

## Methodology Validation Opinion

### GHG Emission Footprint Calculation Methodology of *Carbon Loop Calculator* (Software Platform)

Developed by:

#### **TES- AMM Singapore Pte Ltd**

9 Benoi Sector, Singapore 629844

has been validated in accordance with ISO 14064-3:2019 as  
enabling calculation of GHG Emission Footprint

#### **For the following Carbon footprint calculation:**

- GHG Emission footprint from Processing activities
- Avoided GHG Emissions footprint from TES-AMM  
circular service

Authorized by



Susan Law

SEAP Regional Manager

Date: 09 July 2024

Version 1.0

This statement is valid from 09 July 2024 until 08 July 2027 subject to no  
change in the calculation tool algorithm and satisfactory surveillance audit on  
yearly basis.

SGS International Certification Services Singapore Pte Ltd  
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SGS has been contracted by TES-AMM SINGAPORE PTE LTD (hereinafter referred to as “TES-AMM”), 9 Benoi Sector, Singapore 629844, for the validation of GHG Emission Footprint calculation methodology of *Carbon Loop Calculator*, developed by the organization to facilitate the process of calculating GHG emission footprint of processing activities and avoided GHG emission from TES-AMM circular service, in accordance with

## ISO 14064-3:2019

The version of the *Carbon Loop Calculator* that has been assessed is version 1.0, consistent with the version available on the web site <https://carbon-reporting.sktes.com> at the time of validation, including the “Research Manual on the LCA of IT devices including analysis of their first and second life” Revision 1.0, dated 2 July 2024, and User guide manual: *Carbon\_Reporting\_System\_User\_Guide\_v1.3.pdf*.

## Roles and responsibilities

The management of TES-AMM is responsible for the design, development, maintenance of the *Carbon Loop Calculator*, organizational GHG information system, as well as of the development and maintenance of records in accordance with that system.

It is SGS’s responsibility to express an independent GHG validation opinion on the methodology of the calculation tool as provided by TES-AMM with regards to the agreed criteria.

SGS conducted a third-party validation of the methodology of *Carbon Loop Calculator*. The tool was checked against the calculation requirements of the WRI/WBCSD Greenhouse Gas (GHG) Protocol – Corporate Accounting and Reporting Standard, ISO 14040:2006, ISO 14044:2006, and ISO 14067:2018. The validation engagement was conducted in the period 3 May 2024 to 5 July 2024. The validation was based on the validation scope, objectives and criteria as agreed between TES-AMM and SGS on 18 April 2024.

## Level of Assurance

The level of assurance agreed is that of reasonable assurance.

## Scope

TES-AMM has developed a *Carbon Loop Calculator* to facilitate the process of calculating GHG emission footprint of processing activities and avoided GHG emission footprint from TES-AMM circular service.

TES-AMM has commissioned SGS to independently validate the calculation methodology of its automated tool. This tool was developed by TES-AMM to calculate GHG emissions from IT or technology devices' reuse and recycling, as well as the avoided emissions resulting from these activities. The validation aims to ensure compliance with various standards mentioned in the criteria. The scope of the validation as outlined below.

The engagement covers validation of the TES-AMM's methodology of *Carbon Loop Calculator*, based on ISO 14064-3:2019.

- The validation covered an independent review of the following:
    - The correct implementation of the calculation requirements in line with the criteria. The GHG emissions result produced from the tool was not subject of the validation audit process.
    - The appropriateness of collected foreground data and chosen background data.
    - The appropriateness of calculation tool functionality for its intended purpose. The engagement did not include the software source code within the calculation tool as a part of the validation audit process.
  - Reference to calculation tool (web-based): *Carbon Loop Calculator* version 1.0, consistent with the version available on the web <https://carbon-reporting.sktes.com>
  - Physical infrastructure, activities, technologies, and processes of the organization: GHG emission footprint in the life cycle of processes involving a combination of IT or technology devices' reuse and recycling activities, e.g., IT Asset Disposition and e-waste recycling activities.
  - GHG sources, sinks and/or reservoirs included: Sources as presented in the Research Manual, underlying data/calculation sheets, and *Carbon Loop Calculator* provided by TES-AMM.
    - GHG emission footprint from processing activities at TES-AMM site-specific facilities
- Direct and indirect emissions associated with processing activities:
- Scope 1: Stationary Combustion and Fugitive emissions
  - Scope 2: Purchased Electricity/Energy
  - Scope 3: Category 1, 2, 3, 5, 6, 7, 9, and 15
  - Transportation emissions, i.e., Scope 1 Mobile emissions and Scope 3 Category 4 emissions



- Avoided GHG emission footprint associated with TES-AMM circular service.
  - Recycling: Raw/virgin material extraction emissions and emissions from processing
  - Reuse: Manufacturing emissions and emissions from processing
- Types of GHGs included: CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, SF<sub>6</sub>, HFCs, PFCs, NF<sub>3</sub>
- Time period: *Carbon Loop Calculator* tool is not linked to any specific time period. It is intended to be used in conjunction with site-specific facility data provided by calendar year.
- System boundary considered in the study: Transport, collection, processing at TES-AMM facilities (incl. pre-processing/preparation, dismantling, destruction, separation, shredding, sorting, disposal, and other relevant processes), and system expansion, i.e., the avoided production of virgin raw materials/manufacturing emissions from processes within TES-AMM circular service.
- Reported GHG Emission Footprint and Functional unit: Carbon footprint (in kg CO<sub>2</sub>equivalent) per IT asset processed by TES-AMM (in kg)
- Assumptions: Limitations and assumptions as presented in the Research Manual and underlying data provided by TES-AMM
- Data sources and quality: Data sources as presented in the Research Manual, underlying data, and Data Quality Assessment dated 10 June 2024 provided by TES-AMM
- The version of Research Manual / Methodology document: “Research Manual on the LCA of IT devices including analysis of their first and second life” Revision 1.0 dated 2 July 2024, Carbon Saving Tool - Site Specific Data version 1.6 dated 2 July 2024, MASTERDATA Carbon saving tool version 1.6 dated 2 July 2024, Carbon saving tool - calculations sites data dated 2 July 2024, and User guide manual: *Carbon\_Reporting\_System\_User\_Guide\_v1.3.pdf*.
- Intended user of the validation statement: For TES-AMM internal use and external publication as required.

## Objective

The purposes of this validation exercise are, by review of objective evidence, to independently review: The calculation methodology of *Carbon Loop Calculator* is in accordance with the requirements and criteria used herein.

## Criteria

Criteria against which the validation assessment is undertaken are the requirements of

- WRI/WBCSD Greenhouse Gas (GHG) Protocol – Corporate Accounting and Reporting Standard, GHG Protocol – Corporate Value Chain (Scope 3) Accounting and Reporting

Standard, applicable to the GHG emission footprint from processing activities at TES-AMM site-specific facilities, and

- ISO 14040:2006, ISO 14044:2006, and ISO 14067:2018, applicable to the avoided GHG emission footprint from TES-AMM circular service

## Materiality

Not applicable to this validation engagement, as there is no statement made regarding the result of the GHG emission footprint<sup>1</sup>.

## Methodologies

The validation covered the following activities:

- Desktop review of the methodologies/research manual, underlying calculation sheets/information, *Carbon Loop Calculator version 1.0* (web-based), *Sustainion* reporting platform (web-based), and other supporting documentation
- Conduct interviews with relevant team to obtain an understanding of the key processes, systems, data flows, and controls in place to design, develop, and maintain the *Carbon Loop Calculator*.
- Development of validation approach (validation plan and sampling plan)
  - Identification of critical parameters in terms of error and contribution to the generated GHG emissions result
  - Sample-based reviews of parameters and appropriateness of calculation formula
- Review the appropriateness of methodologies used for the GHG emission footprint calculations including:
  - Reference scenario, proposed scenario, and projected avoided GHG emissions
  - Examination regarding the correct application of calculation methodologies, data consolidation, collected foreground data and chosen background data
  - Cross-check the calculation formula i.e., underlying calculation sheets and data
  - Test using simple datasets and confirming validity of the output through comparison with results obtained by an independent calculation
- Assessment against the criteria
  - The way the Carbon Loop Calculator methodology has been carried out to comply with the calculation rules/methodologies.
  - Review of the evidence and scope provided to us by TES-AMM is prepared in line with the agreed-upon criteria, i.e., completeness of the GHG emission sources, system

<sup>1</sup> The materiality shall be required for the verification engagement and considered by SGS to 5%, based on the needs of the intended user of the GHG Assertion.

boundary, functional unit, data sources and quality, allocation procedures, list of GHGs taken into account, and the characterization factors

- Methods used for the treatment of recycling and reuse in the studies are appropriate and reasonable
- Correct approach, scope and units as required for each component.
- Sampling rule:
  - All identified parameters shall be accessed through Strategy Review and Risk Analysis (SRRA) and Stage 2 audit.
  - The minimum sampling number of each parameter will be no less than the square root of the total data numbers.

## Limitations

The following limitations have been applied to the validation:

- The use of the *Carbon Loop Calculator* and document issuance by individual site-specific users does not automatically lead to a GHG reporting compliant with the above listed standards and requirement.
- We have relied on the data provided by TES-AMM and have not verified the completeness or accuracy of the following information:
  - The calculation methods of “First life (1L)” and “Second life (2L)” device age based on the organization’s internal/external research and observations of the recycling and reuse market.
  - Manufacturing Emission Factors obtained from open sources or external research/ studies. These EFs may require the development of a separate BOM and the creation of new processes within openLCA platform.
  - Recycling rate obtained from EcoQuery, open sources or external research/ studies.
  - Asset’s bill of material (BOM) based on internal/external research/manufacturer product specifications.
  - TES-AMM’s IT systems/data management system, i.e., TES Circle Database (processed assets databases)
  - In cases where TES AMM utilizes of third-party data, our role has been restricted to tracing back a selection of data back to the third-party information, as opposed to confirming the underlying accuracy of the data/result, i.e., data from openLCA 2.1.1, ecoInvent database 3.9.1 (cut-off database), ecoInvent database 3.10 (for product lifecycle data), manufacturer product specification, research literatures, etc.

## Conclusion

TES-AMM provided the GHG Emission Footprint calculation methodology of *Carbon Loop Calculator*



based on the principles of relevance, completeness, consistency, accuracy, and transparency.

SGS's approach is risk-based, drawing on an understanding of the risks associated with modelling GHG emissions information and the controls in place to mitigate these risks. Our examination includes assessment, on a sample basis, of evidence relevant to the methodology and selected emission factors.

Based on the work performed, in SGS's opinion the presented GHG Emission Footprint Methodology of *Carbon Loop Calculator* version 1.0, as described in "Research Manual on the LCA of IT devices including analysis of their first and second life" Revision 1.0, dated 2 July 2024,

- Have been found to comply in all material respects with the applicable requirements and standards used herein.

#### Disclaimer:

- The scope of our assurance was limited to the calculation methodology of the *Carbon Loop Calculator*. The results generated by the tool itself are outside the scope of this assurance.
- Calculation tool's functionality was validated by evaluating its output for a selection of example Carbon footprint calculations. The software source code within the calculation tool was not subject of the audit.

The validation statement will be valid for 3 years subject to no change in the methodology of the *Carbon Loop Calculator* and satisfactory surveillance audits performed annually for first and second year. The objective of the surveillance audit is to check the functionality of the software platform, review of changes if any, and maintenance of the tool.

#### Confidentiality

The reports and attachments may contain relevantly confidential information of the clients. In addition to being submitted as governmental application or certification documents, the reports and attachments are not allowed to be edited, duplicated, or published without the clients' agreement in written form.

#### Avoidance of Conflict of Interest

The reports and attachments are completely complied with the standards and procedures that related authorities established. The reports and attachments of auditing process are conduct with fairness and honesty. If not, the auditing institution not only has to bear the relevant compensation duties, but also to receive legal charge and punishment.

This statement shall be interpreted with the Research Manual Revision 1.0, dated 2 July 2024 of TES-AMM listed above as a whole.

### Validator Group

Above statements coincide with validation process with fairness and impartiality.

Lead Validator:

A handwritten signature in black ink, appearing to read "Adrian Lamano", is positioned above the name.

Adrian Lamano

**Note:** This Statement is issued, on behalf of Client, by SGS International Certification Services Pte Ltd. ("SGS") under its General Conditions for Green Gas Verification Services available at [http://www.sgs.com/terms\\_and\\_conditions.htm](http://www.sgs.com/terms_and_conditions.htm). The findings recorded hereon are based upon an audit performed by SGS. A full copy of this statement, the findings and the supporting GHG Assertion may be consulted at TES-AMM Singapore Pte Ltd, 9 Benoi Sector Singapore 629844. This Statement does not relieve Client from compliance with any bylaws, federal, national or regional acts and regulations or with any guidelines issued pursuant to such regulations. Stipulations to the contrary are not binding on SGS and SGS shall have no responsibility vis-à-vis parties other than its Client..