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TranSensus LCA

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EXECUTIVE SUMMARY

Road transportation is a notable contributor to climate change as well as other environmental impacts. Zero tail-pipe emissions vehicles (ZEVs) offer a promising pathway for reducing impacts. To fully realise the benefits associated with ZEVs it is necessary to evaluate and monitor their sustainability performance. Life cycle-based methodologies present the most logical choices for sustainability performance assessments. These include Life Cycle Assessment (LCA), Social Life Cycle Assessment (SLCA) and Life Cycle Costing (LCC). However, current applications of the methodologies are inconsistent presenting challenges for the implementation of the results for decision-making.

The TranSensus LCA project aims to provide a harmonised, consensus-based methodology for conducting sustainability assessments of ZEVs from a life cycle perspective, including both environmental and social aspects. The consortium comprises of key stakeholders in the mobility field from both academia and industry.

This report aims to provide guidance on the application of the TranSensus LCA methodology. It provides an overview of the guidelines in the form of annotated table of contents which provides a description of the different sections. The guidelines are based on the building blocks established during WP2 and the recommendations resulting from the consensus building (WP2 and WP3).

The guidelines begin with descriptions of the relationships with other standards, guidelines and legislation for contextualisation. This is followed by information on the LCA typology and decomposition tree. The guidelines then include details on the different steps in conducting an LCA specifically, i) goal and scope definition, ii) life cycle inventory, iii) life cycle impact assessment and iv) interpretation. Guidance is provided for both environmental and social assessments.

Guidance areas that are yet to be finalised are written in red text which also provides insights into the current progress made towards consensus.

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Glossary

Allocation – an approach to solving multi-functionality problems. It refers to 'partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems.'

Attributional LCA – a type of LCA focusing on one specific functional unit of the system/product under study, while assuming that the system/product itself does not alter the larger system into which it is embedded/deployed. (e.g., an LCA of one EV, without considering the effects that a large-scale roll-out of EVs may be expected to have on: (i) the demand for LIB metals, and hence on the changing impacts of their supply chains, and (ii) the increased total demand for electricity due to the vehicle's use phase, which may necessitate deployment of new generators and changes in grid mix composition).

Average Data – production-weighted average of specific data.

Background processes – refers to those processes in the product life cycle for which no direct access to information is possible. For example, most of the upstream life-cycle processes and generally all processes further downstream will be considered part of the background processes.

Climate change – EF impact category considering all inputs and outputs that result in greenhouse gas (GHG) emissions. The consequences include increased average global temperatures and sudden regional climatic changes.

Company-specific data – refers to directly measured or collected data from one or more facilities (site-specific data) that are representative for the activities of the company (company is used as synonym of organisation). It is synonymous to 'primary data'. To determine the level of representativeness a sampling procedure may be applied.

Consequential LCA – a type of LCA focusing on the changes induced by the deployment of the system/product under study, on the larger system into which it is embedded/deployed (e.g., an LCA explicitly modelling the expected changes in supply-chain impacts for LIB metals due to a large-scale uptake of EVs)

Co-product – any of two or more products resulting from the same unit process or product system.

Cradle to gate – a partial product supply chain, from the extraction of raw materials (cradle) up to the manufacturer's 'gate'. The distribution, storage, use stage and end of life stages of the supply chain are omitted.

Cradle to grave – a product's life cycle that includes raw material extraction, processing, distribution, storage, use, and disposal or recycling stages. All relevant inputs and outputs are considered for all of the stages of the life cycle.

Cut-off criteria – Specification of the amount of material or energy flow or the level of significance associated with unit processes or product system to be excluded from a study. Adapted from ISO 14040 (2006).

Data quality – characteristics of data that relate to their ability to satisfy stated requirements. Data quality covers various aspects, such as technological, geographical and time-related representativeness, as well as completeness and precision of the inventory data.

Environmental impact – any change to the environment, whether adverse or beneficial, that wholly or partially results from an organisation's activities, products or services.

Foreground elementary flows - direct elementary flows (emissions and resources) for which access to primary data (or company-specific information) is available.

Functional unit (LCA) – defines the qualitative and quantitative aspects of the function(s) and/or service(s) provided by the product being evaluated. The functional unit definition answers the questions 'what?', 'how much?', 'how well?', and 'for how long?'.

Functional unit (SLCA) – Quantified performance of a product system for use as a reference unit in a life cycle assessment study, and also valid for an S-LCA. ISO 14040 (2006).

Goal and scope – The first phase of an LCA or S-LCA; establishing the aim of the intended study, the functional unit, the reference flow, the product system(s) under study and the breadth and depth of the study in relation to this aim. For S-LCA, a unique aspect in practice is the specification of the stakeholder group(s) of interest and the type of assessment (type I or type II).

Impact assessment – phase of the LCA aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product. The impact assessment methods provide impact characterization factors for elementary flows, to aggregate the impact so as to obtain a limited number of midpoint indicators

Impact assessment method – protocol for converting life cycle inventory data into quantitative contributions to an environmental impact of concern.

Impact category – class of resource use or environmental impact to which the life cycle inventory data are related.

Impact category indicator – quantifiable representation of an LCA impact category.

Impact category (SLCA) – A social impact category is a class that covers certain social issues of interest to stakeholders and decision makers. In practice, impact categories are logical groupings of S-LCA (subcategory) results.

Life cycle – consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal.

Life cycle approach – takes into consideration the spectrum of resource flows and environmental interventions associated with a product from a supply-chain perspective, including all stages from raw material acquisition through processing, distribution, use, and end of life processes, and all relevant related environmental impacts (instead of focusing on a single issue).

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

Life cycle costing / Environmental life cycle costing – Life cycle costing, or LCC, or more specifically environmental life cycle costing, is a compilation and assessment of all costs related to a product, over its entire life cycle, from production to use, maintenance, and disposal.

Life cycle impact assessment (LCIA) – phase of life cycle assessment that aims to understand and evaluate the magnitude and significance of the potential environmental impacts for a system throughout the life cycle. The LCIA methods used provide impact characterization factors for elementary flows to aggregate the impact, to obtain a limited number of midpoint and/or damage indicators.

Multifunctionality – if a process or facility provides more than one function, i.e. it delivers several goods and/or services ('co-products'), then it is 'multifunctional'. In these situations, all inputs and emissions linked to the process will be partitioned between the product of interest and the other co-products, according to clearly stated procedures.

Normalization – after the characterization step, normalization is the step in which the life cycle impact assessment results are divided by normalization factors that represent the overall inventory of a reference unit (e.g. a whole country or an average citizen). Normalised life cycle impact assessment results express the relative shares of the impacts of the analysed system, in terms of the total contributions to each impact category per reference unit. Displaying the normalised life cycle impact assessment results for the different impact topics next to each other shows which impact categories are affected most and least by the analysed system. Normalised life cycle impact assessment results reflect only the contribution of the analysed system to the total impact potential, not the severity/relevance of the respective total impact. Normalised results are dimensionless, but not additive.

Scope of the study – The scope is defined in the first phase of the study. It encompasses issues of depth and breadth of the study. It defines the limits placed on the product life cycle (that can be infinite) and on the detail of information to be collected and analysed. It defines where the data will be coming from, how up to date the study will be, how information will be handled, and where the results will be applicable.

Secondary data – data that is not from a specific process within the supply-chain of the company performing a PEF study. This refers to data that is not directly collected, measured or estimated by the company, but rather sourced from a third party LCI database or other sources. Secondary data includes industry average data (e.g., from published production data, government statistics and industry associations), literature studies, engineering studies and patents) and may also be based on financial data, and contain proxy and other generic data. Primary data that go through a horizontal aggregation step are considered to be secondary data.

Sensitivity analysis – systematic procedures for estimating the effects of the choices made regarding methods and data on the results of a PEF study.

Stakeholder – Individual or group that has an interest in any activities or decisions of an organization. (ISO 26000, 2008)

System boundary – definition of aspects included or excluded from the study. For example, for a 'cradle-to-grave' LCA analysis, the system boundary includes all activities ranging from the extraction of raw materials, through processing, distribution, storage and use, to the disposal or recycling stages.

Uncertainty – Uncertainty refers to the lack of certainty e.g. in the prediction of a certain outcome, in a measurement, or in an assessment's results. It is a general term used to cover any distribution of data caused by either random variation or bias. In LCA and S-LCA, evaluation or measurement of uncertainty is an on-going process and relates to all the elements of data quality as well the aggregation model used and to the general aims of the study as set in the Goal and Scope.

Weighting – a step that supports the interpretation and communication of the analysis results. PEF results are multiplied by a set of weighting factors (in %), which reflect the perceived relative importance of the impact categories considered. Weighted EF results may be directly compared across impact categories, and also summed across impact categories to obtain a single overall score.

I. Introduction

TranSensus LCA aims to develop a baseline for a European-wide harmonised, commonly accepted and applied single life cycle assessment (LCA) approach for a zero-emission road transport system including both environmental and social aspects. In this regard, it aims to involve all relevant stakeholders in a consensus-based approach for the development of a life cycle based methodology.

The overall aim of this work package is to consolidate the key outcomes of WP2, WP3 and WP4 and translate them into guidelines. These guidelines intend to support LCA practitioners and users for conducting LCA of the electromobility value chain with a focus on ZEV in accordance with a consensual approach. WP5 will provide inputs for outreach and dissemination tasks (WP6).

This deliverable aims to provide an overview of the guidelines to implement the TranSensus LCA (T-LCA) methodology. It includes a brief description of what is to be included in the different sections of the guidelines.

Items written in red text indicate details that still require a consensus from work conducted by WP2 and WP3.

I.1 Terminology

The following definitions apply in the implementation of the guidelines:

- Shall/ Mandatory – required for compliance with the guidelines
- Should/ Recommended – advisable to implement
- May/ Optional – not required for compliance with guidelines
- Informative – included for information purposes only, no action required

I.2 Scope of guidance book

This guidance book is limited to the provision of guidance regarding the implementation of the T-LCA methodology. It does not provide the background to the decision-making processes that underpin the development of the methodology. These are available in deliverable 2.3 on the final harmonised approach of the TranSensus LCA methodology.

I.3 Structure of Deliverable

The start of the deliverable serves to contextualise the guidance laid out in the document. This includes the relationship of the guidance to existing standards and legislation. Further, information is provided on the ontology. The rest of the deliverable is structured according to the steps of an LCA beginning with the goal and scope and culminating in the interpretation stage.

II. Relationships to existing standards, methodologies and legislation

II.1 Existing standards

Description of relationships to existing ISO standards.

II.2 Methodology

Description of relationships to existing methodologies such as Catena-X and the Battery Passport.

II.2.1 Legislation and regulations

Description of relationships to existing and upcoming EU regulations.

III. LCA Ontology and Decomposition Tree

Introduction: Ontology for an LCI database for the road transport sector and battery value chain in The TranSensus LCA project.

A decision must be taken the inclusion of this section in the guidelines as ontology and decomposition tree are not considered mandatory, but informative.

III.1 TranSensus LCA Ontology

Introduction of the TranSensus LCA Ontology (TLCAO), designed to support decision-making processes, enabling comparison of different vehicles and technologies, identifying areas for improvement, and promoting sustainable practices in the development and deployment of zero-emission vehicles and associated infrastructure

III.2 Decomposition tree

Introduction of a standardized nomenclature system to ensure unambiguous identification of items within the taxonomy of zero-emission vehicles

PART A: Product E-LCA

The following guidance is specific to conducting an environmental life cycle assessment according to the TranSensus LCA methodology.

I. Goal and Scope

Introduction: Assumptions and methodological choices for the development of LCAs under the Transensus-LCA methodology

I.1 Goal

Definition of the 4 types of LCA selected in the Transensus-LCA methodology; description of the goals, users and target audience for each type.

I.2 Scope

Description of the product systems to be evaluated and how they will be assessed, based on the defined objectives. This includes technology coverage, i.e. types of vehicles to be covered.

Note: decision on the inclusion of light means of transport to be made.

I.2.1 Functional unit

Definition of the functional unit according to the LCA typology (retrospective, prospective and fleet) and the type of vehicle under analysis. This includes assumptions for the lifetime of vehicles, which impacts the calculation of the impacts associated to the functional unit.

Coherence revision is required for the list of vehicles. Examples:

- -freight vs lorry/truck
- -light commercial vehicle / van
- -bus /coach

I.2.2 System boundaries

Guidelines for the degree of inclusion and exclusion of stages and subsystems in the cradle-to-grave assessment defined in the TranSensus-LCA methodology.

II. Life Cycle Inventory

Introduction

II.1 Data collection

Minimum data requirements for data collection.

II.1.1 Data and data quality requirements

Data quality requirements in relation to the UNECE level concept.

II.1.1.1 Primary data

Definition of primary data i.e. ‘company data’.

II.1.1.2 Secondary data

Definition of secondary data.

II.2 Production phase modelling

II.2.1 Energy in manufacturing

Selection of location vs market based electricity modelling approach. Safeguards for electricity modelling to be included depending on location vs market based.

II.2.2 Cut offs

Approaches to cut-offs during the production phase.

II.3 Use phase modelling

II.3.1 Energy consumption

Modelling of energy consumption, i. e. electricity, hydrogen.

II.3.2 Non-exhaust emissions

Inclusion of and approaches to non-exhaust emission modelling.

II.3.3 Maintenance

Provision of a non-exhaustive list of parts/processes to be included under maintenance.

II.3.4 Cut offs

Approaches to cut-offs during the production phase.

II.4 End-of-life modelling

This section includes approaches to electricity modelling at end-of-life.

II.4.1 Hierarchy

Explanation of multifunctionality hierarchy including examples of applications.

II.4.2 Consistency across LCA, SLCA and LCC

Description of the framework for applying multifunctionality across the three pillars.

II.4.3 Multifunctionality at end-of-life

Explanation of how to apply multifunctionality at end-of-life.

II.5 Data quality rating

II.6 Best practices

Further practical recommendations that do not fit into the above categories.

III. Life Cycle Impact Assessment

Introduction

III.1 Mandatory impact assessment categories and indicators

Mandatory impact assessment categories for LCA and associated indicators. This includes Impact assessment methods for calculating impact category indicators.

III.2 Optional impact assessment categories and indicators

Optional impact assessment categories for LCA and SLCA and associated indicators.

Inclusion of Cumulative Energy Demand as a mandatory or optional indicator and associated calculation method.

III.3 Resource related indicators

III.3.1 Criticality

Inclusion of criticality and associated method (GeoPol Risk).

III.3.2 Dissipation

Decision on inclusion of dissipation and the associated calculation method if it is to be included.

III.3.3 Circularity

Exclusion of circularity and explanation of reasoning.

III.4 Normalisation and weighting

Application of normalisation and weighting as steps in the LCA.

III.4.1 Normalisation factors

Specification of normalisation factors to be applied.

III.4.2 Weighting

Exclusion of weighting and justification.

IV. Interpretation

Introduction

IV.1 Sensitivity analysis

Description of sensitivity analysis. Specification of mandatory, recommended and optional parameters for the application of sensitivity analysis.

IV.2 Uncertainty

Definition of uncertainty. Specification of mandatory, recommended and optional parameters for the application of uncertainty analysis.

IV.3 Scenario analysis

Description of scenario analysis. Specification of mandatory, recommended and optional parameters for the application of scenario analysis.

PART B: S-LCA

The following guidance is specific to conducting a social life cycle assessment according to the TranSensus LCA methodology.

I. Goal and scope

I.1.1 Goal

Definition of goal for the study.

I.1.2 Scope

Description of the product systems to be evaluated and how they will be assessed, based on the defined objectives.

II. Life Cycle Inventory

II.1 How to conduct a life cycle inventory analysis

How to conduct an S-LCI according to the UNEP guidelines.

II.2 Data quality

How to evaluate the data quality according to the pedigree matrix.

III. Life Cycle Impact Assessment

III.1 Calculation of S-LCIA results

How to approach the calculations from impact categories down to indicators.

III.2 Mandatory impact assessment categories

Mandatory impact assessment categories for SLCA ad associated indicators. This includes Impact assessment methods for calculating impact category indicators.

III.3 Optional impact assessment categories

Optional impact assessment categories for LCA and SLCA and associated indicators.

III.4 General guidance on reference scale approach

General guidance on how to use the reference scale approach.

IV. Interpretation

Introduction

IV.1 Sensitivity analysis

Description of sensitivity analysis. Specification of mandatory, recommended and optional parameters for the application of sensitivity analysis.

IV.2 Uncertainty

Definition of uncertainty. Specification of mandatory, recommended and optional parameters for the application of uncertainty analysis.

IV.3 Scenario analysis

Description of scenario analysis. Specification of mandatory, recommended and optional parameters for the application of scenario analysis.

PART C: Reporting

Inclusion of this section still to be decided.

I. Reporting

I.1 Introduction

Outline to reporting, types of reporting, etc.

I.2 Minimum public reporting

Outline of proposed minimum information to be provided in public reporting

I.3 Recommendations for full LCA reports

Recommendations on information to be provided in full reporting (public or internal)

I.4 Data Quality Rating needs

Recommendations on requirements/options for these

I.5 Third Party Verification

Recommendations on requirements/options for this – including proposed checklist.

PART D: Perspectives and Summary

I. Perspectives

Topics which were discussed by work packages for which insufficient progress was made; will be presented as topics that may become relevant in the future.

II. Summary

This report has provided an overview of the TranSensus LCA methodology application guidelines in the form of annotated table of contents which provides a description of the different sections.

The guidelines begin with descriptions of the relationships with other standards, guidelines and legislation for contextualisation. This is followed by information on the LCA typology and decomposition tree. The guidelines then include details on the different steps in conducting an LCA specifically, i) goal and scope definition, ii) life cycle inventory, iii) life cycle impact assessment and iv) interpretation. Guidance is provided for both environmental and social assessments.