



February 20, 2024

Submitted electronically at <https://ww2.arb.ca.gov/lispub/comm/bclist.php>

Clerk's Office  
California Air Resources Board  
1001 I Street  
Sacramento, CA 95814

Re: Twelve Benefit Corporation Comments on the Proposed Low Carbon Fuel Standard  
Amendments

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Dear Sir/Madam:

Twelve Benefit Corporation (Twelve), based in northern California, appreciates the opportunity to comment on the above-referenced Low Carbon Fuel Standard (LCFS) rulemaking package issued by the California Air Resources Board (CARB).<sup>1</sup>

As detailed below, our comments address the following points:

- CARB should consider broadening the proposed definition of “renewable naphtha;”
- Some of the proposed revisions to the book-and-claim accounting provisions for low-carbon intensity (low-CI) electricity used for hydrogen production are unexplained, unwarranted, and short-sighted;
- Most importantly, CARB through this rulemaking should put in place regulatory provisions to foster the production and uptake of ultra-low carbon Power-to-Liquid Sustainable Aviation Fuel (PtL SAF) and other PtL fuels;
- The “physically connected to California” requirement should be eliminated from proposed subsection 95488.8(i)(3)(A); and
- In view of the proposed revisions to section 95490, CARB should revisit the system boundary for carbon capture and sequestration (CCS) projects when the carbon dioxide (CO<sub>2</sub>) is captured at an alternative fuel production facility.

Please note that Twelve is also a signatory of the comment letter submitted by Infinium on behalf of various PtL fuel producers and airlines.

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<sup>1</sup> Posted at <https://ww2.arb.ca.gov/rulemaking/2024/lcfs2024>.

As we did in our July 3, 2023, submission to CARB on potential changes to the LCFS Program,<sup>2</sup> we first provide background information on our company and our groundbreaking carbon transformation™ technology, as well as a brief overview of PtL fuels, sometimes referred to as electrofuels or e-fuels, before setting out our detailed comments in Part II below.

## I. Background

### A. *Twelve and Carbon Transformation*

Founded in 2015 and headquartered in Berkeley, Twelve currently employs a staff of almost three hundred chemists, engineers, techno-economic experts, product developers, and other specialists, with the vast majority of our personnel working in one of our locations in the San Francisco Bay area. We are on a mission to eliminate global CO<sub>2</sub> emissions and build a fossil-free future.

Our proprietary carbon transformation technology takes captured CO<sub>2</sub> and, using only water and renewable energy, transforms it into synthesis gas (syngas), a combination of carbon monoxide and hydrogen. Once formed, the syngas is routed through an integrated Fischer-Tropsch reactor and then upgraded, ultimately resulting in our E-Jet® fuel – PtL SAF (or as CARB refers to it under the LCFS Program, alternative jet fuel) that meets the specifications in Annex A1 of ASTM International's D7566 Standard (*Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons*) – as well as our E-Naphtha™. We expect our E-Jet, which has been tested and validated under a grant from the U.S. Air Force,<sup>3</sup> to reduce lifecycle greenhouse gas (GHG) emissions by up to 90% in comparison to conventional, petroleum-based jet fuel.<sup>4</sup>

Last summer, we began constructing our first E-Jet plant in Moses Lake, Washington.<sup>5</sup> We selected Moses Lake in part because of the availability and abundance of low-carbon electricity in the state of Washington, including existing (especially hydropower) and new renewable energy sources. Over the next few years, we intend to develop commercial-scale fuel production plants in various locations around the country, and to supply our E-Jet and E-Naphtha to the global airline and chemical industries and other customers. As a California-based company, we hope to be able to arrange for uplift in the state of a sizable portion of the PtL SAF that we produce. Our ability to generate LCFS credits for our ultra-low carbon jet fuel

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<sup>2</sup> A copy of our earlier comment letter, which can be found at [https://ww2.arb.ca.gov/system/files/webform/public\\_comments/4291/Twelve%20Letter%20to%20CARB%20on%20Indirect%20Accounting\\_files%20070323.pdf](https://ww2.arb.ca.gov/system/files/webform/public_comments/4291/Twelve%20Letter%20to%20CARB%20on%20Indirect%20Accounting_files%20070323.pdf), is attached.

<sup>3</sup> See <https://www.af.mil/News/Article-Display/Article/2819999/the-air-force-partners-with-twelve-proves-its-possible-to-make-jet-fuel-out-of/>.

<sup>4</sup> For more on Twelve and carbon transformation, our revolutionary electrochemical technology, please visit our website at [twelve.co](https://twelve.co).

<sup>5</sup> The Moses Lake AirPlant™, which will transform biogenic CO<sub>2</sub> captured from an industrial source, will have a water electrolyzer operating alongside our CO<sub>2</sub> electrolyzer, but in the future, we may produce the clean hydrogen that is needed for the syngas via an alternative hydrogen production pathway (e.g., one of the non-water electrolysis pathways included in the U.S. Department of Energy's 45VH2-GREET Model), or we may opt to obtain the clean hydrogen from a supplier.

will, of course, be a key factor in whether this happens.

### *B. PtL Fuels in General*

While technological approaches to the production of PtL fuels can vary, the common thread among all such fuels is the utilization of the same feedstocks: CO<sub>2</sub> that is either captured from an industrial source (e.g., an ethanol facility) or obtained from direct air capture; and a renewable source of electricity (e.g., solar, wind, hydropower) that is used to create clean hydrogen through the electrolysis of water (or perhaps through some other hydrogen production pathway). The national blueprint for transportation decarbonization, a multi-agency effort released by the federal government early last year, points out that PtL fuels represent “a viable pathway” to sustainable, low-carbon transportation fuels.<sup>6</sup> According to the U.S. Department of Energy (DOE), one of the federal agencies involved in that effort, PtL fuels “have dramatically smaller land, water, and [GHG] footprints compared to fossil fuels.”<sup>7</sup>

Specifically in the context of the hard-to-abate aviation sector,<sup>8</sup> PtL SAF poses fewer land-related issues than most biomass-based SAF, is also advantageous from a water demand standpoint, and has been cited as “the only SAF technology that has the potential for unbounded production,”<sup>9</sup> an apt description given the ever-increasing amount of CO<sub>2</sub> in the Earth’s atmosphere. For its part, Airbus, the commercial aircraft manufacturer, has referred to PtL SAF as an “exciting option” for fueling airplanes, one that “will be necessary to meet [expected SAF] demand,”<sup>10</sup> while the International Energy Agency recently asserted that e-fuels “made from biogenic or air-captured CO<sub>2</sub> can potentially provide full emissions reduction,

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<sup>6</sup> *The U.S. National Blueprint for Transportation Decarbonization: A Joint Strategy to Transform Transportation*, at 55 (Jan. 2023), available at <https://www.energy.gov/sites/default/files/2023-01/the-us-national-blueprint-for-transportation-decarbonization.pdf>.

<sup>7</sup> DOE Bioenergy Technologies Office, “CO<sub>2</sub> Reduction and Upgrading for e-Fuels Consortium,” available at <https://www.energy.gov/eere/bioenergy/co2-reduction-and-upgrading-e-fuels-consortium>.

<sup>8</sup> As the Federal Aviation Administration (FAA) puts it, “decarbonization of the aviation sector is extremely challenging,” and SAF is “critical to the long-term decarbonization of aviation.” See FAA, *United States 2021 Aviation Climate Action Plan*, at 3, 21 (Nov. 2021), available at [https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation\\_Climate\\_Action\\_Plan.pdf](https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf).

<sup>9</sup> Rhodium Group, “Sustainable Aviation Fuels: The Key to Decarbonizing Aviation” (Dec. 7, 2022), available at <https://rhg.com/research/sustainable-aviation-fuels/>; see also World Economic Forum, *Clean Skies for Tomorrow: Delivering on the Global Power-to-Liquid Ambition*, at 10 (May 2022) (referring to PtL SAF’s “high GHG reduction potential” compared to other types of SAF and indicating that the feedstocks “are theoretically unlimited”), available at [https://www3.weforum.org/docs/WEF\\_Clean\\_Skies\\_for\\_Tomorrow\\_Power\\_to\\_Liquid\\_Deep\\_Dive\\_2022.pdf](https://www3.weforum.org/docs/WEF_Clean_Skies_for_Tomorrow_Power_to_Liquid_Deep_Dive_2022.pdf).

<sup>10</sup> Airbus, “Power-to-Liquids, explained” (July 15, 2021), available at <https://www.airbus.com/en/newsroom/news/2021-07-power-to-liquids-explained>; “Sustainable aviation fuels: A new generation of reduced emissions fuels,” available at <https://www.airbus.com/en/sustainability/respecting-the-planet/decarbonisation/sustainable-aviation-fuels>.

making them the primary production pathway that is consistent with achieving [the global aviation sector's goal of] net zero emissions by mid-century.”<sup>11</sup>

## II. Twelve's Comments on the CARB Proposal

With the above background in mind, our detailed comments on CARB's proposed LCFS amendments follow.

### A. *CARB Should Consider Broadening the Proposed Definition of Renewable Naphtha*

As an initial matter, we note that among the new definitions that CARB is proposing to add to section 95481(a) of the LCFS regulation is a definition of the term “renewable naphtha.” The definition would provide, in relevant part, that the term “means naphtha that is produced from hydrotreated lipids and biocrudes, or from gasified biomass that is converted to liquids using the Fischer-Tropsch process.”<sup>12</sup>

As indicated above, Twelve's Moses Lake plant and our future commercial-scale facilities will produce not only E-Jet but also an electrochemical, E-Naphtha. For this reason, Twelve recommends that CARB consider broadening the proposed definition of “renewable naphtha” so that it also encompasses the E-Naphtha to be produced at Twelve's facilities. We suggest the following possible revision to the first sentence of the proposed definition (underline to indicate additions and ~~strikeout~~ to indicate deletions):

“Renewable Naphtha” means naphtha that is produced from hydrotreated lipids and biocrudes, ~~or from gasified biomass that is converted to liquids using the Fischer-Tropsch process,~~ or from captured CO<sub>2</sub>, water, and low-CI electricity that are converted to liquids using electrolysis and the Fischer-Tropsch process.

While we offer this recommendation, we also acknowledge the proposed revision to section 95488.1(d)(4) that would identify “synthetic hydrocarbons” as drop-in fuels subject to Tier 2 pathway classification.<sup>13</sup> If PtL-based naphtha like Twelve's E-Naphtha is meant to be covered by this particular revision, we would appreciate CARB providing clarification to that effect.

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<sup>11</sup> International Energy Agency, *The Role of E-Fuels in Decarbonising Transport*, at 10, 24 (Jan. 2024), available at <https://iea.blob.core.windows.net/assets/a24ed363-523f-421b-b34f-0df6a58b2e12/TheRoleofE-fuelsinDecarbonisingTransport.pdf>. The International Civil Aviation Organization (ICAO) established net-zero carbon emissions by 2050 as the long-term global aspirational goal for international aviation in October 2022. See ICAO Assembly Resolution A41-21, ¶ 7, available at [https://www.icao.int/environmental-protection/Documents/Assembly/Resolution\\_A41-21\\_Climate\\_change.pdf](https://www.icao.int/environmental-protection/Documents/Assembly/Resolution_A41-21_Climate_change.pdf).

<sup>12</sup> Appendix A-1: Proposed Regulation Order (Appendix A-1) at 23.

<sup>13</sup> Appendix A-1 at 117.

*B. Some of the Proposed Changes to the Indirect Accounting Provisions for Low-CI Electricity Used for Hydrogen Production Are Unexplained, Unwarranted, and Short-Sighted*

Proposed section 95488.8(i)(1) would include a major revision to the language on book-and-claim accounting for low-CI electricity that is used in the production of hydrogen. Currently, this regulatory provision allows indirect accounting in two instances: (1) when the low-CI electricity is supplied as a transportation fuel (i.e., for use in an electric vehicle); and (2) when the low-CI electricity is used to make hydrogen via electrolysis, where that hydrogen is then used either as a transportation fuel (i.e., in a hydrogen fuel cell electric vehicle (FCV)) or in the production of another transportation fuel.<sup>14</sup>

CARB is proposing to restructure section 95488.8(i)(1) and the three subsections encompassed within it (i.e., existing subsections (A) and (B) and new subsection (C)), but most important to Twelve is the proposed deletion of the parenthetical in section 95488.8(1) that reads, “(including hydrogen that is used in the production of a transportation fuel),” along with the proposed insertion of the phrase “as a transportation fuel” in the italicized subheading for section 95488.8(i)(1). The deletion of the parenthetical (as well as the corresponding subheading insertion) is irksome and troubling because CARB offers absolutely no explanation or rationale for it – not in the ISOR, and not in Appendix E.<sup>15</sup>

To be sure, CARB has proposed to include in the introductory clause of what would be new section 95488.8(i)(3) language stating that indirect accounting may be used for low-CI hydrogen that is used “to produce alternative fuel for transportation purposes,”<sup>16</sup> but this new section would only apply to low-CI hydrogen injected into a dedicated hydrogen pipeline physically connected to California. We also observe that CARB has not proposed any changes to the introductory language of section 95488.8(i)(2), which allows indirect accounting for pipeline-injected biomethane that is used “to produce hydrogen for transportation purposes (including hydrogen that is used in the production of a transportation fuel).”<sup>17</sup> Yet under new subsection 95488.8(i)(1)(C), CARB is proposing to allow book-and-claim accounting for low-CI electricity only when it is used in direct air capture projects or in the production of hydrogen that is used as a transportation fuel. For unexplained reasons, CARB is seeking to eliminate book-and-claim accounting for low-CI electricity when the electricity is used to make hydrogen that is then used in the manufacture of another transportation fuel (e.g., PtL SAF).

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<sup>14</sup> 17 CCR § 95488.8(i)(1); see also CARB, “Low Carbon Fuel Standard (LCFS) Guidance 19-01: Book-and-Claim Accounting for Low-CI Electricity,” at 1-2 (Oct. 2023), available at [https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/guidance/lcfsguidance\\_19-01\\_Revised\\_Oct2023\\_ADA.pdf](https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/guidance/lcfsguidance_19-01_Revised_Oct2023_ADA.pdf); CARB, “LCFS Electricity and Hydrogen Provisions” (providing as an example the hydrotreating of renewable diesel), available at <https://ww2.arb.ca.gov/resources/documents/lcfs-electricity-and-hydrogen-provisions>.

<sup>15</sup> See Staff Report: Initial Statement of Reasons (ISOR) at 34; Appendix E: Purpose and Rationale of Proposed Amendments for the Low Carbon Fuel Standard Requirements (Appendix E) at 68-69.

<sup>16</sup> Appendix A-1 at 156.

<sup>17</sup> 17 CCR § 95488.8(i)(2); see also CARB, “Low Carbon Fuel Standard (LCFS) Guidance 19-05: Reporting and Recordkeeping for Natural Gas and Book-and-Claim Accounting for Biomethane,” at 6 (Feb. 2024), available at [https://ww2.arb.ca.gov/sites/default/files/2024-02/lcfsguidance\\_19-05.pdf](https://ww2.arb.ca.gov/sites/default/files/2024-02/lcfsguidance_19-05.pdf).

Twelve maintains that this deletion is wholly unwarranted, and we respectfully request that CARB reverse itself or at the very least provide a thorough explanation detailing the rationale for why it believes this change is needed, especially given that CARB knows full well that hydrogen is an integral input in the production of SAF.<sup>18</sup> From our perspective, depriving fuel producers like Twelve of the ability to use indirect accounting for low-CI electricity used to make the electrolytic hydrogen that is essential to the production of PtL SAF is short-sighted and would be a huge misstep in that it would make the scale-up of ultra-low carbon PtL SAF even more challenging than it already is.

It seems fairly clear from both the ISOR and Appendix E that CARB wants to prioritize hydrogen for the on-road vehicle sector, i.e., direct use of hydrogen as fuel for cars and trucks.<sup>19</sup> Twelve has no quarrel with hydrogen's use as a motor vehicle fuel in FCVs. What we vigorously object to is CARB tipping the scale on book-and-claim accounting for low-CI electricity and disadvantaging the aviation sector and PtL SAF producers, as CARB is clearly doing in the proposed rulemaking by limiting book-and-claim only to low-CI electricity that is used to produce hydrogen for use as a transportation fuel.

*C. CARB Should Put in Place Regulatory Provisions To Foster the Production and Uptake of Ultra-Low Carbon PtL SAF and Other PtL Fuels*

In our July 3, 2023, comment letter on potential changes to the LCFS Program, we recommended that CARB expand the indirect accounting rules for low-CI electricity under section 95488.8(i) by enabling book-and-claim accounting for low-CI electricity when it is used as a feedstock for the production of PtL transportation fuels. CARB appears not to have considered Twelve's proposal, but as noted above, in the context of the proposed Tier 2 classification updates in section 95488.1(d), CARB openly acknowledges that "there is a growing interest in producing synthetic fuels by combining hydrogen with captured CO<sub>2</sub>."<sup>20</sup> In the ISOR, CARB states that "the proposed amendments, and the LCFS more broadly, are structured to encourage ongoing innovation and improvement in reducing the carbon intensity of transportation fuels as well as investment in innovative . . . carbon capture, *utilization*, and sequestration approaches."<sup>21</sup> In view of these statements, and considering that the PtL process is a prime example of carbon capture and utilization,<sup>22</sup> Twelve is submitting its proposal anew.

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<sup>18</sup> See ISOR at 34 (referring to "hydrogen used in the production of low-carbon transportation fuels such as renewable diesel and AJF").

<sup>19</sup> In this regard, it bears noting that earlier this month, Shell announced it was permanently closing all of its hydrogen light-duty vehicle fueling stations in California. See "Shell is Immediately Closing All of Its California Hydrogen Stations" (Feb. 9, 2024), available at <https://insideevs.com/news/708156/shell-closes-california-hydrogen-stations/>.

<sup>20</sup> Appendix E at 59.

<sup>21</sup> ISOR at 80 (emphasis added).

<sup>22</sup> See, e.g., DOE, "Clean Fuels & Products Shot™: Alternative Sources for Carbon-based Products," available at <https://www.energy.gov/eere/clean-fuels-products-shottm-alternative-sources-carbon-based-products>; European Commission, "Questions and Answers on the EU Industrial Carbon Management Strategy" (Feb. 6, 2024), available at [https://ec.europa.eu/commission/presscorner/detail/en/qanda\\_24\\_586](https://ec.europa.eu/commission/presscorner/detail/en/qanda_24_586).



In addition to our earlier submission, we are attaching to these comments a marked-up version of Appendix A-1.1 showing the textual regulatory revisions we are proposing today. These revisions are simple, straightforward, and narrowly tailored to “power-to-liquid fuel,” a term that would be defined to mean transportation fuel that is produced from captured CO<sub>2</sub>, water, and low-CI electricity. Allowing indirect accounting for low-CI electricity used in the production of PtL fuel would greatly incentivize the scale-up of these fuels, especially ultra-low carbon PtL SAF, which does not present the indirect land use change impacts or feedstock constraints that other types of SAF (e.g., crop-based SAF and waste oil- or animal fat-based SAF) do. Equally if not more important, extending book-and-claim to the low-CI electricity that is a feedstock (and not process energy) for PtL SAF production would ease the path to achieving the 90 percent jet fuel CI reduction in 2045 that CARB has proposed in Table 3,<sup>23</sup> a reduction level that Twelve fully supports and that CARB stresses “is necessary to accelerate decarbonization of the transportation fuels sector and support the State’s broader climate goals.”<sup>24</sup>

In Appendix E, CARB emphasizes that “the 2022 Scoping Plan Update includes consideration for *integrating other fuels into the LCFS program* and *highlights the importance of continuing to support low-carbon liquid fuels for sectors that are more difficult to transition to ZEV technology, such as aviation*,”<sup>25</sup> while in the ISOR, CARB explains that the 2022 update “anticipates a major shift away from fossil jet fuel by 2045, including 20% zero-emission aviation.”<sup>26</sup> Twelve urges CARB to use the current rulemaking to enable book-and-claim accounting for the low-CI electricity that is essential to PtL SAF (and other PtL fuel) production and thereby facilitate the role ultra-low carbon PtL SAF can play in the decarbonization of California’s aviation sector. Without indirect accounting for feedstock electricity, it will be very difficult for Twelve’s E-Jet and the PtL SAF produced by other fuel producers to contribute to the state’s goal, enshrined in section 38562.2(c) of the Health and Safety Code, of achieving an 85 percent reduction in anthropogenic GHG emissions (below 1990 levels) by 2045.

Please note that if CARB incorporates in the final rule the revisions we are seeking in this part of our comment letter, the feedback provided in Part II.B above becomes moot inasmuch as the recognition of book-and-claim accounting for low-CI electricity used to produce a PtL fuel would encompass both the electricity to make electrolytic hydrogen from water as well as, in Twelve’s case, the electricity to electrolyze CO<sub>2</sub>.<sup>27</sup>

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<sup>23</sup> See Appendix A-1 at 67 (Table 3 specifying for fossil jet fuel substitutes an average CI in 2019 of 94.17 gCO<sub>2</sub>e/MJ, dropping to 10.57 gCO<sub>2</sub>e/MJ in 2045, for an 88.78 percent reduction).

<sup>24</sup> ISOR at 24.

<sup>25</sup> Appendix E at 86 (emphasis added).

<sup>26</sup> ISOR at 26. CARB, in fact, foresees SAF accounting for at least 80 percent of aviation fuel demand in 2045. See CARB, *2022 Scoping Plan for Achieving Carbon Neutrality*, at 73, 206 (Dec. 2022), available at <https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf>.

<sup>27</sup> As we indicated in footnote 17 of our July 3, 2023, comment letter, Twelve’s electrochemical technology is unique in that we also use electricity to transform the CO<sub>2</sub> molecule.

*D. The Physical Connection Requirement Should Be Eliminated From Proposed Subsection 95488.8(i)(3)(A)*

As mentioned above, CARB has proposed in section 95488.8(i)(3), which would be a brand new provision in the LCFS regulation, “to expand [the] use of indirect accounting to include low-CI hydrogen injected into a dedicated hydrogen pipeline, which can be either used directly in transportation, or used in alternative fuel production.”<sup>28</sup> To Twelve’s knowledge, nowhere in the rulemaking documents does CARB speak to the extent to which dedicated hydrogen pipelines currently exist in, or to use the phrasing of proposed subsection 95488.8(i)(3)(A), are “physically connected to California.” As best we can tell, the state had only 16 miles of hydrogen pipeline as of late 2020.<sup>29</sup>

Due to this apparent paucity of in-state hydrogen pipeline infrastructure, Twelve recommends that CARB eliminate the “physically connected to California” requirement that is included in proposed subsection 95488.8(i)(3)(A). We note in this regard that while the ISOR and Appendix E mention the physical connection prerequisite, both are silent on the underlying rationale for it.<sup>30</sup> So long as pipeline-injected low-CI hydrogen meets all of the other conditions laid out in proposed subsections 95488.8(i)(3)(B)-(F), an entity should be allowed to avail itself of indirect/book-and-claim accounting. In Twelve’s view, this would better “incentivize and spur increased development and supply of low-CI hydrogen by providing flexibility to hydrogen production facility siting and supply logistics” and “facilitate and spur the use of low-CI hydrogen in support of California’s decarbonization efforts.”<sup>31</sup>

Thus, book-and-claim accounting would apply to low-CI hydrogen injected into a dedicated hydrogen pipeline network irrespective of whether the pipeline network is physically connected to California. This should have the ultimate effect of encouraging out-of-state fuel producers that use dedicated hydrogen pipeline-supplied low-CI hydrogen in their fuel production process to export their low-carbon fuel to California, and also enable California to benefit to an even greater extent from low-CI hydrogen that is produced outside the state.

*E. CARB Should Revisit the System Boundary for Carbon Capture and Sequestration Projects When the CO<sub>2</sub> is Captured at an Alternative Fuel Production Facility*

Finally, Twelve notes that CARB is proposing various modifications to the provisions in section 95490 governing CCS. Assuming these modifications are adopted, CARB may need to amend its CCS Protocol, which is referenced in the eligibility provision of section 95490 and “applies to CCS projects that capture [CO<sub>2</sub>] and sequester it onshore, in either saline or depleted oil and gas reservoirs, or [in] oil and gas reservoirs used for CO<sub>2</sub>-enhanced oil recovery (CO<sub>2</sub>-

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<sup>28</sup> Appendix E at 71.

<sup>29</sup> See Congressional Research Service, *Pipeline Transportation of Hydrogen: Regulation, Research, and Policy*, at 5 (Mar. 2, 2021), available at [https://www.everycrsreport.com/files/2021-03-02\\_R46700\\_294547743ff4516b1d562f7c4dae166186f1833e.pdf](https://www.everycrsreport.com/files/2021-03-02_R46700_294547743ff4516b1d562f7c4dae166186f1833e.pdf).

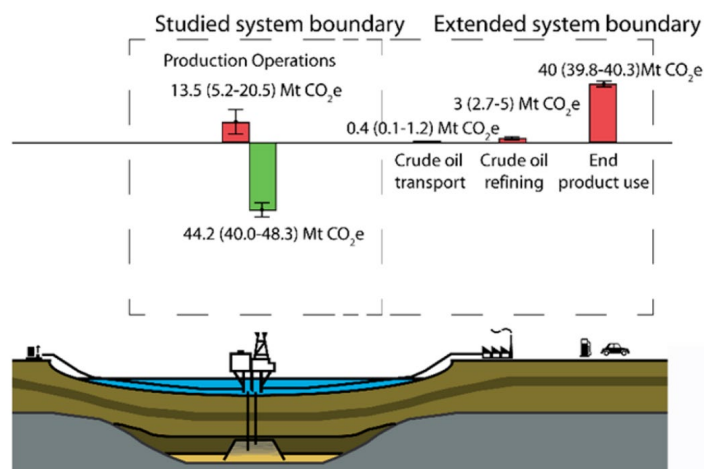
<sup>30</sup> See ISOR at 34; Appendix E at 71-73.

<sup>31</sup> Appendix E at 72.



EOR).<sup>32</sup> Even if the Protocol would not need to be updated as a result of the approved LCFS amendments, Twelve maintains that CARB should review one specific aspect of it – CO<sub>2</sub> capture and sequestration in oil and gas reservoirs used for CO<sub>2</sub>-EOR when the CO<sub>2</sub> was captured on-site at an alternative fuel production facility.

Currently, the CCS Protocol provides that irrespective of whether CO<sub>2</sub> is captured and sequestered in a depleted oil and gas reservoir or saline formation or captured and sequestered in an oil and gas reservoir used for CO<sub>2</sub>-EOR, “the system boundary begins with carbon capture and ends with injection operations including CO<sub>2</sub> leakage. Any emissions downstream of the sequestration site (except entrained CO<sub>2</sub> in the case of CO<sub>2</sub>-EOR) are excluded since they are associated with the downstream products rather than the CCS project.”<sup>33</sup> Twelve urges CARB to revisit this system boundary for CO<sub>2</sub>-EOR projects when the CO<sub>2</sub> is captured on-site at an alternative fuel production facility. More specifically, we believe the system boundary for such CCS projects should be extended to include rather than exclude any GHG emissions associated with the downstream products, as depicted in the figure below. In other words, the emissions



associated with the transport, refining, and end-product use of the recovered oil should be reflected in the CI score of the Tier 2 fuel produced by the alternative fuel producer. In our view, only by including these emissions can there be a truly accurate CI score of the applicable alternative fuel.

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Thank you for your consideration of our comments and proposed regulatory revisions. Please do not hesitate to contact me or my colleague, Ira Dassa ([ira.dassa@twelve.co](mailto:ira.dassa@twelve.co)), if you have any questions.

<sup>32</sup> CARB, “Carbon Capture and Sequestration Protocol Under the Low Carbon Fuel Standard,” available at <https://ww2.arb.ca.gov/resources/documents/carbon-capture-and-sequestration-protocol-under-low-carbon-fuel-standard>.

<sup>33</sup> CCS Protocol at 21.

Sincerely yours,

*Andrew Stevenson*

Andy Stevenson  
Vice President of Commercial  
Twelve Benefit Corporation  
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Attachments



July 3, 2023

Submitted via email to: [LCFSWorkshop@arb.ca.gov](mailto:LCFSWorkshop@arb.ca.gov)

Dr. Cheryl Laskowski, Branch Chief  
Transportation Fuels Branch  
California Air Resources Board  
1001 I St.  
Sacramento, CA 95814

Re: Twelve Benefit Corporation Feedback on Potential Changes to the Low Carbon Fuel  
Standard

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Dear Dr. Laskowski:

Although there is no longer an open feedback period for any of the informal public meetings and workshops that the California Air Resources Board (CARB) has held over the last several months on potential changes to the Low Carbon Fuel Standard (LCFS) Program, Twelve Benefit Corporation (Twelve) is taking this opportunity to submit these comments inasmuch as the formal rulemaking stage for the "Proposed LCFS Amendments" has yet to be reached.<sup>1</sup> To the extent specificity is needed pursuant to the introductory paragraph on CARB's "LCFS Meetings and Workshops" webpage, please consider this comment letter and the accompanying proposed regulatory language as referring to the virtual community meetings held on June 1 and June 2, for which the timeframe for feedback ended on June 14, 2023.<sup>2</sup>

As detailed below, our comments pertain to section 95488.8(i) of the current LCFS regulation. In particular, this letter proposes and discusses the basis for the attached revisions to the regulatory text. The revisions would enable indirect accounting mechanisms for renewable or low-carbon intensity (low-CI) electricity when it is used as a feedstock for the production of power-to-liquid (PtL) transportation fuels, sometimes referred to as electrofuels or e-fuels. We believe these revisions are warranted, as they would significantly incentivize the scale-up of these ultra-low carbon fuels, which are regarded as one of the most promising pathways, if not the most promising pathway to decarbonization of the aviation (and broader heavy-duty transportation) sector. Twelve respectfully requests that CARB include these proposed revisions in its forthcoming LCFS rulemaking package.

Before setting out our comments in Part II below, we first provide background information on Twelve and our groundbreaking carbon transformation™ technology, as well as a brief general overview of PtL fuels.

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<sup>1</sup> See <https://ww2.arb.ca.gov/sites/default/files/2022-11/2022-11-1%20LCFS%20Amendments%20Admin%20Record%20Commencement%20Memo.pdf>.

<sup>2</sup> See <https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/lcfs-meetings-and-workshops>.

## I. Background

### A. *Twelve and Carbon Transformation*

Founded in 2015 and based in northern California, Twelve currently employs a staff of almost three hundred chemists, engineers, techno-economic experts, product developers, and other specialists, with the vast majority of our personnel working in one of our locations in Berkeley and Alameda. We are on a mission to eliminate global carbon dioxide (CO<sub>2</sub>) emissions and build a fossil-free future.

Our patented carbon transformation technology takes captured CO<sub>2</sub> and, using only water and renewable electricity, transforms it into syngas, a combination of carbon monoxide and hydrogen. Once formed, the syngas is routed through an integrated Fischer-Tropsch reactor and then upgraded, ultimately resulting in our E-Jet<sup>®</sup> fuel – PtL sustainable aviation fuel (SAF, or as CARB refers to it under the LCFS Program, alternative jet fuel) that meets the specifications in Annex A1 of ASTM International's D7566 Standard (*Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons*). We expect our E-Jet, which has been tested and validated under a grant from the U.S. Air Force,<sup>3</sup> to reduce lifecycle greenhouse gas (GHG) emissions up to 90% in comparison to conventional, petroleum-based jet fuel.<sup>4</sup>

At the Paris Air Show last month, we publicly announced plans to begin construction of our first E-Jet plant in Moses Lake, Washington.<sup>5</sup> We selected Moses Lake in part because of the availability and abundance of low-carbon electricity in the state of Washington, including existing and new renewable sources. Over the next few years, we intend to develop additional fuel production plants in various other locations around the country. As a California-based company, we hope to be able to arrange for the uplift of a sizable portion of the PtL SAF we produce by aircraft in California.

### B. *PtL Fuels in General*

While technological approaches to the production of PtL fuels vary, the common thread among all such fuels is the utilization of the same feedstocks: CO<sub>2</sub> that is either captured from an industrial source (e.g., an ethanol facility) or obtained through direct air capture; water, which is electrolyzed to produce hydrogen; and a renewable source of electricity (e.g., solar, wind, hydropower). The national blueprint for transportation decarbonization, a multi-agency effort released by the federal government earlier this year, points out that PtL fuels represent “a viable

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<sup>3</sup> See <https://www.af.mil/News/Article-Display/Article/2819999/the-air-force-partners-with-twelve-proves-its-possible-to-make-jet-fuel-out-of/>.

<sup>4</sup> For more on Twelve and our revolutionary CO<sub>2</sub> electrolysis technology, please visit our website at [twelve.co](https://twelve.co).

<sup>5</sup> See <https://www.commerce.wa.gov/news/twelve-announces-plans-to-scale-production-of-sustainable-aviation-fuel-made-from-co2-in-washington-state/>. The Moses Lake plant will use biogenic CO<sub>2</sub> captured from an industrial point source, but our carbon transformation technology also converts CO<sub>2</sub> extracted from the air via direct air capture.

pathway” to sustainable, low-carbon transportation fuels.<sup>6</sup> According to the U.S. Department of Energy (DOE), one of the federal agencies involved in that effort, PtL fuels “have dramatically lower land, water, and [GHG] footprints compared to fossil fuels.”<sup>7</sup> Specifically in the context of the hard-to-abate aviation sector,<sup>8</sup> PtL SAF poses fewer land-related issues than most biomass-based SAF, is also advantageous from a water demand standpoint, and has been cited as “the only SAF technology that has the potential for unbounded production,”<sup>9</sup> an apt description given the ever-increasing concentration of CO<sub>2</sub> in the Earth’s atmosphere. For its part, Airbus, the commercial aircraft manufacturer, has referred to PtL SAF as an “exciting option” for fueling airplanes.<sup>10</sup>

With the above background in mind, our LCFS comments follow.

## II. Indirect Accounting for Renewable or Low-CI Electricity is Warranted for PtL Fuels

Section 95488.8(i), which was added to the LCFS regulation as part of the 2018 rulemaking, makes clear that indirect accounting mechanisms for renewable or low-CI electricity can only be used under the Program in two instances: (1) when the electricity is used as a transportation fuel (i.e., in an electric vehicle); and (2) when the electricity is used to make hydrogen via electrolysis, where that hydrogen is then used either as a transportation fuel (i.e., in a fuel cell electric vehicle) or in the production of another transportation fuel.<sup>11</sup>

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<sup>6</sup> *The U.S. National Blueprint for Transportation Decarbonization: A Joint Strategy to Transform Transportation*, at 55 (Jan. 2023), available at <https://www.energy.gov/sites/default/files/2023-01/the-us-national-blueprint-for-transportation-decarbonization.pdf>.

<sup>7</sup> DOE Bioenergy Technologies Office, “CO<sub>2</sub> Reduction and Upgrading for e-Fuels Consortium,” available at <https://www.energy.gov/eere/bioenergy/co2-reduction-and-upgrading-e-fuels-consortium>.

<sup>8</sup> As the Federal Aviation Administration (FAA) puts it, “decarbonization of the aviation sector is extremely challenging.” See FAA, *United States 2021 Aviation Climate Action Plan*, at 3 (Nov. 2021), available at [https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation\\_Climate\\_Action\\_Plan.pdf](https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf).

<sup>9</sup> Rhodium Group, “Sustainable Aviation Fuels: The Key to Decarbonizing Aviation” (Dec. 7, 2022), available at <https://rhg.com/research/sustainable-aviation-fuels/>; see also World Economic Forum, *Clean Skies for Tomorrow: Delivering on the Global Power-to-Liquid Ambition*, at 10 (May 2022) (referring to PtL SAF’s “high GHG reduction potential” compared to other types of SAF and indicating that the feedstocks “are theoretically unlimited”), available at [https://www3.weforum.org/docs/WEF\\_Clean\\_Skies\\_for\\_Tomorrow\\_Power\\_to\\_Liquid\\_Deep\\_Dive\\_2022.pdf](https://www3.weforum.org/docs/WEF_Clean_Skies_for_Tomorrow_Power_to_Liquid_Deep_Dive_2022.pdf).

<sup>10</sup> Airbus, “Power-to-Liquids, explained” (July 15, 2021), available at <https://www.airbus.com/en/newsroom/news/2021-07-power-to-liquids-explained>.

<sup>11</sup> 17 CCR § 95488.8(i)(1); see also CARB, “Low Carbon Fuel Standard (LCFS) Guidance 19-01: Book-and-Claim Accounting for Low-CI Electricity,” at 1-2 (Dec. 2022), available at [https://ww2.arb.ca.gov/sites/default/files/2022-12/19-01\\_updated%20for%20WREGIS%20changes\\_ADA.pdf](https://ww2.arb.ca.gov/sites/default/files/2022-12/19-01_updated%20for%20WREGIS%20changes_ADA.pdf); CARB, “LCFS Electricity and Hydrogen Provisions,” available at <https://ww2.arb.ca.gov/resources/documents/lcfs-electricity-and-hydrogen-provisions>.

In its November 2018 Final Statement of Reasons (2018 FSOR), CARB reiterated what it had indicated at the outset of the 2018 rulemaking, that “[t]he CI of pathways for electricity supplied to vehicles, and hydrogen produced by electrolysis rely almost entirely on the source of the electricity, but no options exist under the current regulation for matching low-CI electricity to an EV or electrolysis load.”<sup>12</sup> CARB then explained in the 2018 FSOR as follows:

Pathways . . . for hydrogen produced by electrolysis use electricity as a feedstock. Staff views the flexibility for indirect accounting of low-CI electricity for these pathways as analogous to the flexibility that the LCFS has always offered to other biofuels in using a mass balance approach to allocation of finished fuel to various feedstocks. In this regard, electricity has historically been disadvantaged in the program by being limited to the regional grid CI. Additionally, these changes create consistency between the treatment of biomethane that is indirectly supplied through the common carrier pipeline, and renewable electricity that is supplied through the electrical grid.<sup>13</sup>

CARB went on to emphasize that it was not recognizing indirect accounting under the LCFS Program in any other instances (i.e., in instances other than the two specified in section 95488.8(i)(1)) in part because “[t]he GHG benefits of allowing indirect accounting for renewable or low-CI process energy are expected to be relatively small as most alternative fuel production does not rely extensively on electricity consumption.”<sup>14</sup>

As indicated in the attached document, which shows the textual regulatory revisions we are proposing, Twelve maintains that indirect accounting for renewable or low-CI electricity should likewise be allowed in a third, specific and limited instance: when the electricity is used in the production of a PtL transportation fuel like Twelve’s E-Jet. The language changes laid out in the attachment are simple, straightforward, and narrowly tailored. In addition to minor add-ons in section 95488.8(i), all of which are shown in redline, we are putting forward a proposed definition of the term “power-to-liquid fuel” to ensure the intended scope of the proposal is not exceeded.<sup>15</sup> Importantly, the conditions in subparagraphs (1)(A) and (B) would have to be met for indirect accounting to be allowed.

As with the existing authorized uses now contained in section 95488.8(i)(1), the CI value of any fuel producer’s PtL fuel depends, as CARB put it in the 2018 FSOR, “almost entirely on the

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<sup>12</sup> 2018 FSOR at 172, quoting from the Initial Statement of Reasons (2018 ISOR) at III-95. In the 2018 ISOR, CARB proffered as the rationale for indirect accounting that “[s]upport for electricity decarbonization for electric vehicles allows for ultra-low carbon fuel pathways, which will help California better meet GHG emission reduction goals.” 2018 ISOR at III-96.

<sup>13</sup> 2018 FSOR at 172. Elsewhere in the document, CARB stated that “[i]ndirect, or book-and-claim, accounting for renewable or low-CI energy is recognized under the LCFS only for feedstocks or when the input is used directly as a fuel, not process energy.” *Id.* at 483.

<sup>14</sup> *Id.* at 173.

<sup>15</sup> We acknowledge that the term “low-CI electricity” is a defined term in the LCFS regulation (17 CCR 95481(a)(94)) and expressly includes “an eligible renewable resource” as defined under the California Renewables Portfolio Standard Program. Nevertheless, insofar as the subtitles of subsection (i) and paragraph (1) each include the term “renewable,” we recommend from a pure drafting standpoint that this term also be inserted elsewhere in section 95488.8(i)(1), as shown in the attachment.



source of the electricity.” In a presentation at a recent Commercial Aviation Alternative Fuels Initiative event, Dr. Ian Rowe, who co-leads the DOE CO<sub>2</sub> Reduction and Upgrading for e-Fuels Consortium, confirmed this, pointing out that PtL fuels “can have a very low carbon intensity IF they are made with renewable electricity.”<sup>16</sup> Moreover, as with electrolytic hydrogen production, electricity serves as a feedstock for PtL fuel production, not as process energy. Finally, indirect accounting in this additional instance is further justified by the fact that, separate and apart from the electricity being a feedstock rather than process energy, the GHG emission reductions that would result from the allowance of indirect accounting would be quite significant inasmuch as the fuel production process, once again as CARB put it in the 2018 FSOR, “rel[ies] extensively on electricity consumption.” That, of course, is the whole premise behind the burgeoning PtL fuel industry – using electricity (from a renewable source) to ultimately transform CO<sub>2</sub> into an ultra-low carbon liquid fuel.<sup>17</sup>

From a public policy perspective, allowing indirect accounting for renewable or low-CI electricity used in the production of a PtL transportation fuel makes good sense in that it would significantly incentivize not only the scale-up of these promising liquid fuels, but also the much-needed development and utilization of renewable energy resources like solar, wind, and hydroelectric. It is undeniable that the LCFS Program is designed to reduce GHG emissions from the transportation sector, and Twelve’s proposal would squarely further that purpose. That the proposal would also yield ancillary benefits for the electricity grid by supporting lower-CI stationary electricity generation should not be ignored or disregarded, particularly given that for a host of reasons, PtL fuel producers cannot always co-locate their facilities at a renewable electricity source or build a solar or wind farm as part of their fuel production facility.

\* \* \*

Thank you for your consideration of our comments and proposed regulatory revisions. Please do not hesitate to contact me or my colleague, Ira Dassa ([ira.dassa@twelve.co](mailto:ira.dassa@twelve.co)), if you have any questions. As a California-based company, and with the manufacture of the all-important CO<sub>2</sub> electrolyzer stacks that will be deployed at our first fuel production plant now taking place at our facility in Alameda, I want to stress in closing that we would be pleased to meet or otherwise engage with you or your staff on any aspect of our proposal.

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<sup>16</sup> See Ian Rowe (DOE Bioenergy Technologies Office), “Emerging Technologies to Support the SAF Grand Challenge 2050 Goal: Routes to Achieving Net-Zero Fuels and E-Fuels,” at slide 11 (June 16, 2023) (emphasis in original), available at [https://caafi.org/resources/pdf/SAF\\_Virtual\\_Conf\\_June2023\\_Session\\_13\\_Ian\\_Rowe.pdf](https://caafi.org/resources/pdf/SAF_Virtual_Conf_June2023_Session_13_Ian_Rowe.pdf).

<sup>17</sup> Twelve’s proprietary process is unique in that we use electricity not only to create electrolytic hydrogen for the syngas but, equally important, to electrolyze CO<sub>2</sub> via our revolutionary CO<sub>2</sub> electrolyzer technology. Under the current LCFS regulation, our understanding is that indirect accounting can be used for the water electrolysis step. (Note that in the future, we may opt to obtain green hydrogen from a supplier.) However, we are submitting this proposal because the novel CO<sub>2</sub> electrolysis step in our process does not appear to be encompassed within section 95488.8(i)(1), which we assume triggers the applicability of the section 95488.8(h) preclusion against indirect accounting mechanisms “[u]nless expressly provided elsewhere in [the LCFS regulation].” This, in turn, would affect the CI score of our E-Jet fuel.

Sincerely yours,

*Andrew Stevenson*

Andy Stevenson  
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Attachment

cc: Liane M. Randolph, Chair  
Dr. Steven C. Cliff, Executive Officer  
Rajinder Sahota, Deputy Executive Officer  
Anil Prabhu, Manager, Fuels Evaluation Section

§ 95481. Definitions and Acronyms.

(New (a)(120))

(120) “Power to Liquid Fuel” means a synthetic fuel that is produced from captured carbon dioxide, water, and renewable or low-CI electricity.

\* \* \*

§ 95488.8. Fuel Pathway Application Requirements Applying to All Classifications.

\* \* \*

(i) *Indirect Accounting for Renewable or Low-CI Electricity and Biomethane.*

(1) *Book-and-Claim Accounting for Renewable or Low-CI Electricity Supplied as a Transportation Fuel-~~or~~, Used to Produce Hydrogen, or Used to Produce a Power-to-Liquid Fuel.* Reporting entities may use indirect accounting mechanisms for renewable or low-CI electricity supplied as a transportation fuel-~~or~~ for hydrogen production through electrolysis for transportation purposes (including hydrogen that is used in the production of a transportation fuel), or for the production of a power-to-liquid fuel for transportation purposes, provided the conditions set forth below are met:

- (A) Reporting entities may report renewable or low-CI electricity used as a transportation fuel or as an input to hydrogen or power-to-liquid fuel production delivered through the grid without regard to physical traceability if it meets all requirements of this subarticle.
- The renewable or low-CI electricity must be supplied to the grid within a California Balancing Authority (or local balancing authority for hydrogen or power-to-liquid fuel produced outside of California) or alternatively, meet the requirements of California Public Utilities Code section 399.16, subdivision (b)(1). Such book-and-claim accounting for renewable or low-CI electricity may span only three quarters. If a renewable or low-CI electricity quantity (and all associated environmental attributes, including a beneficial CI) is supplied to the grid in the first calendar quarter, the quantity claimed for LCFS reporting must be matched to grid electricity used as a transportation fuel or for hydrogen or power-to-liquid fuel production no later than the end of the third calendar quarter. After that period is over, any unmatched renewable or low-CI electricity quantities expire for the purpose of LCFS reporting.
- (B) Renewable or ~~L~~low-CI electricity can be indirectly supplied through a green tariff program (including the Green Tariff Shared Renewables program described in California Public Utilities Code Section 2831-2833) or other contractual electricity supply relationship that meets the following requirements:
1. Electricity is generated by, or supplied under contract to, the pathway applicant for all environmental attributes of the claimed electricity. In order to substantiate renewable or low-CI electricity claims, the applicant must make contracts available to the Executive Officer, upon request, to demonstrate that the electricity meets the requirements of this subarticle. Generation invoices or metering records are required to substantiate the quantity of renewable or low-CI electricity produced from the renewable assets. Monthly invoices must be unredacted copies of originals showing electricity sourced (in kWh) and contracted price;
  2. All electricity procured by any LSE for the purpose of claiming a lower CI must be in addition to that required for compliance with the California Renewables Portfolio Standard (described in California Public Utilities Code sections 399.11-399.32) or, for hydrogen or power-to-liquid fuel produced outside of California, in addition to local renewable portfolio requirements;
  3. Renewable energy certificates or other environmental attributes associated with the electricity, if any, are retired and not claimed under any other program with the exception

of the federal RFS, and the market-based compliance mechanism set forth in title 17, California Code of Regulations Chapter 1, Subchapter 10, article 5 (commencing with section 95800). Retirement of renewable energy credits for the purpose of demonstrating Green Tariff Shared Renewables procurement to the California Public Utilities Commission does not constitute a double claim.

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