Designation: E3256 – 20

Standard Practice for Reference Scenarios When Evaluating the Relative Sustainability of Bioproducts[1]

This standard is issued under the fixed designation E3256; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice provides guidelines and criteria to follow when selecting reference scenarios, utilizing science-based measurable indicators, to facilitate a transparent and replicable comparison.

1.1.1 It is a common desire for decision makers, researchers, and others to assess the effects of bioproducts. Such assessments inherently require the comparison of conditions under a system with the bioproduct (test scenario) to a system without the bioproduct (the reference scenario).

1.1.2 This practice is applicable, but not limited to, life-cycle assessments (LCA), sustainability analyses, and techno-economic assessments (TEA).

1.2 This practice provides consistent terminology for use with the test and reference scenario. The terminology used in this practice may be used in other documents and by other practitioners with alternate definitions.

1.3 This practice is applicable whenever the test or reference scenario involves biomass directly or energy or industrial chemicals from biomass.

1.4 This practice provides guidelines for developing and documenting reference scenarios that represent the best available data and projections for what is expected to occur in the absence of the biomass-based test scenario to be evaluated.

1.5 The practice is applicable to:

1.5.1 Reviews and evaluations of the suitability of the reference scenario selected for an existing study or comparison.

1.5.2 All biomass-based production systems and materials, including forestry, agriculture, algae, co-products, and wastes.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1705 Terminology Relating to Biotechnology

E3066 Practice for Evaluating Relative Sustainability Involving Energy or Chemicals from Biomass

3. Terminology

3.1 For general terminology, refer to Terminology E1705.

NOTE 1—The user is advised that the definitions used by various industries, marketers, and regulatory bodies can differ from those in this practice. It is the responsibility of the user to ensure that terms used in a particular context are clearly understood.

3.2 *Definitions:*

3.2.1 *baseline, n*—clearly defined data for each of the selected indicators that document trends and conditions prior to the test period.

3.2.1.1 *Discussion*—Baselines are developed from historical data and may include both observed and modeled conditions that are relevant to the assessment. Baselines are associated with a period up to the defined starting point of the test period.

3.2.1.2 *Discussion*—For assessment purposes, baselines should be examined for their relevance to the assessment context. Baselines should be documented in source materials (verifiable data sets or published in peer-reviewed literature) and represent historical evidence. Relevant socio-economic conditions, such as economic growth, market demand, population dynamics as well as environmental conditions, such as climate can impact indicators and must be included in baselines if available.

[1] This practice is under the jurisdiction of ASTM Committee E48 on Bioenergy and Industrial Chemicals from Biomass and is the direct responsibility of Subcommittee E48.80 on Sustainability of Bioenergy and Industrial Chemicals from Biomass.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2.2 *best available data, n*—publicly accessible, credible sources that can be explicitly cited for replicable analyses that strive to represent local contexts and situations.

3.2.2.1 *Discussion*—Quality of source data should be documented (see 3.2.7).

3.2.3 *biomass, n*—substance wholly comprised of living or recently living (non-fossil) material. **E3066**

3.2.4 *bioproduct, n*—material, chemical, or energy derived from biomass.

3.2.5 *co-product, n*—non-primary material from a process that, under the conditions and assumptions of the assessment, adds economic value to the overall process.

3.2.6 *context, n*—historical conditions, trends, and other forces that influence or define the measurement and interpretation of environmental, economic, and social indicators in a specific place and time. **E3066**

3.2.7 *data quality, n*—the inherent features of factual information (such as measurements or statistics) that can be used for analysis and interpretation of data values.

3.2.7.1 *Discussion*—The relative quality of data can be assessed based on metadata or supporting information that explains known limitations and uncertainties, underlying methods for data measurement or selection, confidence levels, or any quality control measures to improve accuracy, precision, legitimacy, validity, reliability, or consistency of the data.

3.2.8 *indicator, n*—specific, science-based, observable, and measurable characteristic. **E3066**

3.2.8.1 *Discussion*—Indicators can be used to assess environmental, social, or economic conditions of a system, to assess effects of activities on phenomena of concern, or to monitor trends in conditions over time.

3.2.9 *product system, n*—collection of *unit processes* performing one or more defined functions, and which models the *life cycle* of a *product* (good or service).

3.2.10 *reference scenario, n*—characterization of conditions, in the absence of the biomass-based option or *test case*, that are relevant to the assessment.

3.2.10.1 *Discussion*—Conditions relevant to assessment often relate to the use of land, energy, and materials. The conditions shall be measured or calculated using documented methods.

3.2.11 *scenario, n*—written storyline with sufficient detail to describe the setting and activities that determine the conditions of interest for an assessment, particularly the qualities and quantities expected or estimated for selected indicators.

3.2.12 *science-based, adj*—applying principles and practices that employ the scientific method. **E3066**

3.2.12.1 *Discussion*—The scientific method is a process of testing a hypothesis based on evidence and typically involves objective observation, experiment, critical analysis, verification, replication, and induction.

3.2.13 *test case, n*—option to be studied and assessed.

3.2.13.1 *Discussion*—The test case may be designed to assess effects of a specific product, process, policy, technological change, or project.

3.2.14 *test scenario, n*—characterization of conditions that occur under the test case that are relevant to the assessment.

3.2.14.1 *Discussion*—Conditions relevant to the assessment often relate to the use of land, energy, and materials. The conditions shall be measured or calculated using documented methods.

4. Discussion of Concepts and Principles

4.1 Definition of terms and units are important. There must be understanding and agreement on clear definitions for the terminology used in an assessment or comparison. The replicability and validity of the assessment or comparison will be undermined if the definitions are inconsistent. For example, if the terminology in the test scenario and reference scenario are inconsistent, the comparison will be problematic. Therefore, the user shall be responsible for using terminology consistently.

4.2 This practice describes how to identify and document the characteristics of a reference scenario that are required when assessing social, environmental, and economic effects of a biomass-based product system, process, or project. The reference scenario is what one expects would occur in the absence of the test scenario. Reference scenarios must be designed with care to serve as useful and valid comparators to specified test scenarios.

4.3 *Over-arching Principles:*

4.3.1 The principles listed below support transparent documentation of assumptions and the use of best available, science-based, citable sources when characterizing a reference scenario. Adhering to these principles for both test and reference scenarios will support comparable assessment results. General requirements include:

4.3.2 *Transparency*—Scenarios shall be developed and communicated in a transparent manner. It is critical to understand the assessment purpose, assumptions, indicators, and data sources used in developing the test and reference scenarios. The indicators included in a scenario and the data sources used to evaluate the indicators shall be reported. Transparent communication of the scenarios allows continual evaluation of whether they are appropriate for comparison.

4.3.3 *Science-based and Measurable Indicators*—Both the test and reference scenarios shall be developed using science-based, measurable indicators when available. Sources that are generally considered reliable and accessible, such as data sets developed by accountable institutions or published, peer-reviewed inventories and reports, shall be used.

4.3.4 *Equivalency*—Scenarios shall be developed and evaluated in an unbiased manner to capture all major effects. The spatial and temporal system boundaries shall be designed to capture equivalent effects so that, for example, if one scenario does not involve imported materials but another requires imports, the effects associated with the imports are considered. To assess effects of feedstock supplies, the actual sources for inputs shall be considered in each scenario and these will often involve distinct geospatial and temporal parameters.

4.3.5 *Replicability*—Test and reference scenarios shall be documented in a manner that would allow a third party to repeat the analysis and generate similar results. The scenarios

shall be designed to allow comparisons of selected indicators. Numerical values for selected indicators shall be calculated for both scenarios.

4.3.6 *Iteration*—Continual re-evaluation of the test and reference scenarios shall be done to identify differences or incorporate new information. Any changes to the test or reference scenarios shall be documented. This iterative process can lead to improved results over time, either by initial assessors or by others.

4.3.7 *Realism*—Scenarios shall be clearly documented to describe the assumptions underlying each scenario and the sources of input data. Assumptions and input data shall be based on "most likely" expectations. Additional scenarios can be used to "bracket" extreme cases that have lower probabilities for occurrence. These might be extremes with "high and low" anticipated indicator values and should strive to be equivalent and balanced to avoid potential bias in interpretations.

4.3.8 *Consistent Terminology*—Each assessment shall clearly define terms used for analysis or cite the sources of the terminology used. Assessments shall cite relevant sources for each definition to improve consistency across analyses. Terminology should be kept as simple and consistent as possible to reduce confusion.

4.3.9 *Best Available Data,* shall represent the system being assessed.

4.3.9.1 Criteria for selecting best available data include, but are not limited to, the following:

(a) Data quality,

(b) Transparency of assumptions,

(c) Clarity of scope and context,

(d) Extent of data (number of points/time frame covered),

(e) Peer reviewed and published,

(f) Readily available to the public (for example, follows FAIR principles),[3] and

(g) Age of data/age of newest data (periodic update).

5. Summary of Practice

5.1 *Formulate the Problem:*

5.1.1 Describe test case:

5.1.2 Identify the purpose and scope of the assessment. Describe the intended use of the assessment results.

5.1.3 Describe the stakeholders:

5.1.3.1 Identify the sponsors of the analysis.

5.1.3.2 Identify who is conducting the analysis.

5.1.3.3 Identify the target audience.

5.1.3.4 Identify additional stakeholders that may be affected by the assessment and should be consulted, including representatives of the target audience.

5.1.4 Identify relevant time frames.

5.1.5 Identify geospatial area of influence, including test scenario (see 5.2) and reference scenario (see 5.3). The total land area within the geographic extent shall be included in the analysis.

5.1.6 Identify indicators selected for assessment.

5.2 *Identify Characteristics of the Test Scenario:*

5.2.1 Document the source of terminology used in the test scenario. If the term is used with a new meaning, fully define the term within the documentation of the test scenario.

5.2.2 Describe test scenario:

5.2.2.1 Identify the temporal and spatial characteristics of the test scenario.

5.2.2.2 Identify known relevant variables impacting selected indicators.

5.2.2.3 Identify assumptions and data sources selected for characterizing conditions under the test scenario.

5.2.3 Identify other variables that may impact the test case that are or could also be responsible for the same changes in selected indicator values in the reference scenario.

5.2.4 Identify factors outside the test case that are or could be responsible for changes in selected indicator values in the reference scenario.

5.2.4.1 Identify data sources available to understand variability and historic trends for these factors.

5.2.4.2 Describe how each of these factors is expected to change under a reference scenario (in the absence of the test case).

5.3 *Identify Characteristics of a Reference Scenario:*

5.3.1 Document the terminology, context, scope (time and place), relevant factors, assumptions, and data sources for characterizing conditions under the reference scenario.

5.3.1.1 The temporal and spatial boundaries shall be consistent between the test and reference scenario. For example, all land included in the geographic boundaries of the test scenario scope shall be included in the reference scenario.

5.3.1.2 Existing data sets with projected future conditions based on historical conditions may need to be adjusted for significant events that occurred in the test scenario, such as recessions, floods, or droughts. All adjustments shall be clearly documented.

5.3.2 Identify any differences compared to the test scenario (for example, in definitions or terms used).

5.3.3 Document numerical values for selected indicators at specified time steps under the reference scenario.

5.3.4 Identify factors responsible or potentially responsible for changes in selected indicator values in the reference scenario.

5.3.4.1 Document the data sources for reported indicator values.

5.3.4.2 Document the data sources for the factors that could be causing changes in the reference scenario.

5.4 *Document Data Sources:*

5.4.1 Provide a table to document each source of data used to develop indicator values (and related factors) under the test scenario.

5.4.2 Provide a table to document each source of data used to develop indicator values (and related factors) under the reference scenario.

5.4.3 See example in Appendix X1.

[3] Aalbersberg, I., et al., "The FAIR Guiding Principles for Scientific Data Management and Stewardship," *Sci Data 3*, 160018, 2016, doi:10.1038/sdata.2016.18.