UL 3600

STANDARD FOR

Sustainability for Measuring and Reporting Circular Economy Aspects of Products, Sites and Organizations

Standard for Sustainability for Measuring and Reporting Circular Economy Aspects of Products, Sites and Organizations, UL 3600

Second Edition, Dated October 23, 2024

Summary of Topics

This is the Second Edition of ANSI/UL 3600, Standard for Sustainability for Measuring and Reporting Circular Economy Aspects of Products, Sites and Organizations, dated October 23, 2024 reflects the latest ANSI approval dates and incorporates the proposals dated February 9, 2024 and July 5, 2024.

The new requirements are substantially in accordance with Proposal(s) on this subject dated February 9, 2024 and July 5, 2024.

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UL 3600

Standard for Sustainability for Measuring and Reporting Circular Economy Aspects of Products, Sites and Organizations

First Edition – January, 2023

Second Edition

October 23, 2024

This ANSI/UL Standard for Sustainability consists of the Second Edition.

The most recent designation of ANSI/UL 3600 as an American National Standard (ANSI) occurred on October 23, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

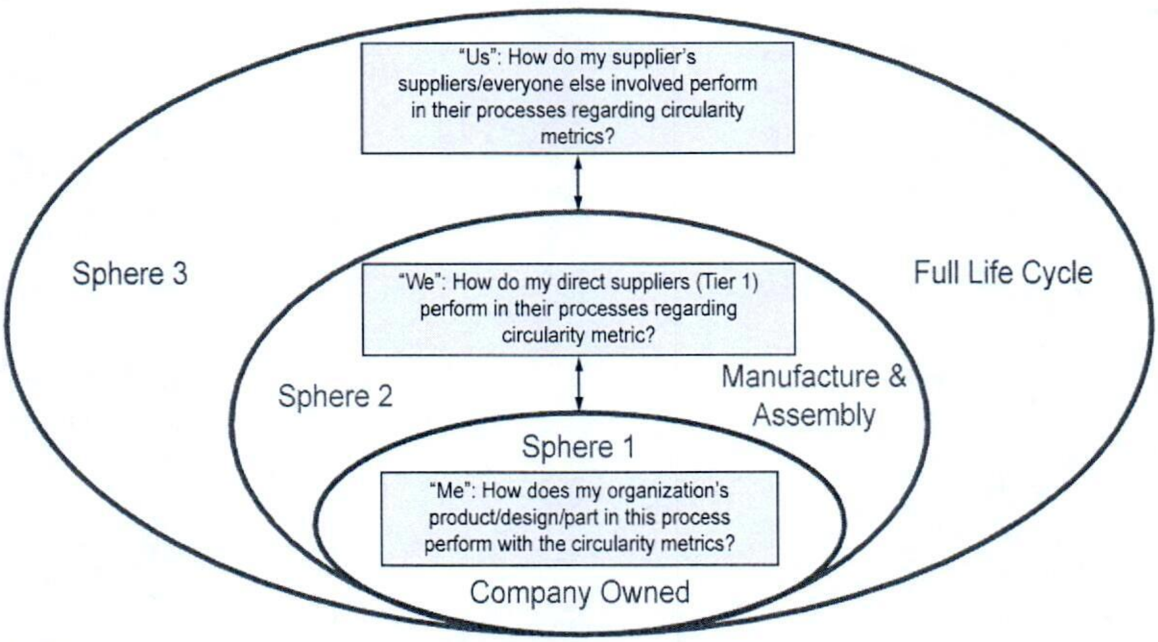
The following concepts have been adopted by the Standards Technical Panel in the development of this Standard and are aspirational.

The boundaries of an assessment can be set against one of three general supply chain boundaries and shall be established before beginning an assessment:

- Sphere 1 – Includes activity data of directly owned and/or managed assets.
- Sphere 2 – Includes all aspects of Sphere 1, as well as Tier 1 suppliers, those suppliers who supply goods (including raw materials, assembly components or semi-finished parts) or services directly to the organization.
- Sphere 3 – Includes all aspects of Sphere 2, as well as the full lifecycle of the products, sites and organizations participating in the supply chain, delivery, use, and post use of the product.
- A graphical representation of the Spheres is shown in Figure 1.

Figure 1

Spheres of Measurement in UL 3600



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These spheres shown in Figure 1 define broad boundaries for projects. An entity may further define the scope of a project to cover a portion of its overall products or sites within the selected sphere. For example, the scope of a specific project may cover one product and one site within the Sphere 1 boundary, or the Sphere 1 boundary may include additional products and sites.

NOTE: In the manufacturing and assembly process, the prioritization is to eliminate material waste sent to incineration and landfill. These non-recoverable materials are not considered circular and are not included in the calculations in UL 3600.

While this standard aims to have its central focus on circularity, it does address other aspects of sustainability such as, biodiversity, social impact, etc. While circularity itself is not the only goal, it is an important component in identifying short- and long-term improvement goals and assessing progress toward full sustainability.

This standard is intended for use by all actors of the product supply chain, up to and including the consumer and post use.

This standard is for the calculation of circular material flow metrics and to instruct the user how to use these metrics to create a Circularity Transparency Label.

1 Scope

1.1 This standard covers the methods and metrics for measuring aspects of the Circular Economy. Aspects include, but are not limited to, materials flows and the impacts of those flows. The standard is split into two major parts: measuring the material flows (measurement methods) and measuring the impacts of those flows (analytics).

1.2 The metrics and measures are focused on materials and the flow of those materials as a result of the activities of organizations and from any products manufactured by those organizations. In addition to the materials and flows, activities and impacts from those materials and flows in other parts of the supply chain shall be included where they represent significant impact and shall be used as a modifier on the material flows. By addressing both flows and impacts, this standard seeks to address the progress toward sustainability in a more holistic way.

2 Normative References

2.1 The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANS LTDD 1.0, *Due Diligence in Procuring/Sourcing Legal Timber*

ASTM D5338, *Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions Incorporating Thermophilic Temperatures*

ASTM D5988-18, *Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials in Soil*

ASTM D6400, *Standard Specification for Labelling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities*

ASTM D6866, *Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis*

ASTM D6691-17, *Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials in the Marine Environment by a Defined Microbial Consortium or Natural Sea Water Inoculum*

ASTM D7612-10, *Standard Practice for Categorizing Wood and Wood-Based Products According to Their Fiber Sources*

ASTM D7991-15, *Standard Test Method for Determining Aerobic Biodegradation of Plastics Buried in Sandy Marine Sediment under Controlled Laboratory Conditions*

ASTM D996-16, *Standard Terminology of Packaging and Distribution Environments*

BS/EN 15343, *Plastics – Recycled Plastics – Plastics recycling traceability and assessment of conformity and recycled content*

BSI/PAS 2050-1, *Assessment of life cycle greenhouse gas emissions from horticultural products*

BSI/PAS 2050-2, *Assessment of life cycle greenhouse gas emissions – Supplementary requirements for the application of PAS 2050 to seafood and other aquatic food products*

CalSAFER, *Candidate Chemical List*

EN 16640, *Bio-based products – Bio-based carbon content – Determination of the bio-based carbon content using the radiocarbon method*

EN 45555, *General methods for assessing the recyclability and recoverability of energy-related products*

ENERGY STAR

EU Regulation No. 2017/821

EU *Protocols*

FAO, *Food and Agriculture Organization, Water Accounting and Auditing Report 43*

Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

GRI, *Global Reporting Initiative*

IEC TR 62635, *Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment*

IFRS, *International Financial Reporting Standards*

ILO, *International Labour Organization*

IPCC, *Intergovernmental Panel on Climate Change*

ISM, *Institute for Supply Chain Management Ethics*

ISO, *International Organization for Standardization*

ISO 9439, *Water Quality – Evaluation of Ultimate Biodegradability of Organic Compounds in Aqueous Medium – Carbon Dioxide Evolution Test*

ISO 14025, *Environmental Labels and Declarations – Type III Environmental Declarations*

ISO 14040, *Environmental management – Life Cycle Assessment – Principles and framework*

ISO 14044, *Environmental management – Life Cycle Assessment – Requirements and Guidelines*

ISO 14050, *Environmental management – Vocabulary*

ISO 14067, *Greenhouse gasses – Carbon footprint of products – Requirements and guidelines for quantification*

ISO 14071, *Environmental management – Life Cycle Assessment – Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006*

ISO 14593, *Water Quality – Evaluation of Ultimate Aerobic Biodegradability of Organic Compounds in Aqueous Medium – Method by Analysis of Inorganic Carbon in Sealed Vessels (CO2 Headspace Test)*

ISO 14851, *Determination of the Ultimate Aerobic Biodegradability of Plastic Materials in an Aqueous Medium – Method by Measuring Oxygen Demand in a Closed Respirometer*

ISO 14852, *Determination of the Ultimate Aerobic Biodegradability of Plastic Materials in an Aqueous Medium – Method by Analysis of Evolved Carbon Dioxide*

ISO 14855-1, *Determination of the Ultimate Aerobic Biodegradability and Disintegration of Plastic Materials under Controlled Composting Conditions – Method by Analysis of Evolved Carbon Dioxide*

ISO 17088, *Organic recycling – Specifications for compostable plastics*

ISO 21644, *Solid recovered fuels – Methods for the determination of biomass content*

ISO 22095, *Chain of custody – General terminology and models*

ISO 26000, *Guidance on Social Responsibility*

ISO 59004, *Circular Economy*

LEED, *Leadership in Energy and Environmental Design*

Luster, S. ed. Diversity, Equity and Inclusion eFieldbook. 1st ed., Kansas City: Extension Foundation, 2019

MSCI (Morgan Stanley Capital International) ESG Ratings

OECD Guidelines for the Testing of Chemicals: Test No. 301, *Ready biodegradability*

REACH Regulation (Annex XIII of Regulation (EC) NO 1907/2006), PBT

REACH Regulation (Annex XIV of Regulation (EC) NO 1907/2006), Substances of Very High Concern (SVHC) Services

RBA, *Responsible Business Alliance*, Code of Conduct

SA 8000, *Social Accountability International*

SB 657, *The California Transparency in Supply Chains Act*

UL ECVP 2789, *Environmental Claim Validation Procedure (ECVP) for Calculation of Estimated Recyclability Rate*

UL ECVP 2799, *Environmental Claim Validation Procedure (ECVP) for Zero Waste to Landfill*

U.N. Paris Agreement, *United Nations, 2015. Available at: http://unfccc.int/paris_agreement/items/9485.php*

UNFCCC CDM, *U.N. Framework Convention on Climate Change (UNFCCC), Clean Development Mechanism (CDM), United Nations. Available at: https://cdm.unfccc.int/Reference/index.html*

United States Business Council for Sustainable Development (US BCSD) and the U.S. Environmental Protection Agency (EPA), Mangan, 1997

US Conflict Minerals Rule, Section 1502

US EPA, *Measuring Recycling: A Guide for State and Local Governments.* Available at: https://archive.epa.gov/wastes/conserve/tools/recmeas/web/html/download.html

WELL Building Standard

3 Terms, Definitions and Abbreviated Terms

3.1 Abbreviations

3.1.1 Abbreviations are summarized alphabetically in Table 3.1

Table 3.1
Abbreviations

CoC	Chain of Custody
CTL	Circularity Transparency Label
GHG	Greenhouse Gas
PET	Polyethylene Terephthalate
pMC & pmC	Percent modern carbon

3.2 Terms and definitions

3.2.1 For the purposes of this standard, the following terms and definitions apply.

3.2.2
anaerobic digestion
The process of biodegradation in the absence of oxygen, producing methane, which is combusted, capturing useful energy such as steam and electricity.

3.2.3
biobased content
Mass percent of biobased material in the product.

3.2.4
biobased material
Materials that can be grown or naturally generated within a foreseeable (example: 100 years) timeframe in the biosphere.

NOTE 1: Typically, the material is part of (but not limited to) the natural biologic nitrogen or carbon cycles.

NOTE 2: Materials that could safely cycle in the biosphere after use if released to the environment.

3.2.5
byproduct
A secondary or incidental product that is produced as a result of the manufacture or production of an intended product.

3.2.6
byproduct synergy
the synergy among diverse industries, agriculture, and communities resulting in profitable conversion of by-products and wastes to resources promoting sustainability

[United States Business Council for Sustainable Development (US BCSD) and the U.S. Environmental Protection Agency (EPA), Mangan, 1997]

3.2.7
closed loop system
A system in which materials are reclaimed, returned to and reused at the same material technical application equivalence or performance specifications as when the material was first used.

3.2.8
component
A single grouping of contents that during production is given a design or function. A component may be a standalone product or is part of a larger whole.

3.2.9
diversity
The presence of differences that may include race, gender, religion, sexual orientation, ethnicity, nationality, socioeconomic status, language, (dis)ability, age, religious commitment, or political perspective.

[Luster, S. ed. Diversity, Equity and Inclusion eFieldbook. 1st ed., Kansas City: Extension Foundation, 2019.]

3.2.10
energy recovery
On-site recovery of energy for reuse for unit processes.

3.2.11
entity
The operation being evaluated to this standard based on defining factors such as location (fixed or variable), time (start and stop), and/or identifiable, discreet operating units. An entity may be a combination of multiple discrete units (e.g., multiple sites, multiple vessels, etc.).

3.2.12
equity
The promoting of justice, impartiality, and fairness within the procedures, processes, and distribution of resources by institutions or systems.

[Luster, S. ed. Diversity, Equity and Inclusion eFieldbook. 1st ed., Kansas City: Extension Foundation, 2019.]

3.2.13
facility
A facility is an entity with a defined boundary and/or address. There may be multiple occupants, or operations within the facility boundary.

3.2.14
inclusion
An outcome to ensure those that are diverse actually feel and/or are welcomed. Inclusion outcomes are met when you, your institution, and your program are truly inviting to all.

[Luster, S. ed. Diversity, Equity and Inclusion eFieldbook. 1st ed., Kansas City: Extension Foundation, 2019.]

3.2.15
life cycle assessment (LCA)
Compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a product system throughout its life cycle.

[ISO 14050]

3.2.16
modern carbon
Explicitly, 0.95 times the specific activity of SRM 4990B (the original oxalic acid radiocarbon standard), normalized to δ13C = −19 % (Currie, et al., 1989). Functionally, the fraction of modern carbon equals 0.95 times the concentration of 14C contemporaneous with 1950 wood (that is, pre-atmospheric nuclear testing). To correct for the post 1950 bomb 14C injection into the atmosphere (5), the fraction of modern carbon is multiplied by a correction factor representative of the excess 14C in the atmosphere at the time of measurements.

[ASTM D6866]

3.2.17
non-renewable material
Material that cannot be naturally regenerated within a foreseeable time frame.

NOTE: Materials that are derived from activities by a technical cycle are not considered renewable resources.

3.2.18
primary package
A container in direct contact with and enclosing the product along with any required protective material(s).

[Reprinted, with permission, from ASTM D996-16, Standard Terminology of Packaging and Distribution Environments, copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be purchased from ASTM International, www.astm.org.]

3.2.19
recovered (reclaimed) material
Material that would otherwise have been disposed of as waste or used for energy recovery but has instead been collected and recovered (reclaimed) as a material input, in lieu of virgin material, for a recycling or manufacturing process.

3.2.20
recycled material
Material that has been reprocessed from recovered (reclaimed) material by means of a manufacturing process, and then made into a final product or into a component for incorporation into a product.

NOTE 1: material that is recycled in a closed loop process is considered separately (see Closed Loop System)

3.2.21
recycled content
The proportion of pre-consumer or post-consumer recycled material, by mass, in a product or packaging.

3.2.22
refurbished
A component or part which is removed from a discarded product and has undergone substantial repair, rebuilding, or remanufacturing before use in a new product or a product which has been removed from service and has been refurbished and returned to the field.

3.2.23
reused
A component or part which is removed from a discarded product and used in a new product with minimal cleaning or cosmetic improvements; or is a product which is designed to be used multiple times.

3.2.24
reused material
Mass of material which is employed in a particular function or application as an effective substitute for a new commercial product or material. Typically, an object is designed to be reused multiple times for the same purpose.

3.2.25
sustainably sourced biomass
Renewable biomass collected or harvested using practices that assure continued provision of the resource at similar or higher quantities over time and without permanent degradation of the qualities of the landscape

3.2.26
technical material
Material that has gone through a technical cycle, as defined in ISO 59004 Clause 3.1.20.

4 Material Flows and Circularity

4.1 General

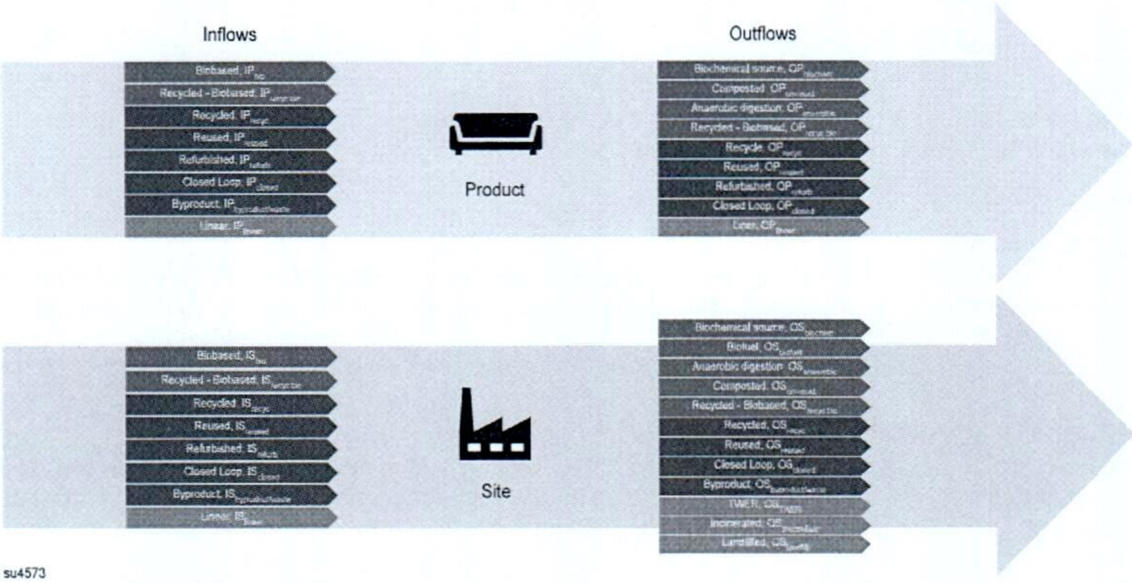
4.1.1 The overall circularity shall include the upstream and downstream material flows. Materials are grouped into Product flows and Site flows when determining Inflows and Outflows.

4.1.2 Figure 4.1 represents the flow of materials through a site and/or product and includes materials that become products along with the ancillary materials that are used at the site but are not shipped with the product. The products are shown on the outflow side of the figure on the upper portion. The material categories defined on the inflow side of the diagram can be either single materials or contained in a component, product, or subassembly from an earlier stage in the material flow.

4.1.3 Circular classification options for Material Inflows and Outflows are defined for both technical material and biobased material streams. For biobased materials, the objective is to regenerate natural systems. For technical materials, the objective is to keep materials in use rather than discarding.

Figure 4.1

Material Inflows and Outflows for a Product and for a Site



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NOTE: Circular materials are subdivided into biobased (green) and technical materials (blue); Non-circular linear material flows are gray.

4.2 Materials classifications

4.2.1 Technical materials

4.2.1.1 For technical materials, upstream circularity is measured through inflows of circular materials such as recycled materials, reused and refurbished parts or components.

4.2.1.2 Downstream circularity, outflow, is measured by assessing the design for potential component or product reuse and material recyclability (and potentially life extension and repair). For technical materials, outflows are classified as circular if designed to be recycled (either open or closed loop), reused or refurbished as parts, components, or products.

4.2.1.3 Technical material inflows

4.2.1.3.1 Technical material inflows shall meet the following requirements:

a) Meet the definition for the type of material being used, and

b) Come from a verifiable supply chain, or

c) Comply with ISO 22095 for chain of custody.

4.2.2 Biobased materials

4.2.2.1 For biobased materials, upstream circularity is measured by assessing the content of biobased material and material derived from biochemical feedstock. Downstream circularity is measured through the potential for composting, anaerobic digestion, recycling, or as a source of biochemical feedstock.

4.2.2.2 Biobased material inflows

4.2.2.2.1 Only Sustainably Sourced Biomass shall be included when quantifying the biobased material sources. Biobased material is eligible if it meets the definition of renewable biomass and is sustainably sourced.

4.2.3 Non-circular materials

4.2.3.1 Materials that are obtained or produced in a manner that violate fair labor practices or considered to be materials of concern, as identified below, shall be deemed non-circular, and therefore, shall be incorporated into the non-circular flow as needed.

4.2.3.2 Circular materials shall be sourced and utilized in accordance with policies and standards that support responsible supply chain practices. The list below identifies some standards and guides to follow. Equivalent options may be pursued.

a) ISO 26000 – Guidance on Social Responsibility

b) For Conflict minerals:

1) EU

2) US Conflict Minerals Rule – Section 1502

c) SA 8000

d) Institute for Supply Chain Management Ethics

e) SB 657 – The California Transparency in Supply Chains Act

f) International Labour Organization (ILO)

4.2.3.3 Materials obtained through methods that are not socially responsible (i.e. child labor or conflict minerals), yet are fully recoverable at end of use, shall not be considered circular in their first life cycle as their original extraction is not sustainable. Furthermore, the recovery process must adhere to the guidance above or it shall continue to be non-circular.

4.2.3.4 Materials of concern are substances that are very persistent and very bio-accumulative (VPVB) or that are determined to be a carcinogen, mutagen or reproductive toxin (CMR), as defined in one or more of the following authoritative list below:

a) CalSAFER Candidate Chemical List;

b) SVHC under REACH Regulation (Annex XIV of Regulation (EC) NO 1907/2006);

c) PBT under REACH Regulation (Annex XIII of Regulation (EC) NO 1907/2006);

d) GHS – specify classification levels: 1,2,3; or

e) Regionally accepted equivalent.

4.2.3.5 Depending on the material in use and its application in manufacturing and/or in product, some materials of concern identified in the selected list above may be eligible for consideration in the circular flow analysis as a circular input if its use and application are necessary to the function and/or enablement of the circular economy broadly, and the material is managed in a closed loop system. Provide the following documents per identified material of concern:

a) What is the material?

1) Any associated (Material) Safety Data Sheets [(M)SDS)]

2) Disclosure requirements, including the current composition approved for a market or application.

b) How is the material being used? Will it be used in the same way or new way in the future?

c) Is the material providing significant benefit to the circular economy which outweighs the risk of extending the use in the circular flow? For example, Solar panel manufacturing or wind turbine manufacturing may require the use of heavy metals or rare earth metals and may constitute a significant benefit to the circular economy.

When such considerations are used to disqualify a material, they shall be noted in any final assessment associated with the CTL.

4.2.4 Relationship between technical and biobased materials

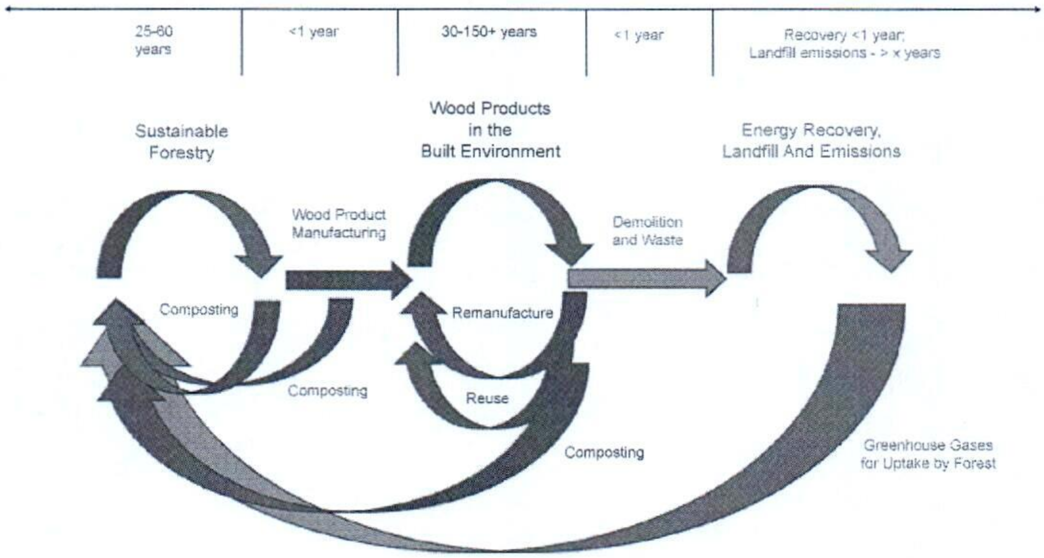
4.2.4.1 Once the material enters the Circular Economy, the downstream material flow shall be measured using the technical material metrics, e.g., recycled biobased content ($IP_{recyc\text{-}bio}$), recycled content (IP_{recyc}), reused content (IP_{reused}), and recyclability (OP_{recyc}).

Example 1: Recycled Biobased Content Example – A PET bottle, which upon visible inspection, has no way to distinguish between biobased and non-biobased materials. If known, the amount of recycled biobased content which is being recycled should be accounted for separately as recycled biobased content. The remainder should be accounted for as recycled content.

An example of biobased and technical material flow is shown in Figure 4.2.

Figure 4.2

Biobased and Technical Material Flows within the Wood Carbon Life Cycle



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NOTE: Circular materials are subdivided into biobased (green) and technical materials (blue); Non-circular flows are orange; Transition between biobased and technical flow is shown in brown.

4.3 Product material flows and circularity

4.3.1 General

4.3.1.1 Product material flows include those materials directly associated with the composition of products and their packaging.

4.3.1.2 Product circularity includes both an upstream and downstream component and is split into technical materials and biobased materials streams.

4.3.2 Product circularity metric considerations

4.3.2.1 Each inflow and outflow measure shall be calculated and reported in Table 9.1. All sources of materials, parts, and components making up the product and product primary package shall be included so that the total inflow or outflow adds up to 100 %. The percent for outflows and percent for inflows are averaged to get a combined Product Circularity rate.

4.4 Site material flows and circularity

4.4.1 General

4.4.1.1 Site circularity material flows include all material flows associated with a given site, excluding products and product packaging. Inflows at a site which become part of a product manufactured at the site are to be included in the product flows.

4.4.2 Site circularity metric considerations

4.4.2.1 For sites all the inflows (or outflows) must add up to 100 % and only the circular flows are used to calculate site material circularity rate. Each upstream and downstream measure shall be calculated and reported in Table 9.1. The percent for outflows and percent for inflows are averaged to get a combined Site Circularity rate, as calculated in 6.3.

4.5 Organization circularity

4.5.1 Circularity metrics for an organization are calculated by including multiple sites and/or products within the scope of the organization.

4.5.2 These calculations can be applied at a range of scopes within the organizational entity, as defined by the organization. For example:

a) One or more products – In this case, only those materials associated with the included product(s) are included in the calculation (top part of Figure 4.1). This includes both materials comprising the product(s) as well as associated packaging.

b) One or more sites – In this case, in addition to the product and or packaging related materials, other material flowing into/out of the site(s) are included in the calculation. For example, this would include waste materials that are disposed of, processing fluids, materials associated with site support activities, etc.

c) The entire organization – The organization may select to include only part of the total activities associated with the site(s) or organization. In any case the extent of the sites and products included in the assessment shall be clearly reported.

5 Product Material Flow Metrics

5.1 Product material inflow metrics

5.1.1 Technical material inflows

5.1.1.1 Recycled content

5.1.1.1.1 The inflow rate (IP_{recyc}) is the mass of recycled material inflow (ipm_{recyc}) divided by the mass of the product as a whole (ipm_{total}).

$$IP_{\text{recyc}} = \frac{ipm_{\text{recyc}}}{ipm_{\text{total}}}$$

5.1.1.2 Closed loop content

5.1.1.2.1 The inflow rate (IP_{closed}) is the mass of material that originates from a closed loop operation (ipm_{closed}) divided by the mass of the product as a whole (ipm_{total}):

$$IP_{\text{closed}} = \frac{ipm_{\text{closed}}}{ipm_{\text{total}}}$$

5.1.1.3 Product and component reuse

5.1.1.3.1 For reused content, the inflow rate (IP_{reused}) is the mass of reused material inflow (ipm_{reused}) divided by the mass of the product as a whole (ipm_{total}):

$$IP_{\text{reused}} = \frac{ipm_{\text{reused}}}{ipm_{\text{total}}}$$

5.1.1.4 Product and component refurbishment

5.1.1.4.1 For refurbished content, the inflow rate (IP_{refurb}) is the mass of refurbished material inflow (ipm_{refurb}) divided by the mass of the product as a whole (ipm_{total}):

$$IP_{\text{refurb}} = \frac{ipm_{\text{refurb}}}{ipm_{\text{total}}}$$

5.1.1.4.2 For 5.1.1.3 and 5.1.1.4, the following restrictions and additions apply:

a) The component, part, or product shall come from an established and documented reuse or refurbished system,

b) The part shall be previously discarded or have been salvaged from a discarded product, and

c) The mass of material is the mass of the part or component being reused or refurbished minus the mass added to the reused part during refurbishment and not from the originally discarded product.

5.1.1.5 Byproduct synergy

5.1.1.5.1 The byproduct synergy inflow rate ($IP_{byproduct/waste}$) is the mass of material that is a byproduct or waste used in lieu of linear content ($ipm_{byproduct/waste}$) divided by the mass of the product as a whole (ipm_{total}).

$$IP_{byproduct/waste} = \frac{ipm_{byproduct/waste}}{ipm_{total}}$$

5.1.1.5.2 The byproduct synergy mass inflows ($ipm_{byproduct/waste}$) are materials that:

a) Are unwanted byproducts or waste from a product or site that can be used as a primary resource with no (or very little) processing, and

b) Are not subjected to additional chemical or heating processing that could change the physical properties of the material to use it as a material input.

5.1.2 Biobased material inflows

5.1.2.1 Qualifying biobased material

5.1.2.1.1 Methods

5.1.2.1.1.1 When entering a Circular Economy metric system for the first-time, biobased material mass inflow (ipm_{bio}) shall be quantified by either:

a) Accordance with a chain-of-custody (CoC) standard, such as ISO 22095; or

b) A testing, inspection, or other verifiable method as a percent content by mass as determined in 5.1.2.1.2.

5.1.2.1.2 pMC

5.1.2.1.2.1 Methods to verify the amount of biobased material shall be performed according to one of the standards listed in Table 5.1.

Table 5.1
Methods to Determine Biobased Content

Standard	Applicable Methods
ISO 21644:2021 Solid recovered fuels – Methods for the determination of biomass content	SDM, MS, pmC
ASTM D6866 – Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis	pMC
EN 16640:2017 – Bio-based products – Bio-based carbon content – Determination of the bio-based carbon content using the radiocarbon method	pMC
NOTE: SDM = selective dissolution method; MS = manual sorting; pmC & pMC = percent modern carbon determined by C^{14} test	

5.1.2.2 Biobased content inflow rate

5.1.2.2.1 The inflow rate (IP_{bio}) is the inflow of mass of biobased material that originates from biobased sources (ipm_{bio}) divided by the mass of the product as a whole (ipm_{total}).

$$IP_{\text{bio}} = \frac{ipm_{\text{bio}}}{ipm_{\text{total}}}$$

Example: 25 % wheat chaff, 25 % rice hulls and 50 % fossil sources are used to produce ethanol. 50 % wheat chaff is converted while 75 % of the rice hulls mass is converted. The final product consists of 15 % biomass from wheat chaff, 23 % from rice hulls and 62 % fossil content.

5.1.2.3 Recycled biobased content inflow rate

5.1.2.3.1 The inflow rate ($IP_{\text{recyc-bio}}$) is the inflow of the mass of recycled biobased material that originates from a biological source and has been recycled ($ipm_{\text{recyc-bio}}$) divided by the mass of the product as a whole (ipm_{total}).

$$IP_{\text{recyc-bio}} = \frac{ipm_{\text{recyc-bio}}}{ipm_{\text{total}}}$$

5.1.3 Linear material inflow

5.1.3.1 Inflows (ipm_{linear}) are classified as non-circular; where the materials are composed of parts or components that do not meet any of the circular categories described in 5.1.1 or 5.1.2.

5.1.3.2 The inflow rate (IP_{linear}) is the mass of the linear material inflow (ipm_{linear}) divided by the inflow mass of the product as a whole (ipm_{total}).

$$IP_{\text{linear}} = \frac{ipm_{\text{linear}}}{ipm_{\text{total}}}$$

5.1.4 Total material inflow

5.1.4.1 Total material mass inflow

5.1.4.1.1 The total material inflow content is the mass of the entire product and its packaging:

$$ipm_{\text{total}} = ipm_{\text{bio}} + ipm_{\text{recyc-bio}} + ipm_{\text{recyc}} + ipm_{\text{reused}} + ipm_{\text{refurb}} + ipm_{\text{closed}} + ipm_{\text{byproduct/waste}} + ipm_{\text{linear}}$$

5.1.4.2 Total circular material flow rate

5.1.4.2.1 The total circular material inflow rate for the products (IP_{rate}) is the sum of the material inflow rates calculated in 5.1.1 – 5.1.2:

$$IP_{\text{rate}} = IP_{\text{bio}} + IP_{\text{recyc-bio}} + IP_{\text{recyc}} + IP_{\text{reused}} + IP_{\text{refurb}} + IP_{\text{closed}} + IP_{\text{byproduct/waste}}$$

5.2 Product material outflow metrics

5.2.1 Product technical material outflows

5.2.1.1 For each technical material outflow, the outflow rate is calculated as the mass percent of the total of all outflows (the finished product and any product packaging weight). The resulting content rates are calculated for the whole product and reported as a percentage of the whole product in the appropriate place in Table 10.1.

5.2.1.2 Recycled content outflow

5.2.1.2.1 The outflow rate (OP_{recyc}) is the mass of a product that is designed to be recycled (opm_{recyc}) divided by the mass of the product as a whole (opm_{total}).

$$OP_{recyc} = \frac{opm_{recyc}}{opm_{total}}$$

5.2.1.2.2 The mass of the product that is designed to be recycled (opm_{recyc}) shall be calculated using one of the following:

a) IEC TR 62635;

b) EN 45555; or

c) UL ECVP 2789

5.2.1.3 Reuse outflow

5.2.1.3.1 The sum of the mass of all the parts which are reused (opm_{reused}), is divided by the mass of the whole product (opm_{total}) to calculate the reuse rate (OP_{reused}).

$$OP_{reused} = \frac{opm_{reused}}{opm_{total}}$$

5.2.1.3.2 The following restrictions apply:

a) A substantial majority of the parts included in opm_{reused} shall be reused in well-established reuse networks, and

b) The recycler shall document the network of reuse through contracts or availability of parts commercially

5.2.1.4 Refurbished outflow

5.2.1.4.1 The outflow rate (OP_{refurb}) is the mass of a product that is designed to be refurbished and used again (opm_{refurb}) divided by the mass of the product as a whole (opm_{total}).

$$OP_{refurb} = \frac{opm_{refurb}}{opm_{total}}$$

5.2.1.4.2 The recycler shall document the network of refurbishment through contracts or availability of parts commercially.

5.2.1.5 Closed loop outflow

5.2.1.5.1 The outflow rate (OP_{closed}) is the mass of materials designed to be part of a closed loop operation (opm_{closed}) divided by the mass of the product as a whole (opm_{total}).

$$OP_{closed} = \frac{opm_{closed}}{opm_{total}}$$

5.2.1.5.2 The following restrictions apply:

a) Materials can be considered for this category only when a substantial majority of material with the same material formulation or composition is part of a closed loop system in a well-established closed loop network; and

b) The recycler shall document the network of the closed loop system through contracts or availability of parts certified to contain closed loop material originating from this or functionally equivalent component.

5.2.1.6 Biobased materials exiting technical material flow

5.2.1.6.1 Each biobased material outflow rate is calculated as the mass percent of the total of all inflows (the finished product weight). The resulting content rates are calculated for the whole product (including packaging) and reported as a percentage of the whole product in the appropriate place in Table 10.1.

5.2.1.6.2 Any biobased material that is not accounted for in the ongoing technical material flows shall be tracked and disposition documented. Disposition upon exit from technical flows shall be segregated by mass into the following categories:

a) Soil amendments: Any biobased material that is expressly used as an input amendment to substrates used to grow new biomass shall be treated as biodegradable and tested for biodegradability.

b) Atmosphere: Any biobased material which goes directly from the technical cycle to the atmosphere, shall be documented in terms of form, quantity, and average residence time in atmosphere (with citation of reference used for residence time, as per example: https://archive.ipcc.ch/ipccreports/tar/wg1/016.htm)

c) Other: Any biobased material leaving the technical cycle and not accounted for in a) or b) shall be documented in terms of mass with disposition in (i) other terrestrial systems, (ii) aquatic/marine systems, (iii) other (defined by user). In these cases, the material shall also be tested for biodegradability according to the method in Table 5.2 matching the expected disposition route.

Table 5.2
Biodegradability Test Methods

Environment	Acceptable Test Methods
Freshwater	OECD 301, ISO 9439, ISO 14593
Freshwater Sediments	ISO 14851, ISO 14852
Salt Water	ISO 14852, ASTM D6691-17 Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials in the Marine Environment by a Defined Microbial Consortium or Natural Sea Water Inoculum
Saltwater Sediments	ASTM D7991-15 Standard Test Method for Determining Aerobic Biodegradation of Plastics Buried in Sandy Marine Sediment under Controlled Laboratory Conditions
Compostability	ISO 14855-1, ASTM D6400
Soil Aerobic biodegradation	ASTM D5988-18 Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials in Soil, ISO 14852

5.2.2 Product biobased material outflows

5.2.2.1 Biochemical content

5.2.2.1.1 The outflow rate ($OP_{biochem}$) is the mass of biobased material outflow designed to be used as a source of biochemicals at end of life ($opm_{biochem}$) divided by the mass of the product as a whole (opm_{total}).

$$OP_{\text{biochem}} = \frac{opm_{\text{biochem}}}{opm_{\text{total}}}$$

5.2.2.2 Anaerobic content

5.2.2.2.1 The outflow rate ($OP_{anaerobic}$) is the mass of biobased material outflow designed to be anaerobically digested at end of life ($opm_{anearobic}$) divided by the mass of the product as a whole (opm_{total}).

$$OP_{\text{anaerobic}} = \frac{opm_{\text{anaerobic}}}{opm_{\text{total}}}$$

5.2.2.3 Compost content

5.2.2.3.1 The outflow rate ($OP_{compost}$) is the mass of biobased material outflow designed to be composted at end of life ($opm_{compost}$) divided by the mass of the product as a whole (opm_{total}).

$$OP_{\text{compost}} = \frac{opm_{\text{compost}}}{opm_{\text{total}}}$$

5.2.2.4 Recycled biobased content

5.2.2.4.1 The outflow rate ($OP_{recyc\text{-}bio}$) is the mass of material outflow from a biobased source and is designed to be recycled ($opm_{recyc\text{-}bio}$) divided by the mass of the product as a whole (opm_{total}).

$$OP_{\text{recyc-bio}} = \frac{opm_{\text{recyc-bio}}}{opm_{\text{total}}}$$

5.2.3 Linear product material outflow

5.2.3.1 For linear product materials, outflows (opm_{linear}) are classified as non-circular; where the materials are composed of parts or components that do not meet any of the circular categories described in 5.2.1 or 5.2.2.

5.2.3.2 Linear product material outflow rate

5.2.3.2.1 For a product's linear material content, the outflow rate (OP_{linear}) is the mass of the linear material outflow (opm_{linear}) divided by the mass of the product as a whole (opm_{total}).

$$OP_{\text{linear}} = \frac{opm_{\text{linear}}}{opm_{\text{total}}}$$

5.2.4 Total material outflow

5.2.4.1 Total material outflow

5.2.4.1.1 The total material outflow is the mass of the entire product and its packaging:

$$opm_{\text{total}} = opm_{\text{biochem}} + opm_{\text{anaerobic}} + opm_{\text{compost}} + opm_{\text{recyc-bio}} + opm_{\text{recyc}} + opm_{\text{reused}} + opm_{\text{refurb}} + opm_{\text{closed}} + opm_{\text{linear}}$$

NOTE: opm_{total} and ipm_{total} should be the same as the sum of the mass in and out of the system is the same.

5.2.4.2 Total circular material outflow rate

5.2.4.2.1 The total circular material outflow rate for the products (OP_{rate}) is the sum of the material outflow rates calculated in 5.2.1 – 5.2.2:

$$OP_{\text{rate}} = OP_{\text{biochem}} + OP_{\text{anaerobic}} + OP_{\text{compost}} + OP_{\text{recyc-bio}} + OP_{\text{recyc}} + OP_{\text{reused}} + OP_{\text{refurb}} + OP_{\text{closed}}$$

5.3 Product circularity metrics

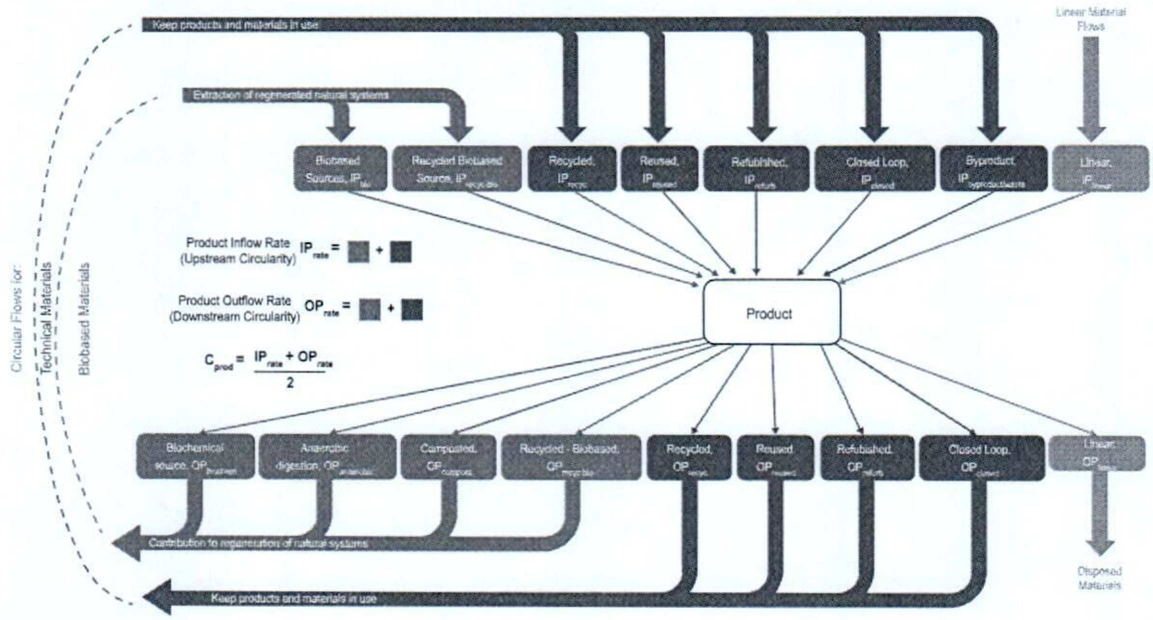
5.3.1 The Product Circularity (C_{prod}) (defined in 4.3.2) is the average of total material inflow rate (calculated in 5.1.4.2) and outflow rate (calculated in 5.2.4.2) rates.

$$C_{\text{prod}} = \frac{IP_{\text{rate}} + OP_{\text{rate}}}{2}$$

5.3.2 Visual representations of the product circularity material flows can be seen in Figure 5.3.

Figure 5.3

Product Circularity Material Metric Flows



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6 Site Material Flow Metrics

6.1 Site circular material inflow metrics

6.1.1 Both Technical and Biobased Material inflows for sites are measured using the same methods and rules as for products, as described in 5.1.1 and 5.1.2. In all cases the variable names used for product inputs IP_{xx} and ipm_{xx} shall be replaced with IS_{xx} and ism_{xx}.

6.1.2 The total circular material inflow rate for the site (IS_{rate}) is the sum of the material inflow rates:

$$IS_{\text{rate}} = IS_{\text{bio}} + IS_{\text{recyc-bio}} + IS_{\text{recyc}} + IS_{\text{reused}} + IS_{\text{refurb}} + IS_{\text{closed}} + IS_{\text{byproduct/waste}}$$

6.2 Site material outflow metrics

6.2.1 Material outflow for a Site is unrelated to material for products or their packaging.

6.2.2 The resulting material content rates (OS_{xx}) are calculated for the whole site (excluding products and their packaging) and reported as a percentage of the whole site. These rate calculations are shown in Table 10.3.

6.2.3 While the outflow for products is measured based on expected fate of the materials, as intended by the design, sites are measured by the actual fate of the materials. Only materials that are sent for recycling, reuse or otherwise diverted from landfill or incineration (with or without energy recovery) are considered circular.

6.2.4 The following requirements apply to all outflows from sites:

a) The material outflow being evaluated for reuse shall be managed by acceptable means of diversion, such as UL ECVP 2799 or equivalent;

b) Materials being sent directly for use as Alternative Daily Cover without further processing are not considered beneficially reused;

c) US EPA "Measuring Recycling: A Guide for State and Local Governments" volume to weight conversion factors;

d) Measurements or studies specific to the material to be recycled, and

e) The outgoing material shall meet the material acceptance requirements of the diverting entity or material processor for that discarded material. Any materials accepted by the diverting entity are considered acceptably processed if the final disposal includes routes other than landfill or thermal processing without energy recovery.

6.2.5 Technical material outflows

6.2.5.1 Recycling

6.2.5.1.1 The mass of recovered or reclaimed material sent for reprocessing into a raw material or input for downstream manufacturing processes (osm_{recyc}).

NOTE: Mass of discarded materials being sent to recovery through Byproduct Synergies are also included in osm_{recyc}

6.2.5.1.2 If estimation is used to calculate osm_{recyc} the following method shall be used:

The sum of the mass of all the parts which are recycled (osm_{recyc}) is divided by the mass of the whole site (osm_{total}) to calculate the recycle rate (OS_{recyc}).

$$OS_{\text{recyc}} = \frac{osm_{\text{recyc}}}{osm_{\text{total}}}$$

6.2.5.2 Reuse

6.2.5.2.1 The material outflow is calculated by multiplying the mass of materials to be reused by the number of reuses:

$$osm_{\text{reused}} = reuses \times m_{\text{per reuse}}$$

6.2.5.2.2 For osm_{reused} the following requirements apply:

a) External reuse, by returning to a supplier, is included in osm_{reuse}; and

b) Once a reused resource can no longer be reused, it now becomes waste in one of the other categories (waste to landfill, recycled or other).

6.2.5.2.3 The sum of the mass of all the parts which are reused (osm_{reused}), is divided by the mass of the whole site (osm_{total}) to calculate the reuse rate (OS_{reused}).

$$OS_{\text{reused}} = \frac{osm_{\text{reused}}}{osm_{\text{total}}}$$

6.2.5.3 Closed loop outflow

6.2.5.3.1 The outflow rate (OS_{closed}) is material sent to closed loop recycling operation for the site (osm_{closed}) divided by the mass of the site as a whole (osm_{total}).

$$OS_{\text{closed}} = \frac{osm_{\text{closed}}}{osm_{\text{total}}}$$

6.2.5.4 Byproduct outflow

6.2.5.4.1 The outflow rate for a Site ($OS_{byproduct/waste}$) is material sent to another site to be used as a raw material for production of new product(s) ($osm_{byproduct/waste}$), divided by the mass of the site as a whole (osm_{total}).

$$OS_{\text{byproduct / waste}} = \frac{osm_{\text{byproduct / waste}}}{osm_{\text{total}}}$$

6.2.6 Biobased material outflows

6.2.6.1 Biochemical material outflow

6.2.6.1.1 The outflow rate for a Site ($OS_{biochem}$) is material sent for processing to extract useful biochemicals before further processing ($osm_{biochem}$), divided by the mass of the site as a whole (osm_{total}).

$$OS_{\text{biochem}} = \frac{osm_{\text{biochem}}}{osm_{\text{total}}}$$

6.2.6.2 Biofuel material outflow

6.2.6.2.1 The outflow rate for a Site ($OS_{biofuel}$) is material produced from biomass being sent for manufacture of or for use directly as a fuel ($osm_{biofuel}$), divided by the mass of the site as a whole (osm_{total}).

$$OS_{\text{biofuel}} = \frac{osm_{\text{biofuel}}}{osm_{\text{total}}}$$

6.2.6.3 Anaerobic material outflow

6.2.6.3.1 The outflow rate for a Site ($OS_{anaerobic}$) is material sent for anaerobic digestion with energy recovery ($osm_{anaerobic}$), divided by the mass of the site as a whole (osm_{total}).

$$OS_{\text{anaerobic}} = \frac{osm_{\text{anaerobic}}}{osm_{\text{total}}}$$

6.2.6.4 Composting material outflow

6.2.6.4.1 The outflow rate for a Site ($OS_{compost}$) is the mass of discarded material which has been sent for processing to create decomposed organic material that is produced when bacteria and soil break down garbage and biodegradable trash, making organic fertilizer ($osm_{compost}$), divided by the mass of the site as a whole (osm_{total}).

$$OS_{\text{compost}} = \frac{osm_{\text{compost}}}{osm_{\text{total}}}$$

6.2.6.5 Recycling material outflow

6.2.6.5.1 The mass of material outflow that originates from a biological source and is sent for reprocessing into a raw material or input for downstream manufacturing processes ($osm_{recyc\text{-}bio}$).

NOTE: Mass of discarded materials being sent to recovery through Byproduct Synergies are also included in $osm_{recyc\text{-}bio}$.

6.2.6.5.2 The sum of the mass of all the parts which are recycled biobased materials ($osm_{recyc\text{-}bio}$) is divided by the mass of the whole site (osm_{total}) to calculate the recycle rate ($OS_{recyc\text{-}bio}$).

$$OS_{\text{recyc-bio}} = \frac{osm_{\text{recyc-bio}}}{osm_{\text{total}}}$$

6.2.7 Linear material outflow

6.2.7.1 Landfill content

6.2.7.1.1 The outflow rate for a Site ($OS_{landfill}$) is the mass of material that has been disposed of in any type of landfill governed by local, regional or national government requirements ($osm_{landfill}$), divided by the mass of the site as a whole (osm_{total}).

$$OS_{\text{landfill}} = \frac{osm_{\text{landfill}}}{osm_{\text{total}}}$$

6.2.7.2 Thermal with energy recovery

6.2.7.2.1 The outflow rate for a Site (OS_{TWER}) is the mass of discarded materials sent for thermal processing with energy recovery (osm_{TWER}), divided by the mass of the site as a whole (osm_{total}).

$$OS_{TWER} = \frac{osm_{TWER}}{osm_{total}}$$

6.2.7.3 Thermal without energy recovery

6.2.7.3.1 The outflow rate for a Site ($OS_{thermal/o}$) is the total mass of solid waste that has been thermally processed in a facility that does not recover ($osm_{thermalw/o}$), divided by the mass of the site as a whole (osm_{total}).

$$OS_{thermalw/o} = \frac{osm_{thermalw/o}}{osm_{total}}$$

6.2.7.4 Total linear material outflow

6.2.7.4.1 The linear material outflow (osm_{linear}) is the mass of material outflow calculated in 6.2.7.1 – 6.2.7.3.

$$osm_{linear} = osm_{landfill} + osm_{TWER} + osm_{thermalw/o}$$

NOTE: Excluded linear content should not be factored into the equation.

6.2.8 Total material outflow

6.2.8.1 Total material outflow

6.2.8.1.1 The total material outflow of the site (osm_{total}) is the total mass of material outflow not related to a product or its packaging:

$$osm_{total} = osm_{biochem} + osm_{biofuel} + osm_{anaerobic} + osm_{compost} + osm_{recyc\text{-}bio} + osm_{recyc} + osm_{reused} + osm_{close} + osm_{byproduct/waste} + osm_{linear}$$

6.2.8.2 Total circular material outflow rate

6.2.8.2.1 The total circular outflow rate for the site (OS_{rate}) is the sum of the material outflow rates calculated in 6.2.5 – 6.2.6:

$$OS_{rate} = os_{recyc} + os_{reused} + os_{closed} + os_{byproduct/waste} + os_{biochem} + os_{biofuel} + os_{compost} + os_{anaerobic} + os_{recyc\text{-}bio}$$

6.3 Site circularity metrics

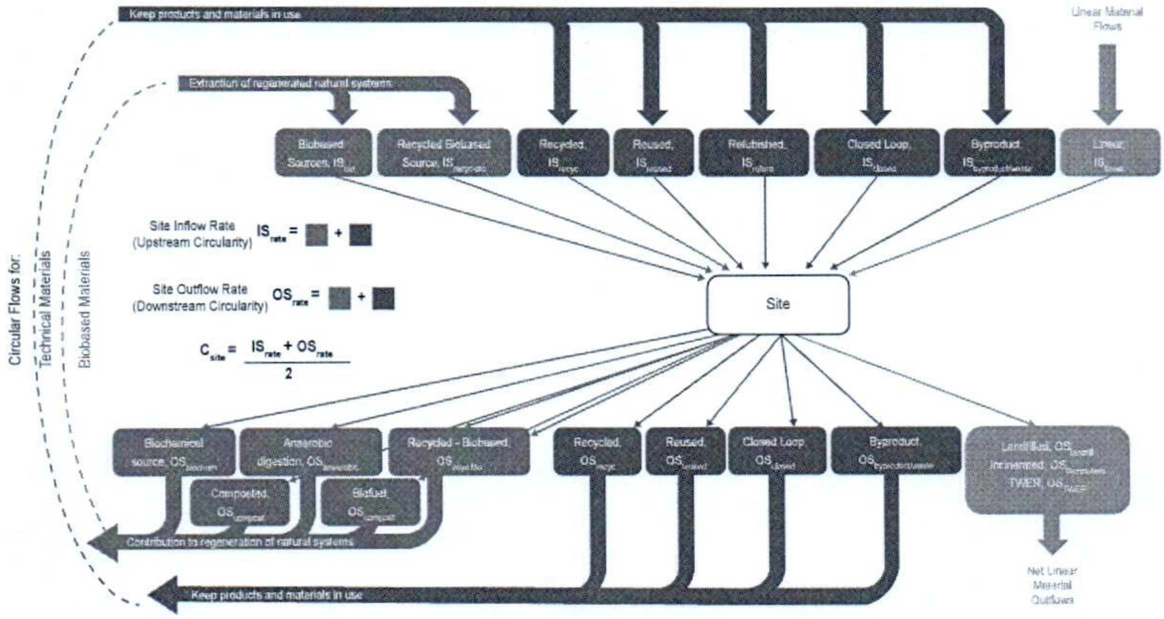
6.3.1 The Site Circularity Rate (C_{site}) (defined in 4.4.2) is the average of total material inflow rate (calculated in 6.1) and outflow rate (calculated in 6.2.8.2) rates.

$$C_{site} = \frac{IS_{rate} + OS_{rate}}{2}$$

6.3.2 Visual representations of the site circularity material flows and site circularity for discarded material flows can be seen in Figure 6.1.

Figure 6.1

Site Circularity for Material Flows



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7 Organizational Circularity Metrics

7.1 Percentage of organization efforts included in the CTL

7.1.1 The percent of organizational activity within the scope of the assessment shall be included as part of the project report. Organizations may select to include only parts of the total activities that impact the Circularity results. When less than the whole organization activities are reported, the activities (products and sites) can be reported as either a list of products and sites or as a percentage of the estimated total activities. Sites can be reported as either the percentage of buildings, sites or separate entities. Products can be reported as a percent of total production using a representative metric, for instance, as a percent of mass of product.

7.2 Product portfolio circularity

7.2.1 The mass weighted average of the individual product circularity (C_{prod}, equation defined in 5.3) is used to calculate product portfolio circularity. The mass is the total mass product produced during the specified measurement period. Products are assessed as outlined in the section below on product circularity.

$$ProductPortfolioCircularity = \frac{\Sigma_{\text{All Products}}(C_{\text{prod}} \times Mass\,ProductShipped)}{MassAllProductsShippedtoMarket}$$

7.2.2 Similar to waste diversion, not all products will have circularity measured. A statement of progress (i.e., 10 of 100 products have been measured to date) shall also be included in the description of product performance.

7.3 Organization site circularity rate

7.3.1 Company level site circularity is the mass weighted average of the site circularity rate (C_{site}) measured for each site (equation defined in 6.3). Company level site circularity shall only reflect the portions of the company that have been measured as specified in the scope. A statement of progress (i.e., 10 of 100 sites have been measured to date) shall also be included in the description of the performance. A statement of the sites included in the evaluation shall also be included.

$$Site\,PortfolioCircularity = \frac{\Sigma_{\text{All Products}}(C_{\text{site}} \times MassMaterials\,Used)}{MassAllMaterialUsed}$$

7.4 Organization circularity

7.4.1 The final circularity assessment is the straight average of the product portfolio circularity and the organization waste diversion, resulting in an assessment from 0 to 100 % circular.

$$OrganizationCircularity = \frac{(Site\,PortfolioCircularity + ProductPortfolioCircularity)}{2}$$

7.4.2 In all cases where a procedure or standard is referenced to calculate circular inflows or outflows, equivalent methods or procedures may be used. When methods not referenced in this standard are used, they shall be documented in the CTL.

8 Social Impact

8.1 This section covers the methods and metrics for measuring the social aspects of the circular economy.

8.2 To capture a product's, site's, or organization's existing social efforts regarding Diversity, Equity, and Inclusion (DEI) and Human Rights, and apply it to the assessment rubric, while also determining which Tier (Sphere) the social impact information is applicable to. DEI, as it applies in this Standard, refers to taking a social inclusion and equal opportunity lens to product design, site and/or organization. Inclusive and equitable product design shall specifically aim to lower barriers to access for users of varied racial, ethnic, cultural, economic, and social affiliation. At an institutional level, DEI refers broadly to policies and practices that protect differences and prohibit and remedy any form of discrimination.

8.3 The questions in Table 10.5, Table 10.6, and Table 10.7 shall be used to develop the Circularity Transparency Labeling input for the product, site, and/or organization.

8.4 The list below identifies some standards and guides to follow. Equivalent options may be pursued:

a) SA8000

b) ISO 26000

c) MSCI ESG Ratings

d) RBA Code of Conduct

e) ISO 59014

9 Environmental Impacts

9.1 General

9.1.1 The intent of this section is to establish an environmental impact inventory for a product and/or product family, site or across and organization's facility boundaries and product lines.

9.1.2 9.2 through 9.4 shall be optional if no applicable environmental impact data is available. However, inclusion of environmental impact data provides an additional layer of reporting, allowing for a comprehensive view of a product's lifecycle impacts or a site and organization's performance as it relates to circularity thus enabling more informed decision making on the part of the consumer.

9.2 Product or product family

9.2.1 Data or results shall be provided from a cradle-to-cradle LCA on the product or product family proposed for the UL 3600 circularity transparency label. The LCA model shall use the parameters reported in Section 4, and shall be in accordance with ISO 14040, ISO 14044 and ISO 14025.

9.2.2 A cradle-to-cradle LCA is reasonable alternative when embodied energy of components going into a product is unavailable.

Embodied energy of product as a whole = (incoming part embodied energy) + (energy at site of manufacturing)

Embodied water of product as a whole = (incoming part embodied water) + (water at site of manufacturing)

Embodied ghg of product as a whole = (incoming part embodied ghg) + (ghg at site of manufacturing)

Report the results, as per Table 10.2, from the LCA across the entire value chain for Primary Energy (mJ), water consumption (L) and Greenhouse Gas Emissions (MT or kg CO_2eq) utilization.

9.3 Site

9.3.1 Energy use, water use and GHG emissions for the site shall be reported. For energy use and GHG emissions, measurements shall be in accordance with the Greenhouse Gas Protocol. For water use, measurements shall be in accordance with the methods used in FAO Water Report 43 water accounting. Report the results as shown on Table 10.4.

9.4 Organization

9.4.1 Energy use, water use and GHG emissions for the organizational portfolio shall be reported. For energy use and GHG emissions, measurements shall be in accordance with the Greenhouse Gas Protocol. For water use, measurements shall be in accordance with methods used in FAO Water Report 43 for water accounting. To account for portfolio level product circularity, and LCA per product or product family is needed and production volume for each product or product family on an annual basis.

NOTE: One LCA can be representative of multiple SKUs, providing minimal modifications such as color, aesthetic variance, or grouped within a product family.

Table 9.1

All products	Units	= LCA Product 1 x Annual Product Volume	= LCA Product 2, 3... x Annual Product Volume	Total
Energy use	MJ			
Energy procured from a renewable source	In percentage with respect to energy use above			
Water use	L			
GHG emissions	MT or kg CO_2eq			

Table 9.2

All sites in scope	Units	Site 1	Site 2, 3...	Total
Energy use	MJ			
Energy procured from a renewable source	In percentage with respect to energy use above			
Water use	L			
GHG emissions (Scope 1 & 2)	MT or kg CO_2eq			

9.4.2 Sphere 1 energy consumption

9.4.2.1 To capture the Sphere 1 total energy consumption, use scope 1 and scope 2 emissions accounting based on the WRI/WBCSD GHG protocol per site, owned and managed, plus the lifetime energy consumption of the product(s) based on ENERGY STAR ® lifetime energy use if available or equivalent method as the following:

a) LEED Building Standard

b) EU Protocols, such as

1) ISO 14066,

2) ISO 14067, and/or

3) ISO 14068

c) GRI (Global Reporting Initiative).

9.4.2.2 The energy consumption, as shown on Table 9.1 and Table 9.2, shall be captured at the research and design, engineering, manufacturing, logistics, warehouses, and all other levels/phases owned by the company. Shall there be a question on ownership boundaries, refer to the GHG Protocol Chapter 3 and/or 4.

9.4.2.3 Shall renewable energy be used, record what proportion of energy consumption is sourced from renewable energy. Provide energy portfolio for sufficient documentation and determination of renewable energy percentage input for Table 9.1 and Table 9.2 to capture overarching sustainability initiatives at the site, product, organization level.

9.4.3 Sphere 1 water usage

9.4.3.1 To capture Sphere 1 total water usage, use water use per site, owned and managed, plus the expected lifetime water use of the product(s) based on existing methods like the following and disclose:

a) ENERGY STAR ® Lifetime

b) ISO 14046 Environmental management – Water footprint – Principles, requirements and guidelines

c) IFRS – International Financial Reporting Standards

d) BREEAM

9.4.3.2 The water usage as shown on Table 9.1 and Table 9.2, shall be captured at the research and design, engineering, manufacturing, logistics, warehouses, and all other levels/phases owned by the company.

9.4.4 Sphere 1 Greenhouse Gas Emissions

9.4.4.1 To capture Sphere 1 total greenhouse gas emissions, use scope 1 and scope 2 emissions accounting based on the WRI/WBCSD GHG protocol and/or ISO 14067 per site, owned and managed, plus the expected greenhouse gas emissions of the product(s) based on existing methods such as the following:

a) ENERGY STAR ® Lifetime

b) LEED Building Standard

c) EU Protocols, such as

1) ISO 14066,

2) ISO 14067, and/or

3) ISO 14068

d) GRI (Global Reporting Initiative).

9.4.4.2 The GHG emissions, as shown on Table 9.1 and Table 9.2, shall be captured at the research and design, engineering, manufacturing, logistics, warehouses, and all other levels/phases owned by the company. For Sphere 2 and Sphere 3, use methods as explained in Clauses 9.4.2 – 9.4.4, per boundaries for Sphere 2 and Sphere 3 as defined in Figure 1, Introduction section.

10 Circularity Transparency Labelling

10.1 General

10.1.1 Using the data generated in Sections 5 through 9, Measurement Methods, the user shall be able to generate a Circularity Transparency Label giving a baseline for the circularity of a product, site, or organization, as described in this Section.

10.2 Determining the circularity transparency label

10.2.1 Product materials impact

10.2.1.1 Materials impact is measured in Section 5. The results shall be presented in Table 10.1 and Table 10.2.

Table 10.1
Circularity Metrics for Products

	Inflow	Outflow
Technical Materials Circularity		
Mass Percent from Recycled content or Estimated Recycling Rate	IP_{recyc}	OP_{recyc}
Mass Percent from Closed Loop System	IP_{closed}	OP_{closed}
Mass Percent from Product and Component Reuse	IP_{reused}	OP_{reused}
Mass Percent from Refurbished content	IP_{refurb}	$O_{Prefurb}$
Mass Percent from Byproduct synergy content	$IP_{byproduct/waste}$	—
Biobased Materials Circularity		
Biobased Material Content	IP_{bio}	$OP_{biochem}$
Recycled Biobased	$IP_{recyc\text{-}bio}$	$OP_{recyc\text{-}bio}$
Composting	–	$OP_{compost}$
Anaerobic Digestion	–	$OP_{anaerobic}$
Flow Rate	IP_{rate}	OP_{rate}
Linear Consumption	**$100 - IP_{rate}$**	**$100 - OP_{rate}$**
Product Circularity	C_{prod}	

Table 10.2
LCA Metrics for Products

	Units	Total
Primary Energy	MJ	
Water Consumption	L	
Greenhouse Gas Emmisions	MT or kg CO_2eq	

10.2.2 Site materials impact

10.2.2.1 Site materials impact is measured in Section 6. The results shall be presented in Table 10.3 and Table 10.4.

Table 10.3
Circularity Metrics for Sites

	Inflow (same as for IP_{xx})	Outflow
Technical Materials Circularity		
Mass Percent from Recycled content or Estimated Recycling Rate	IS_{recyc}	OS_{recyc}
Mass Percent from Product and Component Reuse	IS_{reused}	OS_{reused}
Mass Percent from Product and Component Refurbishment	IS_{refurb}	–
Mass Percent from Closed Loop System	IS_{closed}	OS_{closed}
Mass Percent from Byproduct	$IS_{byproduct/waste}$	$OS_{byproduct/waste}$
Biobased Materials Circularity		
Biobased Material Content	IS_{bio}	$OS_{biochem}$
Biofuel	–	$OS_{biofuel}$
Composting	–	$OS_{compost}$
Anaerobic Digestion	–	$OS_{anaerobic}$
Recycled Biobased	$IS_{recyc\text{-}bio}$	$OS_{recyc\text{-}bio}$
Input and Output Flow Rate	IS_{rate}	OS_{rate}
Linear Material Flows		
Landfill	–	$OS_{landfill}$
Flow Rate	–	OS_{TWER}
Thermal processing without energy recovery	–	$OS_{Thermal\ w/o}$
Linear Consumption	$100 - IS_{rate}$	$100 - OS_{rate}$
Site Circularity	C_{site}	

Table 10.4
Environmental Impacts for Sites

	Units	Total
Energy use	MJ	
Water use	L	
GHG emissions (Scope 1 & 2)	MT or kg CO_2eq	

10.2.3 Social impact

10.2.3.1 If the answer to the question in Table 10.5, Table 10.6, and Table 10.7 is Yes, a value of 100 % shall be given. If the answer is No, a value of 0 % shall be given.

Table 10.5
Social Impact Label, Sphere 1

Questions – Sphere 1	Yes (100 %)	No (0 %)
Does your organization include Diversity, Equity, and Inclusion (DEI) metrics in financial disclosure reports?		
Does your organization publicly disclose a human rights policy?		

Table 10.6
Social Impact Label, Sphere 2

Questions – Tier 1/Sphere 2	Yes (100 %)	No (0 %)
Do your Tier 1 suppliers (Sphere 2) include DEI metrics in their financial disclosure reports?		
Do your Tier 1 suppliers (Sphere 2) publicly disclose a human rights policy?		

Table 10.7
Social Impact Label, Sphere 3

Questions – Tier 2+/Sphere 3	Yes (100 %)	No (0 %)
Do your Tier 2+ suppliers (Sphere 3) include DEI metrics in their financial disclosure reports?		
Do your Tier 2+ suppliers (Sphere 3) publicly disclose a human rights policy		

Annex A
(Informative)

Sustainably Sourced Material Standards and Certifications

A.1 Sustainably Sourced Biobased Materials

A.1.1 Voluntary certification schemes approved by the European Commission (EC) for sustainable biomass are acceptable for documenting sustainably sourced biobased materials. Current approved schemes can be found at https://ec.europa.eu/energy/topics/renewable-energy/biofuels/voluntary-schemes_en

A.2 Wood Procured in Canada and USA

A.2.1 ASTM D7612-10 balloted standards categories (1. Legal, 2. Responsible, 3. Certified) are acceptable. Risk based approaches for accepting 1. Legal and 2. Responsible sources in all other countries shall be employed. Examples of risk-based approaches for non-North American wood include World Resources Institute Forest Legality Initiative or the American National Standard for Due Diligence in Procuring/Sourcing Legal Timber, ANS LTDD 1.0.

A.3 Certification for Biomass

A.3.1 Certification systems and Certification Level for known sustainably sourced biomass are referenced in Annex A, Table A.1. Additional systems may be included if they meet the requirements of the UNFCCC system or are accepted by the European Council.

Table A.1
Sustainably Sourced Material Standards

Biobased Source	Standard	Acceptable Certification Level
Any woody or cellulosic residue used for solid biomass fuel	Dutch SDE+ (Standard for Stimulation of Sustainable Bioenergy Production) provides sustainability requirements for solid biomass(1)	Compliance with SDE+ standard meets requirements of other jurisdictions in EU
Wood Fiber Certification Systems	Forest Stewardship Council (FSC) The remaining 47 FSC standards (outside of North America) have not been reviewed and may be acceptable	FSC Canada FSC United States
	Programme for the Endorsement of Forest Certification (PEFC) The remaining 53 PEFC standards (outside of North America) have not been reviewed and may be acceptable	American Tree Farm System (ATFS) Canadian Standards Association Sustainable Forest Management Standard Z-809 (CSA-SFM) Sustainable Forestry Initiative Forest Management Standard
	SFI 2015-2019 FOREST MANAGEMENT STANDARD	
Agriculture Sources (Soy, Corn, Switchgrass, Sugarcane)	RED2	RED2 as applied to Article 26 of DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018 on the promotion of the use of energy from renewable sources
Note on use of crop residues: Quantitative indicators such as Soil conditioning index (SCI), and Soil Erosion (SE) had been used to define the sustainable removal of crop residues from cropland [1,2]. The SCI does not indicate a desirable or target level of soil organic matter, but it will predict if a particular management system in cropland will have a positive or negative effect on SOM [3]. The rate of crop residue removal can be defined as sustainable if the removal of crop residues at this rate keeps the SE below the threshold values (T) and the SCI index remains above zero [4]. The tools used to estimate the SE and SCI index are the Revised Universal Soil Loss		

Table A.1 Continued on Next Page

Table A.1 Continued

Biobased Source	Standard	Acceptable Certification Level
Equation, Version 2 (RUSLE2), and Wind Erosion Prediction System (WEPS) [2]. The detailed descriptions of using RUSLE2 to estimate SE and SCI index can be found at http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm. The detailed description on WEPS can be found at https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/tools/weps/		
References: [1] Muth DJ, Bryden KM, Nelson RG. Sustainable agricultural residue removal for bioenergy: A spatially comprehensive US national assessment. Applied Energy. 2013;102:403-17. [2] Langholtz M, Stokes B, Eaton L. 2016 Billion-ton report: Advancing domestic resources for a thriving bioeconomy, Volume 1: Economic availability of feedstock. Oak Ridge, TN: Oak Ridge National Laboratory; 2016. p. 448p. [3] Franzluebbers AJ, Causarano HJ, Norfleet ML. Calibration of the soil conditioning index (SCI) to soil organic carbon in the southeastern USA. Plant and Soil. 2011;338:223-32 [4] Muth DJ, Bryden KM. An integrated model for assessment of sustainable agricultural residue removal limits for bioenergy systems. Environmental Modelling & Software. 2013;39:50-69.		

1603 Orrington Ave, Suite 2000
Evanston, Illinois 60201
224.714.4901