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ISO/IEC 17025:2017-Accredited Testing Laboratory

Climate Action Reserve
Argentina Landfill Protocol Development│ Stakeholder Feedback

This comment intends to recommend the inclusion of direct Carbon-14 testing to determine the biogenic portion of CO2 and methane to calculate the GHG reductions under the protocol. Biogenic content measurements following ASTM D6866 Method B currently provide critical value to programs regulating landfill emissions, municipal solid waste combustion and fuels produced from landfill biogas, including the EPA's Greenhouse Gas Reporting Program (GHGRP) and US Renewable Fuel Standard (RFS) programs.

Included here you will find:

Recommendations for the Argentina Landfill Protocol

We recommend including, in the protocol, direct biogenic content testing (Carbon-14) requirements following the ASTM D6866 Method B standard to quantify the biogenic portion of the landfill gas and calculate emissions reductions from generating and destroying it. Direct biogenic content testing is a well-established best practice for verifying the renewable content of biofuels in prominent successful clean fuels programs.

Routine direct biogenic testing requirements are the only reliable method of incentivising the use of biomass-derived content while guaranteeing compliance, and currently play a critical role in prominent similar programs. Direct testing is therefore the best tool to ensure that incentives reward operators who increase the renewable content in biofuels. There is a long, successful track record of Carbon-14 testing requirements enabling fuel decarbonisation programs and emissions reduction programs to verify producers' claims of biogenic content to receive incentives.

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Under the current draft protocol, CO_2 emissions associated with the generation and destruction of landfill gas are considered biogenic. Whilst this approach is consistent with the IPCC guidelines for captured landfill gas[1], it does not reflect the actual composition of biogenic vs fossil-derived MSW and landfill gas.

According to figures from Argentina's Ministry of Health and Environment, only 50% of MSW in Argentina is organic waste[2]. Due to the heterogeneous nature of Municipal Solid Waste, it is difficult to predict the exact portion of biogenic vs fossil-derived MSW present in landfills at any given time without direct testing. However, the assumption that most MSW is organic is incorrect, as landfills will contain fossil-derived waste, such as plastic waste. Therefore, we recommend that the Protocol include considerations regarding the biogenic vs non-biogenic portion of the landfill gas produced and removed from landfills within the methodology to reflect this. Whether a feedstock, biofuels or emissions is biogenic is crucial to accurately calculate emissions reductions, as non-biogenic waste will not be part of the carbon cycle, and its destruction/combustion will add "new" carbon into the atmosphere. Therefore, biogenic and fossil-derived gases should be treated differently under the protocol.

This approach is notably reflected in the EU's voluntary certification legislation that certifies emissions reductions[3], and in the EU's proposed methodology to calculate emissions savings[4]. The methodology makes a distinction between the part of the process that is based on the conventional fossil fuel input and the part of the process that is based on low-carbon fuels, other than recycled carbon fuels, assuming that the process parts are otherwise identical. Under this methodology, both would have to be calculated proportionally to accurately calculate emissions savings. In this regard, Carbon-14 testing is essential to ensure that these calculations are accurate and proportional to avoid misreporting.

This approach is echoed in New Zealand's Second Emissions Reduction Plan, which sets up different targets for methane emissions reduction and biogenic methane emissions reduction[5]. Under the plan, New Zealand aims to reduce net emissions of all greenhouse gases (except biogenic methane) to zero by 2050 and to reduce emissions of biogenic methane to 24–47 per cent below 2017 levels by 2050. Another relevant protocol to rely on is UNFCC ACM0022 on "Alternative waste treatment processes" (pages 41-42). This protocol requires biogenic testing following ASTM D6866 to determine the biogenic

1 2001, "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories" *IPCC.*

2 2021, "Waste Management in the Latam Region, Waste management Country Report - Argentina", Holland Circular Hotspot.

3 2022. "Commission Implementing Regulation (EU) 2022/996 of June 14, 2022 on rules to verify sustainability and greenhouse gas emissions saving criteria and low indirect land-use change-risk criteria." Official Journal of the European Union

4 2024, "Methodology to determine the greenhouse gas (GHG) emission savings of low-carbon fuels", *European Commission.*

5 2024, "New Zealand's Second emissions reduction plan 2026–30", *Ministry of the Environment*

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and fossil fractions of MSW for any cases where the biogenic content of waste cannot be classified or is unknown, which is critical to quantifying the sustainability of landfill gas combustion.[6]

Additionally, the existing regulatory requirements in North America and the EU rely on accurate biogenic testing to determine the allocation of credits to incentivise operators to reduce their emissions. Beta specifically recommends following the example of the US RFS by requiring biogenic testing at the point of biogas production at the landfill, at the point of upgrading to a biomethane fuel, and at the point of injection into the gas grid.[7] We also emphasise the importance of following both the US RFS and the EU RED in uniformly requiring routine direct testing, including for producers opting to use calculation-based approaches internally. The biomethane and biogas markets in the US and EU have developed greatly following these announced regulations.

We also recommend reviewing protocols for biogenic testing of heterogeneous post-combustion CO2 in similar programs, as well, particularly on co-firing and the combustion of waste or landfill gases. Landfills and waste in general are, by nature, not homogeneous. Routine biogenic test results for operations using co-firing and MSW combustion are required under the US EPA's Greenhouse Gas Reporting Program (GHGRP), Canada's Greenhouse Gas Reporting Program (GHGRP) and California's Cap and Trade Program.[8] Canada's GHGRP further requires testing for any mixed or unknown biomass content in obligated industrial emissions. The US EPA's GHGRP is especially important to consider in this context because it has successfully required mandatory quarterly testing and reporting of biogenic content using ASTM D6866 for over 12 years.

These requirements for co-firing and the combustion of MSW provide particularly relevant models for regulating biomethane extracted from the gas grid and directly combusted landfill gases, because in all of these cases, direct testing of the CO2 emissions is the most feasible way to measure their biogenic content due to their heterogeneity. It is also the most accurate way to calculate reduction emissions and to avoid overestimation when allocating credits, and has been shown to produce great results in terms of incentivising the industry to reduce their carbon footprint. All of these programs require testing to follow ASTM D6866, and ISO 13833 would be a relevant European standard to consider in these cases. It may also be relevant to review ASTM D7459 on "Collection of Integrated Samples for the Speciation of Biomass (Biogenic) and Fossil-Derived Carbon Dioxide Emitted from Stationary Emissions Sources," when outlining the logistics of sample collection.[9]

[6] 2022. "Large-Scale Consolidated Methodology: Alternative Waste Treatment Version 3.0" *UNFCCC*
[7] 2023. "40 CFR Parts 80 and 1090– Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes." *EPA*
[8] 2016. "40 CFR Part 98 Subpart C– General Stationary Fuel Combustion Sources." *National Archives Code of Federal Regulations*
2022. "Canada's Greenhouse Gas Quantification Requirements." *Environment and Climate Change Canada*
[9] 2016. "Standard Practice for Collection of Integrated Samples for the Speciation of Biomass (Biogenic) and Fossil-Derived Carbon Dioxide Emitted from Stationary Emissions Sources."

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Biogenic test results following ASTM D6866 Method B provide important data on anaerobic digestion feedstocks, biomethane fuels and landfill gas emissions and should be included in the landfill gas method. This would be in line with the new protocol created for the US RFS, which requires testing at the digester or landfill.[10] It is critical to measure the biogenic content of the biogas feedstock before upgrading to fuel to know how much biogenic content is entering the production of the final fuel product. It is also critical to measure the biogenic content of landfill gas emissions to properly understand and regulate their renewable content.

Hence, not assessing the biogenic content of the methane before applying the Protocol through direct testing would incur the risks of not considering the actual environmental impact of landfill gas removal. Since biomethane and fossil fuel methane are chemically identical molecules, the only way to differentiate the two is to perform Carbon-14 testing of the emissions after combustion to assess what percentage of the mixture was biogenic. As a result, gas chromatography would not be able to accurately determine whether the landfill gas produced will comply with the emissions reduction targets.

Secondly, as the protocol specifies that injecting methane into the pipeline and using it to power a vehicle counts as destruction and therefore falls under the protocol's provisions, biogenic testing should be incorporated to measure the impact of doing so. For reference, quarterly biogenic testing following ASTM D6866 for MSW or landfill gas combustion is currently considered the best practice under leading regulatory programs for the sector, including (please see specific rules hyperlinked):

- The US GHGRP currently requires quarterly routine direct testing following ASTM D686 for biogenic emissions from co-firing and municipal solid waste (MSW) combustion[11].
- California's Cap-and-Trade requires quarterly routine direct testing following ASTM D6866 for biogenic emissions from co-firing and MSW combustion[12].
- Canada's GHGRP requires quarterly routine direct testing following ASTM D6866 for biogenic emissions from any renewable or biogenic fuels derived from biomass, including landfill gas and biogas, as well as for any fuels or fuel mixtures containing an unknown biogenic component[13].
- The EU's ETS requires quarterly routine direct testing for biogenic portions of obligated materials, fuels and emissions[14].
- The UN's Approved Consolidated Methodology (ACM) for Alternative Waste Treatment (UNFCCC ACM0022) requires biogenic testing following ASTM D6866 to determine the biogenic and fossil fractions of MSW for any cases where the biogenic content of waste cannot be classified or is unknown[15].

[10] 2023. "40 CFR Parts 80 and 1090– Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes." *EPA*
[11] 2016. "40 CFR Part 98 Subpart C– General Stationary Fuel Combustion Sources." *National Archives Code of Federal Regulations*
[12] 2016. "40 CFR Part 98 Subpart C– General Stationary Fuel Combustion Sources." *California Air Resources Board*
[13] 2022. "Canada's Greenhouse Gas Quantification Requirements." *Environment and Climate Change Canada*
[14] 2022. "Biomass issues in the EU ETS." *European Commission*
[15] 2022. "Large-Scale Consolidated Methodology: Alternative Waste Treatment Version 3.0" UNFCCC

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In addition to direct combustion of MSW, biogenic testing should also continue to be required for biofuels produced from MSW and landfill gas, such as RNG/biomethane. Quarterly biogenic testing following ASTM D6866 is also considered the best practice for biofuel production using MSW as a feedstock and landfill gas upgraded to biogas/RNG fuels under leading clean fuel programs, including (please see specific rules hyperlinked):

- The US RFS currently requires quarterly routine direct testing following ASTM D6866 for fuels produced from co-processing, municipal solid waste (MSW), biogas and renewable natural gas (RNG)[16].
- California's LCFS requires routine direct testing for fuels produced from co-processing and recommends it for fuels produced from MSW[17].
- Oregon's CFP requires routine direct testing following the protocols of the US RFS third-party engineering reviews[18].
- Washington's CFS requires routine direct testing following the protocols of the US RFS third-party engineering reviews[19].
- Canada's CFR requires routine direct testing for any fuels produced from co-processing and their co-products, and to verify the biogenic portion of feedstocks, including MSW[20].
- The EU's RED requires quarterly routine direct testing for fuels produced from co-processing or biogas and renewable natural gas (RNG)[21].

Lastly, the Protocol operates under the assumption that landfill gas would have an equal portion of CO2 and methane. Whilst this is true for mature sites, not all landfills will have an equal portion of methane and CO2 reflected in their landfill gas. Therefore, we recommend including gas chromatography (GC) following the ASTM D7833 standard to determine the gas composition of the landfill gas.

Gas chromatography and Carbon-14 testing can be used to address fugitive methane emissions. A study by Kerfoot and all on methane gas in landfills also gives insight into Carbon-14 testing application to identify the source of hydrocarbons, especially in cases of carbon leakage. The study aimed to evaluate the environmental tracers at a site where soil gas source and migration evaluation is complicated by the presence of multiple methane sources and a complex geological setting. The study collected data in the studied areas using gas probes. Since the decomposition of organic matter produces methane and carbon dioxide, the relative concentrations and stable and radiogenic isotope composition can help track methane migration and detect changes in the gas composition and the source of methane. The study found dramatic differences in gas composition only in the transect. The study concluded that 37% of the

[16] 2023. "40 CFR Parts 80 and 1090– Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes." *EPA*
[17] 2020. "Reporting Co-Processing and Renewable Gasoline Emissions Under MRR." *California Air Resources Board*
[18] 2023. "Oregon Clean Fuels Program." Oregon Department of Environmental Quality
[19] 2022. "Chapter 173-424 WAC: Clean Fuels Program Rule." Washington State Legislature
[20] 2022. "Clean Fuel Regulations: Quantification Method for Co-Processing in Refineries." Environment and Climate Change Canada
[21] 2023. "Renewable energy- method for calculating the share of renewables in the case of co-processing." European Commission

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methane measured was sourced from the landfill biogas, highlighting how dramatically the radiocarbon value of methane can vary at a single site for both concentration and the biogenic portion. This study highlights the need for constant monitoring, especially for projects close to oil/gas pipelines, and/or other sources of contamination, to detect potential leaks and to accurately determine the biogenic portion of carbon dioxide removed from the atmosphere. Carbon-14 emissions testing can differentiate biogas CH_4 from other sources that have historically relied only on $\delta^{13}C$, augmenting non-point source tracking efforts, such as potential nearby oil refineries and gas pipelines. Kerfoot et. al. undertook the evaluation of the age and time series of CH_4 gas release from landfill gas versus natural gas mixtures of a municipal solid waste landfill in southern California that sits overlying a natural gas reservoir.[22] They were able to explain, using $^{14}C_{CH4}$, that 37% of the measured methane was derived from landfill gas, which has a distinguishing $^{14}C_{landfill}$ of 118.2 pMC, whereas the $^{14}C_{natural\ gas}$ methane is < 0.3 pMC.

What is Biogenic Testing (Carbon-14)?

Carbon-14 analysis is a reliable method used to distinguish the percentage of biobased carbon content in a given material. The radioactive isotope carbon-14 is present in all living organisms and recently expired material, whereas any fossil-based material that is more than 50,000 years old does not contain any carbon-14 content. Since Carbon-14 is radioactive, the amount of carbon-14 present in a given sample begins to gradually decay after the death of an organism until there is no carbon-14 left. Therefore, a radiocarbon dating laboratory can use carbon-14 analysis to quantify the carbon-14 content present in a sample, determining whether the sample is biomass-based, fossil fuel-derived, or a combination.

The analysis is based on standards such as ASTM D6866 and its international equivalents developed for specific end uses, such as ISO 13833. ASTM D6866 is an international standard developed for measuring the biobased carbon content of solid, liquid, and gaseous samples using radiocarbon dating.[23] There are also many international standards based on the specific use of direct Carbon-14 testing, such as ISO 13833, which is an international standard developed for measuring the biogenic carbon content of stationary sources' emissions.[24]

Carbon-14 analysis yields a result reported as % biobased carbon content. If the result is 100% biobased carbon, this indicates that the sample tested is completely sourced from biomass material such as plant or animal byproducts. A result of 0% biobased carbon means a sample is only fossil fuel-derived. A sample that is a mix of both biomass sources and fossil fuel sources will yield a result that ranges between 0% and 100% biobased carbon content. Carbon-14 testing has been incorporated into several

[22] 2013. Kerfoot et al, “Evaluation of the age of landfill gas methane in landfill gas-natural gas mixtures using co-occurring constituents,” *Environ. Sci Processes*, *15*, 1153-1161
[23] 2021. “Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis.” *ASTM International (D6866-21)*
[24] 2013. “ISO 13833:2013 Stationary source emissions: Determination of the ratio of biomass (biogenic) and fossil-derived carbon dioxide.” *International Organization for Standardization*

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regulations as the recommended or required method to quantify the biobased content of a given material.

ASTM D6866 Method B - The Most Reliable Method

Carbon-14 is a very well-established method which has been in use by many industries (including the fossil fuel industry) and academic researchers for several decades.

Carbon-14 measurements done by commercial third party testing is robust, consistent, and with quantifiable accuracy/precision of the carbon-14 amount under **ASTM D6866 method B**. The EN 16785 is the only standard that allows a variant of the Mass Balance (MB) method of 'carbon counting' under EN 16785-2. The EN 16785-1 requires that the biocarbon fraction be determined by the carbon-14 method. However, when incorporating this EN 16785 method, certification schemes like the "Single European Bio-based Content Certification" **only** allow the use of EN 16785-1 due to its reliability and the value of a third-party certification. http://www.biobasedcontent.eu/en/about-us/

In ASTM D6866 method B, the carbon-14 result is provided as a single numerical result of carbon-14 activity, with a graphical representation that is easily understood by regulators, policy makers, corporate officers, and, more importantly, the public. The overwhelming advantage of carbon-14 is that it is an independent and standardised laboratory measurement of any carbon-containing substance that produces highly accurate and precise values. In that regard, it can stand alone as a quantitative indicator of the presence of biobased vs. petroleum feedstocks. When carbon-14 test results are challenged, samples can be rapidly measured to verify the original reported values (unlike mass balance).

The quantification of the biobased content of a given product can be as low as 0.1% to 0.5% (1 relative standard deviation – RSD) based on Instrumental error for Method B (AMS). This error is exclusive of indeterminate sources of error in the origin of the biobased content and manufacturing processes. As such a total error of +/-3% (absolute) has been assigned to the reported Biobased Content to account for determinate and indeterminate factors.[25]

It is also important that the program should always require ASTM D6866 Method B, rather than allow Method C for any use. Where ASTM D6866 Method B uses the AMS Instrument to measure ^{14}C, Method C uses Liquid Scintillation Counting (LSC). In Method B, the AMS Instrument directly measures the ^{14}C isotopes. However, in Method C, scintillation molecules indirectly absorb the beta molecules that are released with the decay of ^{14}C and convert the energy into photons, which are measured proportionally to the amount of ^{14}C in the sample. Since Method B directly measures the ^{14}C isotopes and Method C measures them indirectly, Method B is significantly more precise and should be prioritised in regulations.

[25] 2021. Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis. *ASTM International (D6866-21).* pp 1-19. doi: 10.1520/D6866-21.

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[26] LSC measurements, like those used in Method C, are commonly used as an internal testing tool when samples are limited and accuracy does not need to be extremely high.

About Beta Analytic

Beta Analytic was among the originators of the use of Accelerator Mass Spectrometry (AMS) for the ASTM D6866 biobased/biogenic testing standard using Carbon-14 to distinguish renewable carbon sources from petroleum sources. Beta began testing renewable content in 2003 at the request of United States Department of Agriculture (USDA) representatives who were interested in Beta's Carbon-14 capabilities for their BioPreferred® Program (www.biopreferred.gov). At their request, Beta joined ASTM under subcommittee D20.96. Beta's previous president, Darden Hood, was positioned as a technical contact for the USDA and, within 3 months, completed the ASTM D6866-04 standard. The Carbon-14 technique is now standardised in a host of international standards, including ASTM D6866, CEN 16137, EN 16640, ISO 16620, ISO 19984, BS EN ISO 21644:2021, ISO 13833 and EN 16785. Carbon-14 analysis can be used on various types of samples (gas, liquids and solids). Beta Analytic continues to be a technical contact for ASTM D6866 with current president Ron Hatfield, and is involved with all their latest ASTM D6866 versions.

The Carbon-14 standardised method is also incorporated in a variety of regulatory programs, including the California AB32 program, US EPA GHG Protocol, US EPA Renewable Fuels Standard, United Nations Carbon Development Mechanism, Western Climate Initiative, Climate Registry's Greenhouse Gas Reporting Protocol and EU Emissions Trading Scheme.

We are currently technical experts on Carbon-14 in the following committees:

ASTM D6866 (D20.96) Plastics and Biobased Products (Technical Advisor)
ASTM (D02.04) Petroleum Products, Liquid Fuels and Lubricants (Technical Advisor)
ASTM (061) US TAG to ISO/TC 61 Plastics (Technical Expert)
USDA BioPreferred Program TAC (Technical Advisor)
ISO/TC 61/SC14/WG1 Terminology, classifications, and general guidance (Technical Expert)
CEN/TC 411 Biobased Products
CEN/TC 411/WG 3 Biobased content
CEN/TC 61/SC 14/WG 1 Terminology, classifications, and general guidance (Technical Expert)

ISO/IEC 17025:2017 Accredited Laboratory

To ensure the highest level of quality, laboratories performing ASTM D6866 testing should be ISO/IEC 17025:2017 accredited or higher. This accreditation is unbiased, third-party awarded and supervised. It is

[26]2022. "Testing the methods for determination of radiocarbon content in liquid fuels in the Gliwice Radiocarbon and Mass Spectrometry Laboratory." *Radiocarbon*

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unique to laboratories that not only have a quality management program conformant to the ISO 9001:2008 standard, but more importantly, have demonstrated to an outside third-party laboratory accreditation body that Beta Analytic has the technical competency necessary to consistently deliver technically valid test results. The ISO 17025 accreditation is specifically for natural level radiocarbon activity measurements, including biobased analysis of consumer products and fuels, and for radiocarbon dating.

Required tracer-free facility for Carbon-14

For carbon-14 measurement to work, be accurate, and repeatable, the facility needs to be a tracer-free facility, which means artificial/labelled carbon-14 has not and has never been handled in that lab. Facilities that handle artificial carbon-14 use enormous levels relative to natural levels, and it becomes ubiquitous in the facility, and cross-contamination within the facility, equipment and chemistry lines is unavoidable. Results from a facility that handles artificial carbon-14 would show elevated renewable contents (higher pMC, % Biobased / Biogenic values), making those results invalid. Because of this, Federal contracts and agency programs (such as the USDA BioPreferred Program) require that AMS laboratories be 14C tracer-free facilities in order to be considered for participation in solicitations.

Areas where cross-contamination might occur include but are not limited to; biomedical or nuclear reactors, isotope enrichment/depletion columns, water, soil, plant, or air samples collected near or at biomedical/nuclear reactor sites, medical, industrial, or hazardous waste sites, samples specifically manipulated to study the uptake/fractionation of stable isotopes due to biological or metabolic processes. To learn more about the risks associated with testing natural levels of Carbon-14 samples in a facility handling artificially enhanced isotopes, please see the additional information provided after this comment.

References

2001. "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories", *IPCC.* https://www.ipcc-nggip.iges.or.jp/public/gp/english/

2010. "40 CFR Part 80 Subpart M– Renewable Fuel Standard." National Archives Code of Federal Regulations

2013. "ISO 13833:2013 Stationary source emissions: Determination of the ratio of biomass (biogenic) and fossil-derived carbon dioxide." *International Organization for Standardization*

2013. Kerfoot et al, "Evaluation of the age of landfill gas methane in landfill gas-natural gas mixtures using co-occurring constituents," *Environ. Sci Processes, 15, 1153-1161*

2016. "Standard Practice for Collection of Integrated Samples for the Speciation of Biomass (Biogenic) and Fossil-Derived Carbon Dioxide Emitted from Stationary Emissions Sources."

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2016. "40 CFR Part 98 Subpart C– General Stationary Fuel Combustion Sources." *National Archives Code of Federal Regulations*
https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-C

2016. "40 CFR Part 98 Subpart C– General Stationary Fuel Combustion Sources." *California Air Resources Board*

2020. "Reporting Co-Processing and Renewable Gasoline Emissions Under MRR." *California Air Resources Board*
https://ww2.arb.ca.gov/sites/default/files/2020-09/MRR_coprocessing-slides_Sept_2020.pdf

2021. Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis. *ASTM International (D6866-21).* pp 1-19. doi: 10.1520/D6866-21.

2021. "Waste Management in the Latam Region, Waste Management Country Report - Argentina", Holland Circular Hotspot.
https://hollandcircularhotspot.nl/wp-content/uploads/2021/04/Report_Waste_Management_Argentina_20210322.pdf

2022. "Canada's Greenhouse Gas Quantification Requirements." *Environment and Climate Change Canada*
https://publications.gc.ca/collections/collection_2023/eccc/En81-28-2022-eng.pdf

2022. "Biomass issues in the EU ETS." *European Commission*
https://climate.ec.europa.eu/system/files/2022-10/gd3_biomass_issues_en.pdf

2022. "Large-Scale Consolidated Methodology: Alternative Waste Treatment Version 3.0" *UNFCCC*
https://cdm.unfccc.int/UserManagement/FileStorage/61X9DPNL7G4Y5JMB3CKFHUSREO2QVI

2022. "Testing the methods for determination of radiocarbon content in liquid fuels in the Gliwice Radiocarbon and Mass Spectrometry Laboratory." *Radiocarbon*

2022. "Chapter 173-424 WAC: Clean Fuels Program Rule." Washington State Legislature

2022. "Clean Fuel Regulations: Quantification Method for Co-Processing in Refineries." Environment and Climate Change Canada
https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations/compliance/quantification-methodco-processing-refineries.html

2023. "Oregon Clean Fuels Program." Oregon Department of Environmental Quality
https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=1560

2023. "Renewable energy- method for calculating the share of renewables in the case of co-processing." European Commission
https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12711-Renewable-energy-method-for-calculating-the-share-of-renewables-in-the-case-of-co-processing_en

2023. "40 CFR Parts 80 and 1090– Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes." *EPA*
https://www.govinfo.gov/content/pkg/FR-2023-07-12/pdf/2023-13462.pdf

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2024, "Methodology to determine the greenhouse gas (GHG) emission savings of low-carbon fuels", *European Commission*.
https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14303-Metodologija-za-dolocitev-prihranokov-emisij-toplogrednih-plinov-zaradi-nizkoogljicnih

2024, "New Zealand's Second emissions reduction plan 2026–30", *Ministry of the Environment*.
https://environment.govt.nz/publications/new-zealands-second-emissions-reduction-plan/