, https://irena.org/publications/2013/Jul/Road-Transport-The-Cost-of-Renewable-Solutions.

13 Neste, "California Low Carbon Fuel Standard Credit Price," Neste worldwide, January 24, 2017, https://www.neste.com/investors/market-data/lcfs-credit-price; U.S. Environmental Protection Agency, "RIN Trades and Price Information, Other Policies and Guidance," August 23, 2018, https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rin-trades-and-price-information.

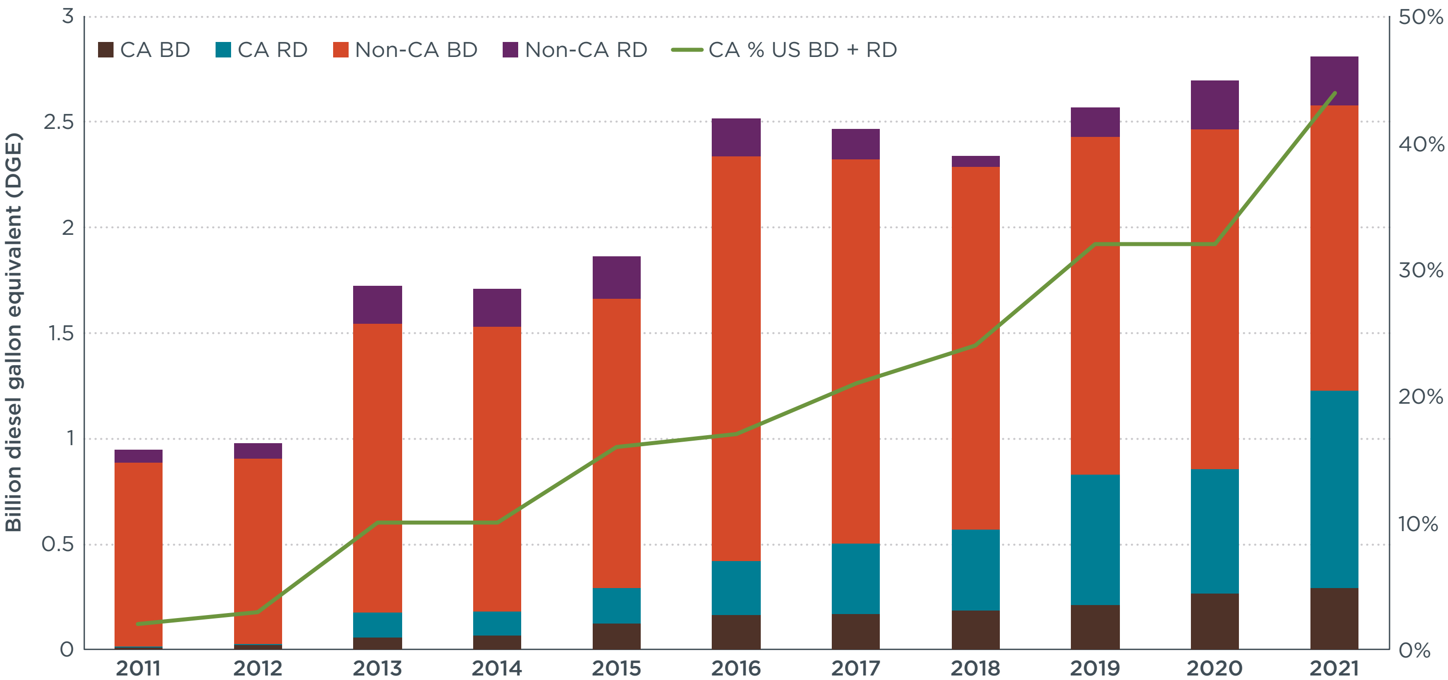

Figure 3. Biodiesel (BD) and renewable diesel (RD) usage trends within and outside California

The recent trend of U.S. BBD consumption shifting to California is poised to continue and accelerate. In May, the Contra Costa County Board of Supervisors permitted two refinery conversions in the San Francisco Bay Area with a combined capacity of 1.8 billion gallons of renewable diesel per year.[14] Planned growth in BBD markets despite limited domestic feedstock availability raises serious concerns about where the lipid feedstocks will come from and what impact the diversion of these lipids to fuel markets will have on other food prices and other markets.

In an analysis derived from Zhou, Baldino, and Searle and described in Appendix A,[15] we find that nationally, BBD production (around 3 billion DGE) has already overtaken the amount that could be produced from available feedstock supply (around 2.1 billion DGE), leading to increasing vegetable oil imports.[16] It is clear that any further expansion in BBD production nationally will be constrained by feedstock limitations. To the extent that BBD expansion does occur, this growth will exacerbate the U.S. vegetable oil trade balance. Because waste oil BBD receives such favorable treatment in the LCFS and because renewable diesel is one of the most favorable compliance mechanisms, we expect UCO renewable diesel—and its associated fraud risk—to play an increasingly large role in LCFS compliance as the targets become more stringent over the coming decade.

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14 Contra Costa County Department of Conservation and Development, "Phillips 66 Rodeo Renewed Project Staff Report," accessed June 14, 2022, https://www.contracosta.ca.gov/DocumentCenter/View/74662/CDLP20-02040-cpc-web-version-rev; Joseph W. Jr Lawlor, "Martinez Refinery Renewable Fuels Project" (Contra Costa County Department of Conservation and Development, 2022), https://www.contracosta.ca.gov/DocumentCenter/View/74650/LP20-2046-Presentation-County-Planning-Commission-.

15 Yuanrong Zhou, Chelsea Baldino, and Stephanie Searle, "Potential Biomass-Based Diesel Production in the United States by 2032" (Washington, D.C.: ICCT, 2020), https://theicct.org/publication/potential-biomass-based-diesel-production-in-the-united-states-by-2032/.

16 "U.S. Department of Agriculture Economic Research Service, "USDA ERS - Oil Crops Yearbook," accessed January 24, 2022, https://www.ers.usda.gov/data-products/oil-crops-yearbook/oil-crops-yearbook/#Soy%20and%20Soybean%20Products.

Despite clear availability limitations, the domestic BBD industry is moving swiftly ahead with capacity expansion projects. The U.S. Energy Information Authority (EIA) estimates that annual U.S. renewable diesel production capacity could grow nearly 800%, or by 4.5 billion gallons, between 2020 and 2024 if planned projects materialize.[17] The EIA Short Term Energy Outlook (STEO) forecasts that U.S. BBD consumption will rise 45% from 2021 to 2023 based on the U.S. Environmental Protection Agency's proposed rule for the 2022 RFS.[18] This increase is equivalent to an additional 1.2 billion DGE of U.S. BBD consumption.

GLOBAL DISPLACEMENT OF VEGETABLE OILS WOULD CONTRIBUTE TO FOOD PRICE SPIKES AND DEFORESTATION

Outside the biofuels sector, there is high demand for vegetable oil in non-fuel markets, including food products, livestock feed, soaps and detergents, and other products. The main economic effect of increasingly diverting vegetable oil from existing uses to fuel production will be a short-term price increase combined with a long-term increase in vegetable oil production.[19] Concerns about vegetable oil prices have become increasingly severe in light of a recent spike in global food prices.[20] Crude soybean oil prices nearly tripled between January 2019 and May 2022, exceeding the 2021 prices shown in Figure 2,[21] while vegetable oils more broadly are leading the world food price index to record highs—it is likely that vegetable oil demand for BBD production globally has contributed to this trend.

Diverting lipid-based feedstocks from existing markets also presents significant sustainability concerns. Increasing the global supply of vegetable oils, directly or indirectly, necessarily comes at the cost of forests and other natural lands. In practical terms, biofuel producers could generate higher volumes of BBD using three major strategies: 1) increase the crush rate of whole soybeans to produce additional soy oil for domestic consumption; 2) purchase higher quantities of imported BBD feedstocks alongside reducing the quantity of exports; or 3) procure lipid feedstocks for BBD that are currently consumed in other end uses. All three strategies would massively disrupt the trade balance of lipids. Increased demand for waste-derived, imported BBD feedstocks increases fraud risk from falsely labeled waste oil feedstocks and indirect emissions from feedstock diversion.[22] Documented cases of producer level fraud in the United States and European Union are discussed in Appendix B.

Today, roughly half of whole soybeans are crushed within the United States.[23] Crushing separates soybeans into soy oil, used in food, consumer products and the biofuels market, and soymeal, a protein-rich product used in animal feed. If all soybeans were

17 U.S. Energy Information Administration, "U.S. Renewable Diesel Capacity Could Increase Due to Announced and Developing Projects," July 29, 2021, https://www.eia.gov/todayinenergy/detail.php?id=48916.

18 U.S. Energy Information Administration, "STEO Data Browser - 8a. U.S. Renewable Energy Consumption," June 7, 2022, https://www.eia.gov/outlooks/steo/data/browser/#/?v=24&f=A&s=&id=&maptype=0&ctype=linechart.

19 Ed White, "Food Security Worries Spark Biofuel Debate," *The Western Producer* (blog), March 31, 2022, https://www.producer.com/news/food-security-worries-spark-biofuel-debate/.

20 Food and Agriculture Organization of the United Nations, "FAO Food Price Index," accessed May 11, 2022, https://www.fao.org/worldfoodsituation/foodpricesindex/en/.

21 "Soybean Oil Prices - 45 Year Historical Chart," macrotrends, accessed May 11, 2022, https://www.macrotrends.net/2538/soybean-oil-prices-historical-chart-data.

22 Chris Malins and Cato Sandford, "Animal, Vegetable or Mineral (Oil)?".

23 "Fats and Oils: Oilseed Crushings, Production, Consumption and Stocks 2020 Summary 03/01/2021," *Fats and Oils*, 2020, 27.

sent to crushing plants to meet rising demand for biofuels, we estimate that this would raise domestic soy oil BBD availability to a maximum 33.7 billion pounds in 2030, or 4 billion DGE of fuel. Put another way, maximizing the soybean crush rate could increase total U.S. BBD production by more than two-fold. Increased consumption of soy oil from domestically crushed whole soybeans will leave a gap in the global soy oil market. This trend would also lead to an increase in U.S. soymeal exports in place of whole soybeans. Agricultural analysts have already noted the rising trend in U.S. soymeal exports in response to increased BBD demand.[24] China is the largest importer of U.S. whole soybeans and would be impacted by the anticipated shifts in the soybean trade[25]—soy oil from soybean crushing in China accounts for roughly 30% of its domestic vegetable oil supply.[26] If this soy oil is effectively retained in the United States instead of being sent to China as part of whole soybeans, China would need to find a new source of vegetable oil, which is likely to come in the form of palm oil, or soy oil imported from other regions.[27]

Palm oil, globally the least expensive vegetable oil and one of the most widely consumed, is strongly associated with tropical deforestation. Nearly 90% of the world's palm oil is produced in Indonesia and Malaysia.[28] In Indonesia, 70% of palm oil expansion is at the expense of peatlands and forests,[29] and across Indonesia and Malaysia combined, one-third of palm oil expansion is onto very carbon-rich peat soils.[30] When taking the GHG emissions from deforestation and peat oxidation into account, most life-cycle analyses performed for regulatory purposes find that biofuel produced from palm oil results in higher lifecycle GHG emissions than petroleum.[31] Palm oil expansion is also associated with significantly negative biodiversity impacts in Southeast Asia.[32]

Like palm oil, soy oil production has been linked to tropical deforestation in the Brazilian Amazon. Brazil has become the leading producer of soybeans globally and

24 Kim Chipman and Michael Hirtzer, "U.S. Soy Meal Exports Soar as Biofuel Frenzy Boosts Bean Crush," *Bloomberg.Com*, January 21, 2022, https://www.bloomberg.com/news/articles/2022-01-21/u-s-soy-meal-exports-soar-as-biofuel-frenzy-boosts-bean-crush.

25 "Soybean 2020 Export Highlights," USDA Foreign Agricultural Service, accessed May 11, 2022, https://www.fas.usda.gov/soybean-2020-export-highlights.

26 USDA Foreign Agricultural Service, "Table 27: China Oilseeds and Products Supply and Distribution," June 10, 2022, https://apps.fas.usda.gov/psdonline/app/index.html#/app/downloads.

27 USDA Foreign Agricultural Service, "Oilseeds: World Markets and Trade," July 2021, https://apps.fas.usda.gov/psdonline/circulars/oilseeds.pdf.

28 Food and Agricultural Organization of the United Nations, "Crops and Livestock Products," FAOSTAT, accessed February 23, 2022, https://www.fao.org/faostat/en/#data/QCL.

29 Kemen G. Austin, Prasad S. Kasibhatla, Dean L. Urban, Fred Stolle, and Jeffrey Vincent, "Reconciling Oil Palm Expansion and Climate Change Mitigation in Kalimantan, Indonesia," *PLOS ONE* 10, no. 5 (May 26, 2015): e0127963, https://doi.org/10.1371/journal.pone.0127963.

30 Jukka Miettinen, Chenghua Shi, and Soo Chin Liew, "Land Cover Distribution in the Peatlands of Peninsular Malaysia, Sumatra and Borneo in 2015 with Changes since 1990," *Global Ecology and Conservation* 6 (April 1, 2016): 67–78, https://doi.org/10.1016/j.gecco.2016.02.004.

31 Katrina Sideco, "Detailed Analysis for Indirect Land Use Change," California Air Resources Board, 2014, https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/iluc_assessment/iluc_analysis.pdf ; Hugo Valin et al., "The Land Use Change Impact of Biofuels Consumed in the EU: Quantification of Area and Greenhouse Gas Impacts," August 27, 2015; David Laborde, "Assessing the Land Use Change Consequences of European Biofuel Policies," International Food Policy Research Institute, October 2011, https://ebrary.ifpri.org/utils/getfile/collection/p15738coll5/id/197/filename/198.pdf; ICAO, "CORSIA Eligible Fuels- Life Cycle Assessment Methodology," June 2019, https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA%20Supporting%20Document_CORSIA%20Eligible%20Fuels_LCA%20Methodology.pdf.

32 Chelsea Petrenko, Julia Paltseva, and Stephanie Searle, "Ecological Impacts of Palm Oil Expansion in Indonesia" (Washington, D.C.: ICCT, 2016), https://theicct.org/publication/ecological-impacts-of-palm-oil-expansion-in-indonesia/.

is another large exporter to China.[33] Between 2001 and 2005, approximately 26% of soy expansion in Brazil occurred on forested land with the remainder onto pasture.[34] A moratorium adopted by major soy companies in 2006 has helped limit the level of forest land expansion, however this has not fully eliminated the practice. Current levels of deforestation from soybean planting may be higher than previously believed due to indirect effects of cropland expansion in the Chaco region of Argentina, Paraguay, and Bolivia.[35] Further, there is strong evidence of soy expansion in the Cerrado savanna region of Brazil, not covered under the soy moratorium. An estimated 30% of soy expansion in the Cerrado between 2000 and 2014 disturbed native vegetation.[36] Soy expansion onto the Cerrado also has a negative impact on biodiversity. Only 20% of land in this region remains undisturbed, with few legal protections in place to prohibit land conversion.[37]

There is also strong evidence that increased consumption of soy oil and other oil and fat feedstocks in U.S. biofuel production indirectly increases U.S. palm oil imports to substitute for the diverted soy oil in non-fuel uses, such as cooking and consumer products. Santeramo and Searle identified a statistically significant causal relationship between increased soy biodiesel demand and increased palm oil imports in the United States between 1992 and 2016.[38] Thus, increased use of soy oil for biofuel in the United States ultimately results in palm-related deforestation, peat drainage, and biodiversity impacts in Southeast Asia, with associated high GHG emissions. Feedstock substitution is also a problem associated with waste and byproduct oils and fats such as UCO, tallow, and inedible corn oil. While none of these feedstocks can be used in food, they have valuable uses in livestock feed and consumer products. Displacing them from those uses necessitates the production of other materials to replace them—usually other agricultural commodities such as soy oil and corn. O'Malley, Searle, and Pavlenko found that displacement GHG emissions for biofuels produced from waste and byproduct oils and fats can be generally within the range of indirect emissions for food-based biofuels.[39] Waste oils are also associated with producer-level fraud, as outlined in Appendix A.

SETTING A CAP

In response to the arguments presented above, we recommend that CARB set a cap on the volume of lipid-derived BBD based on its current consumption in California. This cap could be revised upward in the future based on the growth of lipid resources nationally; the increase would be adjusted to account for California's equitable share of domestic lipid supply, which is approximately 7%.

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33 USDA Foreign Agricultural Service, "Oilseeds: World Markets and Trade," June 2022, https://apps.fas.usda.gov/psdonline/circulars/oilseeds.pdf.

34 Stephanie Searle and Jacopo Giuntoli, "Analysis of High and Low Indirect Land-Use Change Definitions in European Union Renewable Fuel Policy" (Washington, D.C.: ICCT, 2018), https://theicct.org/publication/analysis-of-high-and-low-indirect-land-use-change-definitions-in-european-union-renewable-fuel-policy/.

35 Searle and Giuntoli, "Analysis of High and Low Indirect Land-Use Change."

36 Arnaldo Carneiro Filho and Karine Costa, "The Expansion of Soybean Production in the Cerrado" (INPUT - Iniciativa para o Uso da Terra, October 2016).

37 Aline C. Soterroni et al., "Expanding the Soy Moratorium to Brazil's Cerrado," *Science Advances* 5, no. 7 (July 17, 2019): eaav7336, https://doi.org/10.1126/sciadv.aav7336.

38 Fabio Gaetano Santeramo and Stephanie Searle, "Linking Soy Oil Demand from the US Renewable Fuel Standard to Palm Oil Expansion through an Analysis on Vegetable Oil Price Elasticities," *Energy Policy* 127 (April 1, 2019): 19–23, https://doi.org/10.1016/j.enpol.2018.11.054.

39 Jane O'Malley, Stephanie Searle, and Nikita Pavlenko, "Indirect Emissions from Waste and Residue Feedstocks: 10 Case Studies from the United States" (Washington, D.C.: ICCT, 2021), https://theicct.org/publication/indirect-emissions-from-waste-and-residue-feedstocks-10-case-studies-from-the-united-states/.

A cap would be set on the volume of lipid-based fuel eligible for crediting within the LCFS credit market. To illustrate how a volume cap might be calculated, we reference our domestic feedstock availability projections through 2030. We calculate a potential lipids cap for 2030, based on the current consumption of BBD feedstocks in California (4.35 million tonnes, or 1.1 billion DGE) plus California's share of expected growth in BBD feedstock availability (0.1 million tonnes) detailed in Appendix A. Using this method, we recommend setting the lipids cap at roughly 4.44 million tonnes, or 1.2 billion DGE, in 2030, a 2.2% increase from today's level of BBD consumption in California. Intermediate targets based on annual availability projections could be set for interim years.

In effect, lipid fuels will be traded at a discount relative to other pathways to reflect their high market and sustainability risks. In a highly saturated fuel market where supply outpaces the annual cap, lipid fuel produced in excess of the cap will have lower market value than other types of low-carbon fuel. Whereas the value of other types of low-carbon fuel in California reflects both the wholesale fuel value plus the value of associated LCFS credits, the value of lipid-based BBD produced in excess of the cap will converge with the price of BBD sold in non-California markets. Fuel producers could partially mitigate this reduction in value by reducing emissions along their supply chain to receive greater compensation for an energy equivalent unit of fuel (MJ) sold underneath the cap. Setting a cap on the volume of lipid-based fuel sold within California could also stimulate growth in non-lipid fuel production that delivers the greatest GHG reduction benefits.

APPENDIX A: FEEDSTOCK AVAILABILITY ANALYSIS

We define availability as the domestic supply of feedstocks, including current imports, minus their share used in competing sectors. We assess the domestic availability of BBD feedstocks, building off an analysis by Zhou, Baldino, and Searle, and find that current consumption of some BBD feedstocks may already exceed domestic availability. Zhou assessed annual domestic feedstock production, net exports, and competing uses to calculate total U.S. BBD potential through 2032. In total, the authors estimated that the domestic availability of the seven most common lipid feedstocks nationwide, including soybean oil, corn oil, and tallow, could increase by a maximum of 11% between 2018 and 2032.[40]

We update that analysis to account for updated whole soybean production projections from the U.S. Department of Agriculture (USDA),[41] updates to 5-year historical trends, an update to feedstock consumption volumes in competing sectors, and newly reported data on annual UCO exports.[42]No USDA data is reported for historical feedstock usage in the oleochemicals sector, so we assume a constant weighted share relative to other non-BBD feedstock consumption based on data from Informa Economics.[43] Future consumption in this sector is assumed to increase linearly over time.

40 Yuanrong Zhou, Chelsea Baldino, and Stephanie Searle, "Potential Biomass-Based Diesel Production in the United States by 2032."

41 U.S. Department of Agriculture, "USDA Agricultural Projections to 2030," February 2021, https://www.usda.gov/sites/default/files/documents/USDA-Agricultural-Projections-to-2030.pdf.

42 Greenea, "The Year 2021: Which Investments Will See the Light in the Biofuel Industry?," 2021, https://www.greenea.com/wp-content/uploads/2021/01/Greenea-Horizon-2030-Which-investments-will-see-the-light-in-the-biofuel-industry-1.pdf.

43 Informa Economics, "A Profile of the North American Rendering Industry," prepared for the National Renders Association, 2011.

We estimate that BBD availability could increase by a maximum of 21% (equivalent to 0.34 billion DGE of BBD) from 2020 to 2030, with soybean and yellow grease accounting for the largest growth in volumes. Volumes of UCO are not tracked by the USDA, so we adopt yellow grease data as the closest equivalent. Yellow grease is comprised of UCO along with other types of waste oils and animal fats from food processing, such as at restaurants. We calculate California's share of BBD growth by multiplying domestic availability potential by the state's current share of the national distillate fuel market, or 7.3%.[44] This value could be adjusted in later years if consumption trends change.

We convert annual feedstock availability estimates to their DGE using fuel production yield data reported in the Greenhouse Gases, Regulated Emissions, and Energy Use in Technology (GREET) model. Volumes are calculated for both biodiesel and renewable diesel and weighted by the annual share of BD and RD production capacity reported by the EIA to estimate BBD totals.[45]

APPENDIX B: WASTE OIL FRAUD

In addition to the land use change and greenhouse gas emissions risk associated with lipid fungibility, producer-level fraud has emerged as another pressing issue for waste oil markets. This issue has attracted political attention in the European Union, where there is evidence of fraudulent UCO being imported from foreign suppliers. There are two cases of waste oil fraud that have been prosecuted in the EU. An October 2020 case tried in the Netherlands involved three major players: a Bosnian company that claimed to sell UCO biodiesel imported from a U.S. supplier; the receiving company, Biogra Trading LLC; and a third company based out of the Netherlands also in contract with Biogra Trading. Upon receiving the UCO biodiesel shipment from the Bosnian company, Biogra Trading LLC, incurred an import duty fee that should only apply to soy oil-based biofuel. Under this suspicion and an overlap of personnel between the Dutch and Bosnian based suppliers, the European Anti-Fraud Office (OLAF) pursued an investigation. Biogra Trading tested the material claimed to be UCO biodiesel by a third party and concluded the fuel was "most probably [soybean biodiesel], not [UCO biodiesel]."[46] The reason for this fraudulent scheme was likely due to UCO's higher credit value within European fuels policy.

Another case involved a Norwegian company selling UCO biodiesel to the EU that was claimed to be sourced from a producer in Canada. However, an OLAF investigation found that this fuel was actually sourced from the United States and made up of soy oil later blended with vegetable oil in Canada.[47] Both the sending and receiving companies based out of Canada and Norway were also owned and operated by the same parent company based out of Switzerland. This case of fraud was likely conducted to avoid anti-dumping and other fees equivalent to €62 million if the same fuel products were to be imported from the United States. The producers also aimed to take advantage of incentives from renewable energy schemes such as

44 U.S. Energy Information Administration, "Table F5: Distillate Fuel Oil Consumption Estimates, 2020," 5.

45 U.S. EIA, "Monthly Biodiesel Production Report," February 2021.

46 Court of Rotterdam, ECLI:NL:RBROT:2020:11063, Rechtbank Rotterdam, C/10/605414 / KG ZA 20-913, No. ECLI:NL:RBROT:2020:11063 (Rb. Rotterdam October 28, 2020).

47 European Anti-Fraud Office (European Commission), "The OLAF Report 2019: Twentieth Report of the European Anti Fraud Office, 1 January to 31 December 2019" (LU: Publications Office of the European Union, 2020), https://data.europa.eu/doi/10.2784/8525.

the EU Renewable Energy Directive (RED) for selling UCO rather than vegetable-oil based biofuel.

In the United States, there are several prominent examples of waste oil fraud under the RFS program. In the early years of the program, Keystone Biofuels in Pennsylvania claimed higher volumes of RFS credits than actual production as well as forged quality tests that identified soy biodiesel as UCO biodiesel.[48]

Biofuel producers can readily commit waste oil fraud due to the challenge of verifying the physical composition of blended fuel. Because pure UCO and UCO blended with vegetable oil feedstocks are entirely indistinguishable, the risk of UCO fraud is especially high.[49] Once feedstocks are converted to biofuel, fuel can be analyzed for its fatty acid composition; however, the fuel's precise feedstock makeup can no longer be accurately determined. Feedstocks may also be labeled differently across geographic regions. Generally, UCO is traded between several intermediaries along the supply chain, which increases the potential for fraud and faulty labeling. For example, Malaysia acts as a UCO trading hub, but Kristiana, Baldino, and Searle found that the country seems to export more UCO than it imports in addition to the volumes it could plausibly produce.[50] Because of this, there is rampant speculation that Asian UCO imports to the EU may be fraudulent.[51] Complex supply chains are also common for palm oil and its derivatives, leading to high fraud potential.

48 U.S. Attorney's Office Eastern District of Pennsylvania, "Owners Of Lehigh Valley Companies And Their Engineer Charged In Green Energy Fraud Scheme," December 21, 2015, https://www.justice.gov/usao-edpa/pr/owners-lehigh-valley-companies-and-their-engineer-charged-green-energy-fraud-scheme.

49 E4tech, Cerulogy, International Council on Clean Transportation, Navigant, SCS Global Services, and Wageningen University & Research, "Assessment of the Potential for New Feedstocks for the Production of Advanced Biofuels," October 2021, https://www.e4tech.com/resources/239-assessment-of-the-potential-for-new-feedstocks-for-the-production-of-advanced-biofuels-renewable-energy-directive-annex-ix.php.

50 Tenny Kristiana, Chelsea Baldino, and Stephanie Searle, "An Estimate of Current Collection and Potential Collection of Used Cooking Oil from Major Asian Exporting Countries."

51 Farm Europe, "Fraudulent Used Cooking Oil Biodiesel – Bad for the Climate and a Blow to EU Farm, Oilseed and Plant Protein Sectors," *Euractiv*, October 25, 2019, https://www.euractiv.com/section/agriculture-food/opinion/fraudulent-used-cooking-oil-biodiesel-bad-for-the-climate-and-a-blow-to-eu-farm-oilseed-and-plant-protein-sectors/.