



Product Certification Statement (Ex Ante Verification Statement)

Product ID: 001

Product Name: ErthCycle

Ex Ante Certification Date: 11.02.2022

Certification Statement:

This is to state that, for a period of 24 months following the "Ex Ante Certification Date" listed above the aforementioned Product: *ErthCycle*

- has been certified without qualification
 is unable to be certified

with *reasonable assurance* according to the ATOA Certification Standard for Greener Plastics™ v1.0.

Certifier Attestation:

Lead Reviewer: In executing this Certification Statement, I certify that the information contained in this certification is true, accurate and complete.

A handwritten signature in blue ink, appearing to read "Sami Osman".

Lead Reviewer, Signature

Sami Osman

Printed Name:

Product Manufacturer Authorization:

I am a duly authorized signatory for the manufacturer(s) of the aforementioned product, and have the legal authority to authorize ATOA to issue this Product Certification with respect to this product on behalf of my organization.

A handwritten signature in black ink, appearing to read "Caprice Bayliss".

Authorized Signatory, Signature

Caprice Bayliss

Printed Name:



Product Certification Report (Ex Ante Verification Report)

Product ID: 001

Product Name: ErthCycle:

Ex Ante Certification Date: 11.02.2022

Certification Report:

Ex-ante Certification Report for *ErthCycle*, Product ID:001, based on information assessed up to the Certification Date stated above.

Prepared by ATOA Carbon, on behalf of Product Manufacturer:



Product Certification Report (Ex Ante Verification Report)

Document Information

Document Owner	Chief Technical Officer
Document Approved by:	Chief Technical Officer
Document Version	1.0
Last Updated	11/02/2022
Product ID:	001
Product Name:	ErthCycle
Certification Date:	11.02.2022
Certification Valid Until:	11.01.2024

INTRODUCTION

1 Scope of and Criteria for Ex-Ante Certification Report

This Ex-Ante Verification Report was prepared by ATOA Carbon, on behalf of the product manufacturer, pursuant to requirements set out in the ATOA Certification Standard for Greener Plastics™, Sections 2.3, and 3.2, and the requirements in ATOA Certification Standard for Greener Plastics™ PE & PP, Section 3.I. The criteria applied in conducting the Ex-ante assessment include those named in the aforementioned sections of the relevant standards, as well as the following standards:

- i. International Standards Organization. ISO 14040:2006 Environmental Management – Life Cycle Assessment – Principles and Framework;
- ii. International Standards Organization. ISO 14044:2006 Environmental Management – Life Cycle Assessment – Requirements and Guidelines;
- iii. International Standards Organization. ISO 14064:2006 Greenhouse Gases Part 2 “Specification with Guidance at the Project Level for Quantification, Monitoring and Reporting of Greenhouse Gas Emissions Reductions or Removal Enhancements”;
- iv. International Standards Organization. ISO 14064:2006 Greenhouse Gases Part 3 “Specification with Guidance for the Validation and Verification of Greenhouse Gas Assertions”;
- v. *World Business Council for Sustainable Development and World Resources Institute. The GHG Protocol for Project Accounting*. Available online at: <https://ghgprotocol.org/standards/project-protocol>.

2 Materials reviewed for Ex-Ante Certification

To gain certification under these standards, the plastics manufacturer submitted an ex-ante assessment to ATOA Carbon, to demonstrate the specified product(s) meet the requirements of the overarching standard and the product specific standard named herein. In accordance with the requirements outlined above, the manufacturer submitted a report entitled 'Product Environmental Footprint Report, dated October 21st, 2014, prepared by Intertek Testing Services Shenzhen Limited. The ATOA team reviewed this report, conducted multiple interviews with members of the product manufacturing team, and reviewed additional materials, including those summarized below.

- I. 3 R Initiative, Guidelines for Corporate Plastic Stewardship, Available online at: <https://www.3rinitiative.org/guidelines-for-corporates>.
- II. Andrady, A (2003). *Plastics in the environment*. P. 762. John Wiley & Sons,
- III. Blanco, I, et al., (2020) *Life-Cycle Assessment in the Polymeric Sector: A Comprehensive Review of Application Experiences on the Italian Scale*. *Polymers* 2020, 12, 1212; doi:10.3390/polym12061212
- IV. Deng, X.; Li, Y.; Liu, H.; Zhao, Y.; Yang, Y.; Xu, X.; Cheng, X.; Wit, B.d. *Examining Energy Consumption and Carbon Emissions of Microbial Induced Carbonate Precipitation Using the Life Cycle Assessment Method*. *Sustainability* 2021, 13, 4856. Available online at: <https://doi.org/10.3390/su13094856>.
- vi. Life Cycle Impacts for Postconsumer Recycled Resins: PET, HDPE, and PP, Submitted to The Association of Plastic Recyclers, Submitted by *Franklin Associates, a Division of ERG for ACC Plastics Division, APR, NAPCOR, and PETRA*.
- vii. *Life Cycle Inventory of 100% Postconsumer HDPE and PET Recycled Resin from Postconsumer Containers and Packaging. January 2011. Conducted by Franklin Associates, a Division of ERG for ACC Plastics Division, APR, NAPCOR, and PETRA*. Available online at: <https://plastics.americanchemistry.com/Education-Resources/Publications/Life-Cycle-Inventory-of-Postconsumer-HDPE-and-PET-Recycled-Resin.pdf>
- viii. United States Environmental Protection Agency (EPA). (2016). *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM), Containers, Packaging, and Non-Durable Goods Materials Chapter*. Available online at: https://www.epa.gov/sites/production/files/2016-03/documents/warm_v14_containers_packaging_non-durable_goods_materials.pdf
- ix. United Nations Framework Convention on Climate Change (UNFCCC), Approved Clean Development Mechanism (CDM) Methodology AMS.III.B.A. *Recovery and recycling of materials from E-Waste*, Version 3.0.
- x. United Nations Framework Convention on Climate Change (UNFCCC), Approved Clean Development Mechanism (CDM) Methodology AMS.III.A.J. *Recovery and recycling of materials from solid wastes*, Version 8.0.
- xi. United Nations Framework Convention on Climate Change (UNFCCC), Clean Development Mechanism (CDM) Approved Consolidated Baseline and Monitoring Methodology ACM0005, *Increasing the Blend in Cement Production*, Version 7.1 *Recovery and recycling of materials from E-Waste*, Version 3.0.
- xii. Verified Carbon Standard (VCS) Methodology VM0040: *Methodology for Greenhouse Gas Capture and Utilization in Plastic Materials*, Version 1.0, 23 July 2019.
- xiii. Verified Carbon Standard (VCS) Methodology VM0043: *Methodology for CO₂ Utilization in Concrete Production*, Version 1.0, 5 April 2021.
- xiv. Verified Carbon Standard (VCS) Methodology (Under Development) *Methodology for the use of alternative materials to displace the production of plastics*, Version 1.0, 27 August 2021.

3 Assessment of appropriateness of materials reviewed for Ex-Ante Certification

In accordance with the requirements set out in ATOA Certification Standard for Greener Plastics™, Sections 2.3, and 3.2, an assessment was made regarding the report submitted to ATOA entitled 'Product Environmental Footprint Report, dated October 21st, 2014, prepared by Intertek Testing Services Shenzhen Limited. ATOA interviewed representative of the plastics manufacturer to ascertain any Conflicts of Interest

between report authors and the plastics manufacturer. No Conflicts of Interest were found. ATOA also assessed whether the report authors appeared to have requisite expertise such that the report would meet requirements of the standard. ATOA staff reviewed the report itself, and extensive literature on similar products, and consulted with industry experts. Based on the nature of the information provided, ATOA staff were able to confirm the contents of the report themselves indicate the report authors had sufficient expertise regarding the subject matter and contents of the report. ATOA also reviewed materials available online on both the author's website and multiple additional sources, and ascertained the author has conducted extensive testing of similar subject matter. Based on this review ATOA determined the report in question meets the requirements of Section 3.2 of the ATOA Certification Standard for GreenerPlastics™.

4 Ex-Ante Certification Findings

Based on the reviews described above, ATOA have determined, to a reasonable level of assurance, that the aforementioned product has met the requirements of Section 3.1. of ATOA Certification Standard for GreenerPlastics™ PE & PP.



Lead Reviewer, Signature



Printed Name:



Certification Standard

for

Greener Plastics™

v1.0



Certification Standard for

Greener Plastics™

v1.0

Document Information

Document Owner	Chief Technical Officer
Document Approved by:	Chief Technical Officer
Document Version	1.0
Last Updated	11/02/2022

INTRODUCTION

1 General

- 1.1 'Plastic' is a universally held term that refers to a diverse array of polymers available globally today, that are characterized by widely diverse chemical composition, manufacturing methods and raw material feedstocks¹. By some estimates, nearly 415 million tonnes of plastics are produced each year.² Plastics, especially in developed nations, can be found in almost every aspect of our daily lives. The sustainable use of plastics is not only possible, it is imperative.
- 1.2 This Standard is designed to require manufacturers of plastics to meet minimum standards with respect to greenhouse gas (GHG) and broader environmental impacts, with respect to plastics manufacturing, as well as support a continuing effort to improve and/or maintain such environmental impacts. The Standard does this by requiring plastics manufacturers to: primarily (i) reduce greenhouse gas (GHG) emissions from the manufacture of plastics; and secondarily, consider means to (ii) reduce cumulative energy demand; and (iii) minimize acidification.
- 1.3 This Standard requires adherence to requirements designed to ensure no double claiming of emission reductions associated with Greener Plastics. Such requirements include those that ensure plastics can effectively be traced from the production facility to the end user, and guidance regarding who can claim

¹ Walker, S.; Rothman, R. Life cycle assessment of bio-based and fossil-based plastic: A review. J. Clean. Prod. 2020, 261, 121158.

² Guidelines for Corporate Plastic Stewardship, February 2021, p.3.

emission reductions towards their GHG footprint. Each Seller of ATOA certified plastics must obtain ATOA approval for any claims relating to the GHG impacts of selling plastics certified under this Standard.

2 Scope

- 2.1 This Greener Plastics certification standard establishes minimum GHG emission reductions, and minimum safeguards with respect to energy demand and acidification, associated with plastics manufacturing.
- 2.2 This certification standard applies to all types of plastics manufacturing. With respect to GHG emission reductions, criteria will be established to identify a minimum level of emission reductions that must be met for a manufacturing process and product to gain certification under this standard. Separate GHG reduction thresholds will be established per product category and laid out in separate Appendices to this Standard. Users should consult with ATOA to ensure they are using the most up to date version of guidance applicable to them.
- 2.3 This standard contains both an ex-ante assessment and ongoing ex-post assessments. To gain certification under this standard each plastics manufacturer must submit an ex-ante assessment which demonstrates they meet the requirements set out in a product-specific standard attached as an Appendix to this overarching framework standard. At a minimum each plastics manufacturer must submit a report performed by an independent and suitably qualified entity, that covers the product in question, that was published within the last 10 years. ATOA will conduct a Conflict Of Interest review, to confirm the author of the report is sufficiently independent from the plastics manufacturer, and will conduct a review to confirm that the entity in question is sufficiently qualified to author such a report. See further details regarding the ex-ante review in Section 3.2 below.
- 2.4 In order to obtain permission to sell plastics that have been certified under this Standard, each seller must provide sufficient information to ATOA, and follow guidance from ATOA in order to meet traceability requirements for all certified plastics leaving their manufacturing facilities, as set out in the Section 3.3 ex-post assessment requirements. Users should consult with ATOA to ensure they are using the most up to date version of guidance applicable to them. Each Seller must also obtain ATOA approval for any claims relating to the GHG impacts of selling plastics certified under this Standard.

3 Overview of Certification Process

- 3.1 This standard contains both an ex-ante assessment and ongoing ex-post assessments.
- 3.2 **Ex-ante Assessment:** To gain certification under this standard, each plastics manufacturer must submit an ex-ante assessment which demonstrates they meet the requirements set out in a product-specific standard attached as an Appendix to this overarching framework standard. At a minimum each plastics manufacturer must submit a report performed by an independent and suitably qualified entity, that covers the product in question, that was published within the last 10 years. ATOA will conduct a Conflict Of Interest review, to confirm the author of the report is sufficiently independent from the plastics manufacturer, and will conduct a review to confirm that the entity in question is sufficiently qualified to author such a report. ATOA staff then assesses the submitted report to confirm it meets the requirements of this section, and that the plastics meet the requirement of the relevant Appendix for the given type of plastic. Once such an assessment is complete, ATOA staff issue a certificate which confirms the facility in question has either passed or failed to meet the requirements of this Standard.
- 3.3 **Ex-post Assessment:** To maintain certification under this standard, each plastics manufacturer must submit an ex-post assessment of their performance against the standard at least once every year which demonstrates they meet the requirements set out in a product-specific standard attached as an Appendix to this overarching framework standard. Each ex-post assessment must contain sufficient data to demonstrate plastics

manufacturing at the facility for the 6 months preceding submission of the report met the requirements of this standard. Each ex-post assessment must include detail regarding the specific volumes of certified plastics produced, in order to facilitate tracing and assurance regarding claims being made in relation to such plastics.

3.3.1 *Independent expert Verification*

Each ex-post assessment must be either reviewed and approved or developed in the first instance by an independent and suitably qualified verification entity that has expertise in the testing of plastics. ATOA will conduct a Conflict-of-Interest review, to confirm the third-party verification entity is sufficiently independent from the plastics manufacturer and will conduct a review to confirm that the entity in question is sufficiently qualified to conduct the ex-post assessment. Each ex-post assessment must be carried out to a reasonable level of assurance, in compliance with the chosen Greener Plastics standard, ISO 14064-1:2006, ISO 14064-2:2006, ISO 14064-3:2006. Each verification body and team member must be accredited under ISO 14065:2013, ISO 14065:2020, IAF MD 6:2014, or be accredited under an accreditation program approved by ATOA (such as entities approved by ANSI National Accreditation Board, Entidad Mexicana de Accreditation, A.C). For instances where the ex-post assessment is initially developed by an entity other than the expert verification body, the report submitted to the expert verification body must meet a quantitative materiality threshold by demonstrating >99% level of accuracy (<1% error) relative to the verification body's independently calculated emission reductions.

3.3.2 *ATOA Review and Approval of Verification Report*

Once a verification has been completed and a report submitted to ATOA from the verification body, ATOA staff then assesses the submitted verification report to confirm it meets the requirements of this section, and that the plastics meet the requirement of the relevant Appendix for the given type of plastic. Each verification report must also contain information demonstrating the volumes of plastics produced that meet the requirements of this standard, and an attestation that the manufacturer and/or purchaser of the plastics have not overclaimed with respect to either the volume of such plastics produced, or the associated emission reductions. Once such an assessment is complete, ATOA staff issue a certificate which confirms the facility in question has either passed or failed to meet the requirements of this Standard. If ATOA assesses the facility to have passed the requirements of this standard a certificate will be issued to the facility to demonstrate compliance with the standard, which certificate will be valid for a period of 12 months from the date of issuance.

3.4 *Missing Data Substitution*

For periods where requisite data on GHGs are missing, the applicant must submit a methodology to ATOA for substitution of such missing data, for ATOA's approval. The missing data substitution procedures for NOx CEMS found in Section 75.33 of 40 United States Code of Federal Regulations Part 75 may be used. If there are no prior quality-assured data or minimal available data is specified in Section 75.33, the missing data must be substituted using the minimum potential baseline concentration for missing data in the historical baseline period, and the maximum potential concentration for missing data in the ex-post review period. All instance of data substitution must be reviewed by an approved verifier and/or ATOA to assess reasonableness.

3.5 *Plastics Buyers/Sellers:* Each entity that seeks accreditation for the manufacture and/or sale of Greener Plastics certified plastics must follow the steps outlined below:

- 3.5.1 Enter into an agreement with ATOA to be bound by these and other program rules;
- 3.5.2 Provide all requisite data requested by ATOA;

- 3.5.3 Obtain ATOA approval for any marketing materials pertaining to environmental attributes associated with the sale of certified plastics, for purposes of ensuring proper accounting for and attribution of GHG emission reductions associated with the sale of the certified plastics, and in particular that no double claiming of environmental attributes has occurred.
- 3.5.4 Obtain ATOA approval pertaining to the use of any data relating to any specific plastics manufacturing facility, for purposes of ensuring such data is protected and appropriate permissions have been granted by each manufacturing entity.

4 Updates to this Standard

- 4.1 ATOA is committed to the continuous improvement of this Standard. Standards maintenance is an ongoing process that will be assessed annually. As best available agronomic and scientific guidance, and technologies evolve, the product category requirements will be reviewed and possibly amended. Users should consult with ATOA to ensure they are using the most up to date version of guidance applicable to them.

5 Glossary

For the purpose of this Standard, the following definitions apply:

ANSI	American National Standards Institute
CEMS	Continuous Emissions Monitoring System
CO ₂ e	Carbon dioxide equivalent
CH ₄	Methane
GHG	Greenhouse gas

Appendix A



**Certification Standard
For**

Greener Plastics™

**PE & PP
v1.0**

Document Information

Document Owner	Chief Technical Officer
Document Approved by:	Chief Technical Officer
Document Version	1.0
Last Updated	11/02/2022

INTRODUCTION

1 General

- I. Poly Ethylene (PE) and Poly Propylene (PP) are plastic polymers with high strength-to-density ratio, that are resistant to many solvents, that are used for a wide variety of applications, including plastic bottles for food and non-food applications, corrosion-resistant piping, building materials, geomembranes and a myriad other applications. Global PE production reached over 49 million tonnes in 2020, and PP production was above 56 million tonnes by 2018, per data from Statista.

- II. PE and PP are typically produced using petrochemical feedstocks. Opportunity exists to reduce the GHG profile of PE and PP production, as well as realize broader environmental impacts such as reduced cumulative energy demands from the manufacturing process and reduced acidification, through feedstock substitution.

2 Scope

- I. This Greener Plastics PE and PP certification standard establishes minimum GHG emission reductions, and minimum safeguards with respect to energy demand and acidification, associated with plastics manufacturing.
- II. Note that the overarching ATOA Greener Plastics certification standard also contains various requirements for Identify Preservation and market claims, as set out in Section 2.4-2.5 of the Standard.

3 Quantification Methodology

I. Quantitative GHG Emission Reduction Threshold for PE & PP

In order to be eligible under this Standard, PE and PP manufacturers must demonstrate a reduction in GHGs related to their production of PE and/or PP of at least 5% per unit of PE and/or PP output, relative to their own historical baseline conditions. The PE or PP production facility must also demonstrate that their emissions during both the historical baseline period and the period where they are using the feedstock substitute are at or below regional average PE or PP GHG production emissions, per unit of PE or PP output. In order to demonstrate regional average production emissions, literature may be used from a source deemed suitable by ATOA staff, including reports prepared by independent experts (such as Life Cycle Assessments), peer reviewed literature, and data the prepared by entities such as the Intergovernmental Panel on Climate Change (IPCC), National or sub-national environmental governmental agencies.

II. GHGs to be Assessed for PE & PP

The GHG accounting boundary for this standard includes all process-related GHGs that were generated during the PE or PP production process at the manufacturing facility in question, including specifically any CO₂, CH₄, and N₂O process emissions, as well as emissions from the combustion of fossil fuels at the manufacturing facility.

III. Quantifying Historical Baseline PE & PP GHG Emissions

Each time the standard is applied to a PE or PP production facility, a historical baseline representing the GHG emissions within the GHG accounting boundary must be compiled for the given PE or PP production facility. Depending on the specifics of the given facility, either a dynamic or static baseline may be most reasonable. Each entity submitting a facility for consideration under this standard must use the methodology set out in the ATOA Greener Plastics™ PE or PP Parameters document, attached to and incorporated into this standard as Appendix B. Entities may also seek permission from ATOA to develop and use their own quantification methodology specific to their facility, or request that ATOA provide them with such a methodology. In the case of a methodology submitted by the entity itself, the third-party expert verification body chosen to review the ex-post report for the project will provide an opinion on the reasonableness of the chosen baseline approach, and then ATOA staff will determine if the approach is acceptable. All data must be gathered in a manner that meets all local regulatory requirements, using metering equipment that is shown to meet manufacturer requirements for Quality Assurance/Quality Control (QA/QC). Where possible, direct measurements of GHGs including N₂O should be undertaken using a Continuous Emissions Monitoring System (CEMS). All data used under this program must be retained for a minimum of 7 years from the time an application is made to ATOA under this standard. Note that entities applying under this standard may approach ATOA prior to submission of their facility for accreditation, to explore suitable baseline quantification methodologies. The historical baseline period

must contain data from at least twelve (12) months of continuous operation immediately prior to the use of the substitute feedstock. In the case where certification is sought for a specific end-product, and the manufacture of that given product took place across multiple facilities, the parties involved should seek ATOA guidance and approval for aggregating emissions across the multiple facilities to develop an historical baseline for the given product.

IV. Quantifying GHG Emissions from Greener Plastics Manufacturing

In order to maintain certification under this program, each PE or PP production facility must conduct an assessment of the GHG emissions from the manufacture of PE or PP using the chosen feedstock substitute, on at least an annual basis. The same GHG accounting boundary that was used for the historical baseline period must be used for the ex-post assessment of emissions using the feedstock substitute. Each entity submitting a facility for consideration under this standard must use the methodology set out in the ATOA Greener Plastics™ PE & PP Parameters document, attached to and incorporated into this standard as Appendix B. Entities may also seek permission from ATOA to develop and use their own quantification methodology specific to their facility, or request that ATOA provide them with such a methodology. . In the case of a methodology submitted by the entity itself, the third-party expert verification body chosen to review the ex-post report for the project will provide an opinion on the reasonableness of the chosen substitute feedstock quantification approach, and then ATOA staff will determine if the approach is acceptable. All data must be gathered in a manner that meets all local regulatory requirements, using metering equipment that is shown to meet manufacturer requirements for Quality Assurance/Quality Control (QA/QC). Where possible, direct measurements of GHGs including N₂O should be undertaken using a Continuous Emissions Monitoring System (CEMS). All data used under this program must be retained for a minimum of 7 years from the time an application is made to ATOA under this standard. Note that entities applying under this standard may approach ATOA prior to submission of their facility for accreditation, to explore suitable feedstock substitute quantification methodologies. The assessment of feedstock substitute production emissions must be conducted over the same amount of time as the historical baseline period, and in all cases must contain at least three months' worth of production data. In the case where certification is sought for a specific end-product, and the manufacture of that given product took place across multiple facilities, the parties involved should seek ATOA guidance and approval for aggregating emissions across the multiple facilities in order to develop an historical baseline for the given product.

V. Missing Data Substitution

For periods where requisite data on GHGs are missing, the applicant must submit a methodology to ATOA for substitution of such missing data, for ATOA's approval. The missing data substitution procedures for NO_x CEMS found in Section 75.33 of 40 United States Code of Federal Regulations Part 75 may be used. If there are no prior quality-assured data or minimal available data as specified in Section 75.33, the missing data must be substituted using the minimum potential baseline concentration for missing data in the historical baseline period, and the maximum potential concentration for missing data in the ex-post review period. All instance of data substitution must be reviewed by an approved verifier and/or ATOA to assess reasonableness.

4 Updates to this Standard

- I. ATOA is committed to the continuous improvement of this Standard. Standards maintenance is an ongoing process that will be assessed annually. As best available agronomic and scientific guidance, and technologies evolve, the product category requirements will be reviewed and possibly amended. Users should consult with ATOA to ensure they are using the most up to date version of guidance applicable to them.

5 Glossary

For the purpose of this Standard, the following definitions apply:

ANSI	American National Standards Institute
CEMS	Continuous Emissions Monitoring System
CO ₂ e	Carbon dioxide equivalent
CH ₄	Methane
GHG	Greenhouse gas
ISO	International Organization for Standardization
NO	Nitric oxide
NO ₂	Nitrogen dioxide
N ₂ O	Nitrous oxide
NO _x	Nitrogen oxide; refers to NO and NO ₂
QA/QC	Quality Assurance / Quality Control
SSR	Source, Sink and Reservoir of Greenhouse Gases

6 References

- I. 3 R Initiative, *Guidelines for Corporate Plastic Stewardship*, Available online at: <https://www.3rinitiative.org/guidelines-for-corporates>.
- II. Andrady, A (2003). *Plastics in the environment*. P. 762. John Wiley & Sons,
- III. Blanco, I, et al., (2020) *Life-Cycle Assessment in the Polymeric Sector: A Comprehensive Review of Application Experiences on the Italian Scale*. *Polymers* 2020, 12, 1212; doi:10.3390/polym12061212
- IV. Climate Action Reserve, *Landfill Project Protocol*, Version 1.0, April 24 2019.
- V. Climate Action Reserve, *Adipic Acid Production Protocol*, Version 5.0, September 30, 2020.
- VI. Climate Action Reserve, *Nitric Acid Production Protocol*, Version 2.2, April 18 2019.
- VII. Deng, X.; Li, Y.; Liu, H.; Zhao, Y.; Yang, Y.; Xu, X.; Cheng, X.; Wit, B.d. *Examining Energy Consumption and Carbon Emissions of Microbial Induced Carbonate Precipitation Using the Life Cycle Assessment Method. Sustainability* 2021, 13, 4856. Available online at: <https://doi.org/10.3390/su13094856>.
- i. International Panel on Climate Change, *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (2001). Available online at: <https://www.ipcc.ch/publication/good-practice-guidance-and-uncertainty-management-in-national-greenhouse-gas-inventories/>.
- ii. International Panel on Climate Change, *IPCC Guidelines for National Greenhouse Gas Inventories*, Chapter 10: Emissions from Livestock and Landfill (2006).
- iii. International Panel on Climate Change (2014) *Climate Change 2014 Synthesis Report: Summary for Policymakers*. Geneva: IPCC
- iv. International Standards Organization (2010). *Stationary Source Emissions --Determination of the Mass Concentration of Dinitrogen Monoxide (N2O) -- Reference Method: Non-Dispersive Infrared Method*. Available online at: <https://www.iso.org/standard/40113.html>.
- v. International Standards Organization. ISO 14040:2006 Environmental Management – Life Cycle Assessment – Principles and Framework;
- vi. International Standards Organization. ISO 14044:2006 Environmental Management – Life Cycle Assessment – Requirements and Guidelines.
- vii. International Standards Organization. ISO 14064:2006 Greenhouse Gases Part 2 “Specification with Guidance at the Project Level for Quantification, Monitoring and Reporting of Greenhouse Gas Emissions Reductions or Removal Enhancements”.
- viii. International Standards Organization. ISO 14064:2006 Greenhouse Gases Part 3 “Specification with Guidance for the Validation and Verification of Greenhouse Gas Assertions”.
- ix. Life Cycle Impacts for Postconsumer Recycled Resins: PET, HDPE, and PP, Submitted to The Association of Plastic Recyclers, Submitted by Franklin Associates, a Division of ERG for ACC Plastics Division, APR, NAPCOR, and PETRA.
- x. *Life Cycle Inventory of 100% Postconsumer HDPE and PET Recycled Resin from Postconsumer Containers and Packaging*. January 2011. Conducted by Franklin Associates, a Division of ERG for ACC Plastics Division, APR, NAPCOR, and PETRA. Available online at: <https://plastics.americanchemistry.com/Education-Resources/Publications/Life-Cycle-Inventory-of-Postconsumer-HDPE-and-PET-Recycled-Resin.pdf>
- xi. Royer S-J et al., (2018) *Production of methane and ethylene from plastic in the environment*. PLoS ONE 13(8): e0200574. Available online at: <https://doi.org/10.1371/journal.pone.0200574>
- xii. *United States Code of Federal Regulations (CFR). Title 40*. Available online at: https://www.ecfr.gov/cgi-bin/textidx?SID=279f36b48682c8391859ad082975596b&mc=true&tpl=/ecfrbrowse/Title40/40cfr75_main_02.tpl
- i. United States Environmental Protection Agency (EPA). (2016). *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM), Containers, Packaging, and Non-Durable Goods Materials Chapter*. Available online at: https://www.epa.gov/sites/production/files/2016-03/documents/warm_v14_containers_packaging_non-durable_goods_materials.pdf

- ii. United States Environmental Protection Agency. (2011). *PSD and Title V Permitting Guidance for GHGs*. Available online at: <https://www.epa.gov/title-v-operating-permits/psd-and-title-v-permitting-guidance-ghgs>.
- iii. United States Environmental Protection Agency. (2018). *Method 7E - Nitrogen Oxide - Instrumental Analyzer*. Available online at: <https://www.epa.gov/emc/method-7e-nitrogen-oxide-instrumental-analyzer>.
- i. United States Department of Energy 1605(b) Technical Guidelines for Voluntary Reporting of Greenhouse Gas Program.
- ii. United States Environmental Protection Agency (EPA) (2020). *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2018*.
- iii. United States Environmental Protection Agency (EPA), *Technical Support Document for the Adipic Acid Production Sector: Proposed Rule for Mandatory Reporting of Greenhouse Gases*. Available online at: https://www.epa.gov/sites/production/files/2015-02/documents/ti_e_tsd_adipic_epa_2-12-09.pdf.
- iv. United Nations Framework Convention on Climate Change (UNFCCC), Approved Clean Development Mechanism (CDM) Methodology AMS.III.B.A. *Recovery and recycling of materials from E-Waste*, Version 3.0.
- v. United Nations Framework Convention on Climate Change (UNFCCC), Approved Clean Development Mechanism (CDM) Methodology AMS.III.A.J. *Recovery and recycling of materials from solid wastes*, Version 8.0.
- vi. United Nations Framework Convention on Climate Change (UNFCCC), Clean Development Mechanism (CDM) Approved Consolidated Baseline and Monitoring Methodology ACM0005, *Increasing the Blend in Cement Production*, Version 7.1 *Recovery and recycling of materials from E-Waste*, Version 3.0.
- vii. Verified Carbon Standard (VCS) Methodology VM0040: *Methodology for Greenhouse Gas Capture and Utilization in Plastic Materials*, Version 1.0, 23 July 2019.
- viii. Verified Carbon Standard (VCS) Methodology VM0043: *Methodology for CO₂ Utilization in Concrete Production*, Version 1.0, 5 April 2021.
- ix. Verified Carbon Standard (VCS) Methodology (Under Development) *Methodology for the use of alternative materials to displace the production of plastics*, Version 1.0, 27 August 2021.
- x. *World Business Council for Sustainable Development and World Resources Institute. The GHG Protocol for Project Accounting*. Available online at: <https://ghgprotocol.org/standards/project-protocol>.

Appendix B



Greener Plastics™

**PE & PP
Parameters
v1.0**

Document Information

Document Owner	Chief Technical Officer
Document Approved by:	Chief Technical Officer
Document Version	1.0
Last Updated	11/02/2022

INTRODUCTION

1 General

- i. This ATOA Greener Plastics™ PE & PP Parameters document is an accompaniment and incorporated into the ATOA Certification Standard for Greener Plastics™, and contains the default equations and emission factors necessary for use of the default equation and emission factor quantification option outlined in Section 3(iii) and 3(iv) of that Standard.

2 Scope

- i. The default emission factors and equations that are contained in this document are all sourced and adapted from peer reviewed publications listed in the References section of this document. Users should consult with ATOA to ensure they are using the most up to date version of guidance applicable to them.
- ii. The default equations and emission factors contained in this document relate to the following Greenhouse Gas (GHG) Sources, Sinks and Reservoirs (SSRs):

Table 1. Sources, Sinks and Reservoirs (SSRs) of Greenhouse Gas (GHG)

SSR	Source Description	Gas / Element	Included (I) or Excluded (E)	Justification/Explanation
1	Fossil fuel use	CO ₂	I	The net quantity of emissions from fossil fuels used in the manufacture of plastics and greener plastics are significant and likely to materially change.
2	Electricity use	CO ₂	I	The net quantity of emissions from electricity used in the manufacture of plastics and greener plastics are significant and likely to materially change.
3	Biogenic emissions	CO ₂	E	CO ₂ emissions associated with the generation and destruction of landfill gas are excluded from the GHG Assessment Boundary. ³
4	Emissions from incineration of plastics	CO ₂	I	CO ₂ emissions released during the combustion of plastics at end-of-life are significant and likely to materially change.
5	Emissions from degradation of plastics	CH ₄	I	CH ₄ emissions released during the degradation of plastics at end-of-life are significant and may materially change.
6	Emissions from the production of alternative Greener Plastics input	CO ₂	I	Emissions associated with the manufacture of alternative sustainable plastics input materials may be significant and likely to materially change.

3 Default Quantification Methodology

As set out in Section 3(iii) and 3(iv) of the ATOA Certification Standard for Greener Plastics™ PE or PP, unless an alternative quantification methodology is approved, the equations set out below must be utilized as the default quantification methodology. Note that default values for emission factors and other parameters will be provided by ATOA upon request, or values submitted by the user may be utilized once approved by ATOA. Users should consult with ATOA if requiring further guidance on how to use these equations and on sourcing appropriate emission factors and other parameters.

³ CO₂ emitted during combustion of any biomass and biogas used in the manufacture of plastics or in end-of-life fate of plastics is excluded in accordance with the guidance contained in Intergovernmental Panel on Climate Change’s (IPCC) guidelines contained in *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*; p.5.10, ftnt.

Equation 1. Total Emission Reductions

$ER = \sum_{f,t} [BE - PE]$		
Where,		
ER	= Total emission reductions for the reporting period	<u>Units</u> tCO ₂ .e
BE	= Average historical baseline emissions at facility <i>f</i> during production cycle <i>t</i> (Equation 2)	tCO ₂ .e
PE	= Average project emissions during the reporting period at facility <i>f</i> during production cycle <i>t</i> (Equation 3)	tCO ₂ .e

Equation 2. Average Historical Baseline Emissions

$BE = \sum_{f,t} p (Q_{AMy} \times WAF_p \times EF_p)$		
Where,		
BE	= Baseline emissions utilizing conventional plastics manufacturing processes	<u>Units</u> tCO ₂ .e
Q_{AMy}	= Net quantity of the new sustainable plastic input utilized by the project in year <i>y</i>	t
WAF_p	= Weight Adjustment Factor for plastic type <i>p</i> (See Equation 3 below)	Fraction
EF_p	= Emission factor for the production of conventional plastic material <i>p</i>	tCO ₂ .e / t plastic

Equation 3. Weight Adjustment Factor

$WAF_p = \sum_{f,t} p (WBP_p / WGP_p)$		
Where,		
WAF_p	= Weight Adjustment Factor for plastic type <i>p</i> (See Equation 3 below)	<u>Units</u> Fraction
WBP_p	= Average weight of representative sample of the conventionally produced plastic	g
WGP_p	= Average weight of representative sample of the Greener Plastic	g

Equation 4. Total Project Emissions

$PE = PE_{deg} + PE_{inc} + PE_{CO2} + PE_{GPM}$			
<i>Where,</i>			
PE	=	Project emissions during the reporting period	<u>Units</u> tCO ₂ .e
PE_{deg}	=	Project emissions from the degradation of greener plastics	tCO ₂ .e
PE_{inc}	=	Project emissions from the incineration of greener plastics	tCO ₂ .e
PE_{CO2}	=	Project CO ₂ emissions during the manufacture of the greener plastics	tCO ₂ .e
PE_{GPM}	=	Project emissions from the manufacture of the new sustainable plastic input utilized by the project	tCO ₂ .e

Equation 5. Project Emissions from the Degradation of Greener Plastics

$PE_{deg} = Q_{AMy} \times R_{deg} \times EF_{deg}$			
<i>Where,</i>			
PE_{deg}	=	Emissions from the avoided degradation of greener plastics	<u>Units</u> tCO ₂ .e
Q_{AMy}	=	Net quantity of the new sustainable plastic input utilized by the project in year y	t
R_{deg}	=	Ratio of plastic inputs that do not release CH ₄ emissions upon degradation ⁴	ratio
EF_{deg}	=	Emission factor for CH ₄ emissions released from the degradation of conventional plastic <i>p</i>	tCO ₂ .e / t plastic

⁴ All plastics are considered to emit CH₄ emissions upon degradation, unless specific evidence is provided to reasonably demonstrate that a given input does not. In such cases the percentage of total inputs represented by the given non-degradable input must be provided. See Andrady, A (2003). *Plastics in the environment*. P. 762. John Wiley & Sons, and Royer S-J et al., (2018) *Production of methane and ethylene from plastic in the environment*. PLoS ONE 13(8): e0200574. Available online at: <https://doi.org/10.1371/journal.pone.0200574>

Equation 6. Project Emissions from the Incineration of Greener Plastics

$PE_{inc} = Q_{AMy} \times R_{deg} \times EF_{inc}$			
Where,			
PE_{inc}	=	Project emissions from the incineration of greener plastics	Units tCO ₂ .e
Q_{AMy}	=	Net quantity of the new sustainable plastic input utilized by the project in year y	t
R_{deg}	=	Ratio of end-of-life plastic that is incinerated in the region into which they are sold	ratio
EF_{inc}	=	Emission factor for CO ₂ emissions released from the incineration of greener plastic <i>p</i>	tCO ₂ .e / t plastic

Equation 7. Project CO₂ emissions from the manufacture of the greener plastics.

$PE_{CO2} = (Q_{El} \times EF_{El}) + (Q_{ff} \times EC_{ff} \times EF_{ff})$			
Where,			
PE_{inc}	=	Project CO ₂ emissions from the manufacture of the greener plastics	Units tCO ₂ .e
Q_{El}	=	Net quantity of electricity used in the manufacture of greener plastics during the reporting period	MWH
EF_{El}	=	Emission factor for CO ₂ emissions from the use of electricity	tCO ₂ .e / MWH
Q_{ff}	=	Net quantity of fossil fuels used in the manufacture of greener plastics during the reporting period	fuel unit
EC_{ff}	=	Energy content of fossil fuel used in manufacture of greener plastics	TJ / fuel unit
EF_{ff}	=	Emission factor for CO ₂ emissions from the combustion of fossil fuels	tCO ₂ .e / TJ

Equation 8. Project emissions from the production of alternative input materials

$PE_{Ai} = Q_{AMy} \times EF_{Ai}$			
<i>Where,</i>			
PE_{Ai}	=	Project emissions from the production of alternative input materials	<u>Units</u> tCO ₂ .e
Q_{AMy}	=	Net quantity of the new sustainable plastic input utilized by the project in year y	t
EF_{Ai}	=	Emission factor for producing the new alternative input material	tCO ₂ .e / t