TranSensus LCA

COORDINATING

THE HARMONISATION OF A

TRANSPORT-SPECIFIC

LIFE CYCLE ASSESSMENT (LCA)

Our road transport system is rapidly transforming in response to climate change and resulting demand for a high sustainability over the full value chain and the full life cycle. New propulsion systems are achieving steadily increasing market shares, and new infrastructures and mobility concepts will be needed for connected and automated vehicles, as well as to achieve the vision of smart and climate-neutral cities. In order to define realistic sustainability goals – for all stakeholders in the mobility sector – and to select the most sustainable solutions, the environmental, economic and social impact of technologies and mobility concepts must be assessed and continuously monitored in a holistic way.

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Overview on TranSensus LCA

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. Such a European single LCA approach is seen as a key element in achieving the Green Deal targets, making Europe the first digitally enabled circular, climate-neutral and sustainable economy. Bringing together relevant stakeholders from industry and research, an evidence- and real-life data-based LCA approach will be conceptualised and harmonised embracing environmental, economic and social aspects by consensus.

- Conceptualise and demonstrate a single, European-wide real-data LCA approach for zero-emission road transport
- Harmonisation of methodologies, tools and datasets
- Elaborate an ontology and framework for a Europe-an-wide LCI database
- Conceptualise LCI data management and update along the life cycle and along the supply chain
- upcoming technologies and demands.
- Paving the way for LCA-based product and business development

The conceptual approach for a consensus LCA will be elaborated within the consortium considering retrospective and prospective assessment of vehicles and battery value chains. Furthermore, the demands and requirements of a circular economy, social aspects (S-LCA) as well as LCC or total cost of ownership will be considered where relevant. The conceptualisation will be based on available and ongoing activities beyond TranSensus LCA and along the different life cycle stages and assessment steps. The building blocks of a single, European-wide LCA will be elaborated defining the perimeter, the objective and applications of the approach. Furthermore, data ontology, foreground and background LCI data modelling, recommendations to enable fair comparisons, and circular value chains will be considered. Once a sufficient maturity of concept is reached, a harmonisation and consensus will be sought with all relevant stakeholders of the road transport community, including industry along the respective value chains, mobility providers and planners, standardisation bodies, legislators and the EC. Besides, synergies with and transfer to non-road markets such as other transport modes, general mechanical engineering or consumer products will be analysed.

Impact

Accelerated uptake of zero-emission mobility across Europe

A concept for a transport-specific LCA will be harmonised with a representative group of stakeholders. This paves the way for a wide-scale uptake of the TranSensus LCA approach by industry allowing them to provide information on the product sustainability in an objective and comparable way.

Increased user acceptance, improved air quality, a more circular economy and reduction of environmental impacts

With the proposal for transparent and comparable assessment of environmental impacts (TranSensus LCA approach) the benefits of sustainable and circular economy based solutions will become more evident. Consequently, the user acceptance for those will increase through reliable and trustworthy information resulting in a demand pull which need to be met by industry. Thus, more zero-emission solutions will enter the market based on a LCA and CE-driven development.

Effective design, assessment and development of innovative concepts in road vehicles and mobility services thanks to life-cycle analysis tools and skills, in a circular economy context.

A harmonised, commonly accepted LCA driven by industrial stakeholders decreases threshold for uptaking and implementing a LCA into the product development. Once the consensus process will be finalised, the industry will be able to perform a LCA already in the product development in an efficient way.

Review of current practices on life cycle approaches along the electromobility value chain

The review on LCA showed that a clear distinction should be considered when evaluating entire vehicles, and when evaluating batteries as a core element of ZEVs. This has implications on the goal and scope definition concerning important aspects such as the functional unit and system boundary. Distance-based functional unit is a typical choice for vehicles (sometimes also incorporating occupancy or loading factors for commercial vehicles), while energy provided by battery in its lifespan is dominating the battery-focused sources.

Proper definition of the goal and scope lays the ground for a consistent meaningful LCA study. The three big scopes defined within TranSensus LCA are thought to be comprehensive for the LCAs conducted nowadays, nonetheless, a clear-cut is sometimes hard to draw between theses scopes. Therefore, the authors suggest clear indication to the scope of LCAs and elaboration on the final intended application.

A typical implication of this is defining the modelling approach whether attributional or consequential that better suit the scope and application and point out any deviation from the standard practices of any of the two modelling approaches. Justified deviations are acceptable even if the harmonized methodology of TranSensus LCA is intended to be systematic as much as possible, however adaptability to different technologies of powertrains and core components like batteries should be accounted for.

Functional unit (FU) and system boundaries definition are principal methodological choices in LCA and there are interconnected. It seems that the controversial point here is the service lifetime (from calendar year, mileage and battery charging cycles) whether for full-vehicle studies or battery-focused studies. Since including use phase in the system boundary is typical for a full cradle-to-grave study, service lifetime should be

Figure: Selected review results for Goal and Scope Definition

Aspect		
Functional Unit	**Distance-based** functional unit (vkm, pkm, or tkm)	• **Capacity-based** (kWh or MJ) • **Throughput-based** (kWh or MJ) • **Mass-based** (kg of battery)
System Boundary	**Cradle to grave**	• **Cradle to grave** • **Cradle to gate**

a focal point for harmonization as it heavily affects the functional unit definition. For the functional unit, a distance-based functional unit appear as the most common choice for vehicles, however refining is required on whether to include other factors like passengers carried or goods transported for better representativeness of the function (particularly for commercial vehicles). For batteries, a harmonization is required whether to adopt a capacity-based or throughput based functional unit. Other less harmonized aspects are clear rules for cut-offs/system boundary (e. g. notably for aspects such as maintenance and infrastructure).

Inventory data is perhaps the area that requires the most attention, since harmonization was partly or fully absent in the reviewed work. This starts from the medium of data collection and type of data (primary or secondary) at each stage of the life cycle. Electricity generation modelling (and also hydrogen production for relevant powertrains using this fuel) is arguably the most impactful on the results hence pushing towards clear guidelines on electricity (and hydrogen) supply mix choices should be a priority (i.e. including agreed standardized future projections for these). In particular, there are different views on the treatment of renewable electricity with certificates, and concerns over additionality, and consistency with recent new EU rules for renewable hydrogen. Data and assumptions on operational energy consumption also need reviewing, to ideally find ways to better account for real-world performance (compared to regulatory-testing data). In addition, typical **multifunctionality** issues in the field (especially co-production of primary materials and EoL of vehicles/batteries) should be dealt with by providing clear rules for

Figure: Selected review results for Life Cycle Inventory

Aspect		
Data	• Lack of a standardised approach to **inventory data collection** • Lack of **primary data** is a big obstacle • Data quality and availability varies according to life stage • LCI databases: ecoinvent, MLC (former GaBi) databases, GREET	
Electric Energy Modelling (Use stage)	• LCI datasets: **EU average grid mix/ Country-specific/ residual grid mix** • **Future grid mixes** (i.e. the change over the vehicle lifetime, not just static sensitivities) are not discussed enough despite importance	
Multifunctional processes	• A distinction is usually found between **EoL and upstream processes** • Studies are relatively vague on choices to deal with multifunctionality • **Allocation** is the main choice in co-production • Five choices in EoL: **CFF*, Cut-off, Avoided burden, 50:50, APOS**	

allocation and/or substitution. EoL multifunctionality is the area where. most unharmonized practices are observed as it is linked to vast immature possibilities especially for batteries when it comes to recycling or giving a second life in other applications. Other minor conflicts were found in how/whether maintenance is modelled, also direct emissions from tires/brake pads wearing in ZEV.

Summary

- Lack of harmonization in LCA application for ZEVs was obvious at many points.
- Certain level of consensus was found for some aspects like functional unit however defining service lifetime is debatable.
- The aspired harmonized approach should be policy-relevant, clear, and methodologically sound for example:
  - Ideally cradle-to-grave LCAs should be the default;
  - Functional unit should reflect the actual service the system provides;
  - A clear data type (primary vs secondary) hierarchy should be provided for each life cycle stage;
  - Clear instructions to model and test electric-energy mixes;
  - A consistent framework to tackle multifunctionality problems in the value chain;
  - Stress on reporting relevant impact indicators like CED, PM, RD (and dissipation);….

Figure: Selected review results for Life Cycle Impact Assessment

Aspect		
LCIA method	• **IPCC GWP 100** for Climate-change-focused studies • **EF method** is recommended but rarely followed in practice • **ReCiPe and CMLIA** are very common • **Mixing impact indicators** from different LCIA methods is a common practice	
Impact categories	• **Climate Change (By far)** • Acidification	• PCOF • Eutrophication
Normalization and Weighting	• Normalization is rarely applied in individual studies • Weighting is almost absent	

Analysis of needs and gaps for the development of a harmonised LCA/S-LCA approach

Key Findings regarding needs for the TranSensus LCA method

The analysis enabled to identify, discuss and define the key needs the TranSensus LCA method shall seek to cover. It simultaneously provided a level of prioritization regarding these needs, as support to the development of the TranSensus LCA method in downstream WPs of the TranSensus LCA project.

As top priority, the TranSensus LCA method, and the resulting studies building on this method, shall be:

- Understandable, i.e. providing clear scope and results to audience (including limitations);
- Standardized, i.e. there shall be one clear, unique, TranSensus LCA method;
- Accurate, i.e. providing indicators close to the actual (true) value of the environmental and social performance of the system analyzed
- Auditable, i.e. with credible verification process (or audits) overcoming the challenge of confidentiality;
- Accepted by the scientific community and industrials;
- Trustworthy, i.e. the audience shall have confidence in how far the outcomes of a study correctly represent the environmental and social impacts of a product.

Key Findings regarding needs for the TranSensus LCA method

- A common, harmonized way to account for real-world product performance is missing for setting of the **functional units**.
- Clear, detailed rules on inclusion/ exclusion of elements of the **system boundaries** are needed.
- An unambiguous, reliable, and commonly agreed approach to address **multifunctionality** is needed.
- Clear rules are needed on the mandatory use of **primary (supplier-specific) data** as opposed to secondary data.
- Clear guidance and rules on secondary LCI databases to ensure consistency with primary data.
- Lack of harmonized and commonly agreed approach to **model electricity** and hydrogen consumption.
- Harmonization is still needed for the **end-of-life modelling**.
- Unique, standardized, set of **impact categories** and associated impact assessment methods are missing agreed to be relevant and robust.
- Harmonized guidance to support **quality assessment**, data sharing along the supply chain, and communication.

Proposal for the TranSensus-LCA harmonized approach

The TranSensus-LCA methodology proposed consists in more than 137 requirements (56 mandatories) and covers all phases of life cycle assessment for zero emission vehicle. This methodology has been developed for product LCA and gives guidelines and rules for a prospective LCA as well as OEM and macro fleet LCA.

The development of the building blocks relied on a scientific and voting approach divided according to ISO 14040 LCA framework. Based on the state of the art and the analysis of needs and gaps, discussions on practices, scientific alternatives and methodologies enabled to provide recommendations or a limited number of alternatives to address each treated topic. Consensus on each requirement has been reached through voting exercise with the beneficiaries, associated members and both Advisory boards (industry and scientific), overall > 50 stakeholders were involved in the consensus building process up to now.

The LCA framework developed describes the mandatory, recommended and optional requirements that build the harmonised, robust, transparent, commonly accepted and applied single life cycle assessment approach for zero emission road transport system, including environmental and social aspects. In doing so, 4 different LCA types were considered (see Figure below). The framework is published in Deliverable D 2.3 which can be downloaded from the project webpage.

Figure: LCA types considered

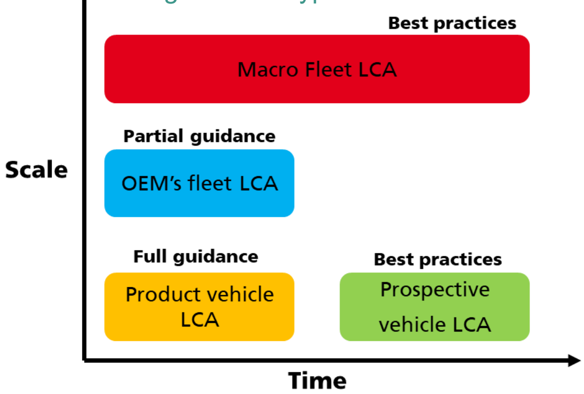
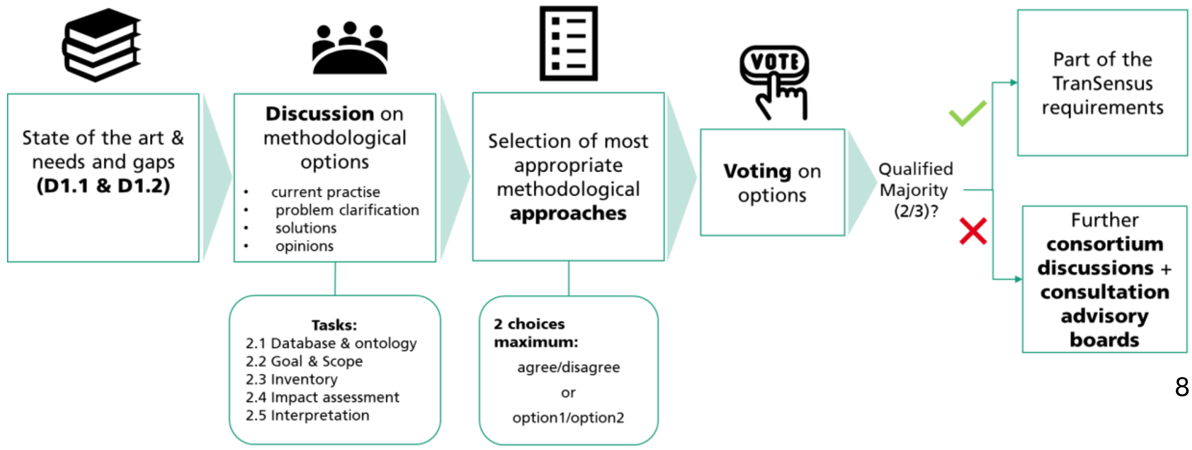
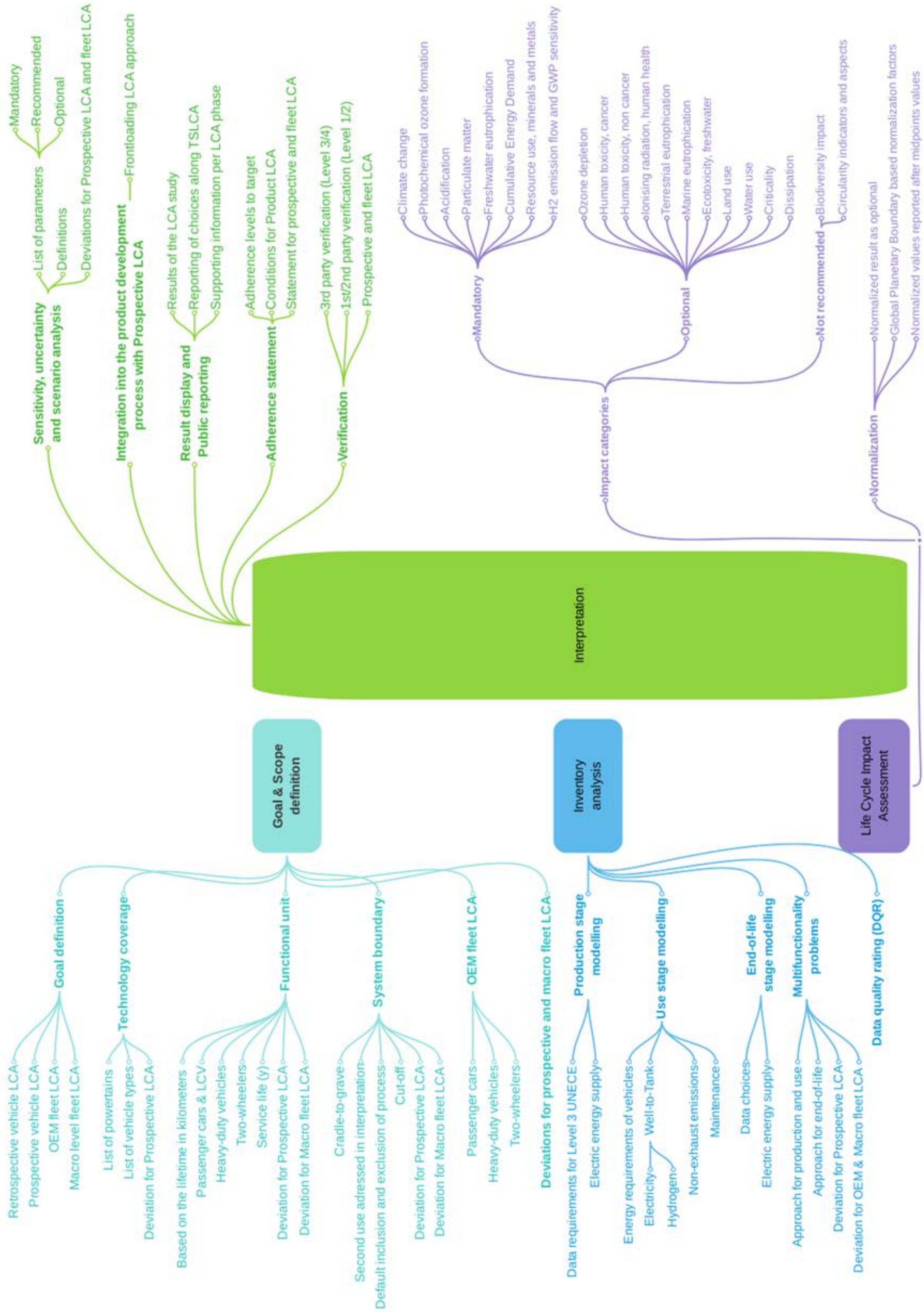


Figure: Methodology applied to define the TranSensus –LCA approach



Overview of E-LCA requirements



Examples for E-LCA requirements

Goal and Scope - Cut-off of flows

A Hierarchical process has been defined:

No intentional cut-off of flows shall be made, where these can be reasonably avoided.

In case a cut-off is needed, an absolute threshold based on 3% of the environmental impacts (all life cycle stages, company-specific data) should be applied.

To use the cut-off allowance, all cut-off flows cumulative shall be below 3% of the environmental impacts in all mandatory impact categories (if the cut-off flows impact is above 3% in even one of the mandatory impact categories, it cannot be excluded.)

+ Screening analysis

Electricity modelling

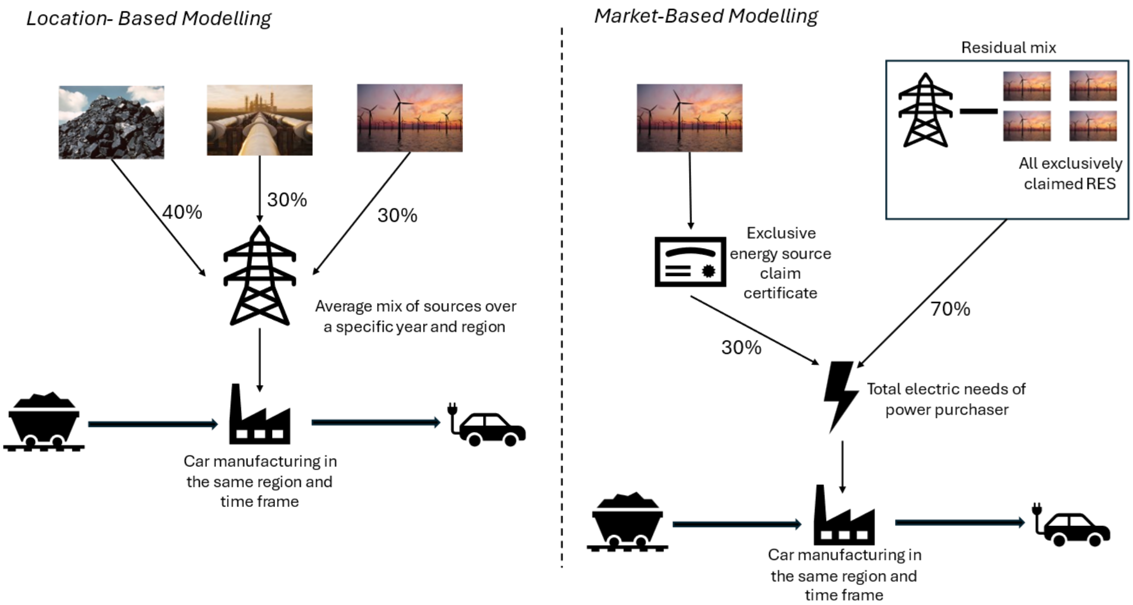
A hierarchical order of options has been agreed upon:

A Location-based modeling by default with conservative exceptions

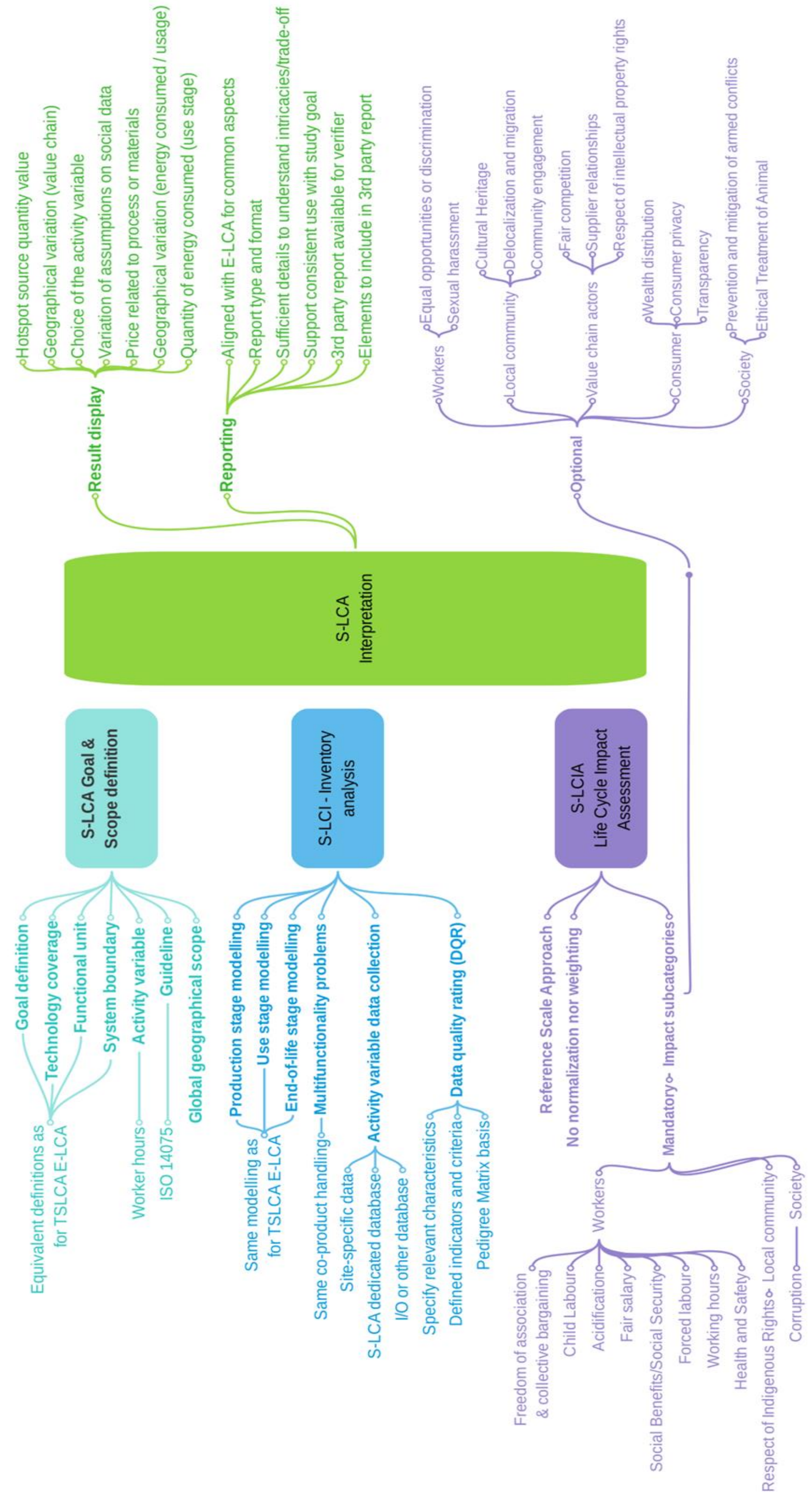
In the presence of EACs for industries. A 100% market-based modeling is HIGHLY RECOMMENDED in which only Residual mixes are used in the absence of EACs for any process (in the entire value chain.)

Lastly, TSLCA acknowledged the challenges in applying a 100% market-based modeling à a mixed approach is proposed with a clear acknowledgment of the inevitable double counting, hence encouraging working towards the above two options instead

Figure: Location-based vs. market-based electricity modelling



Overview of S-LCA requirements



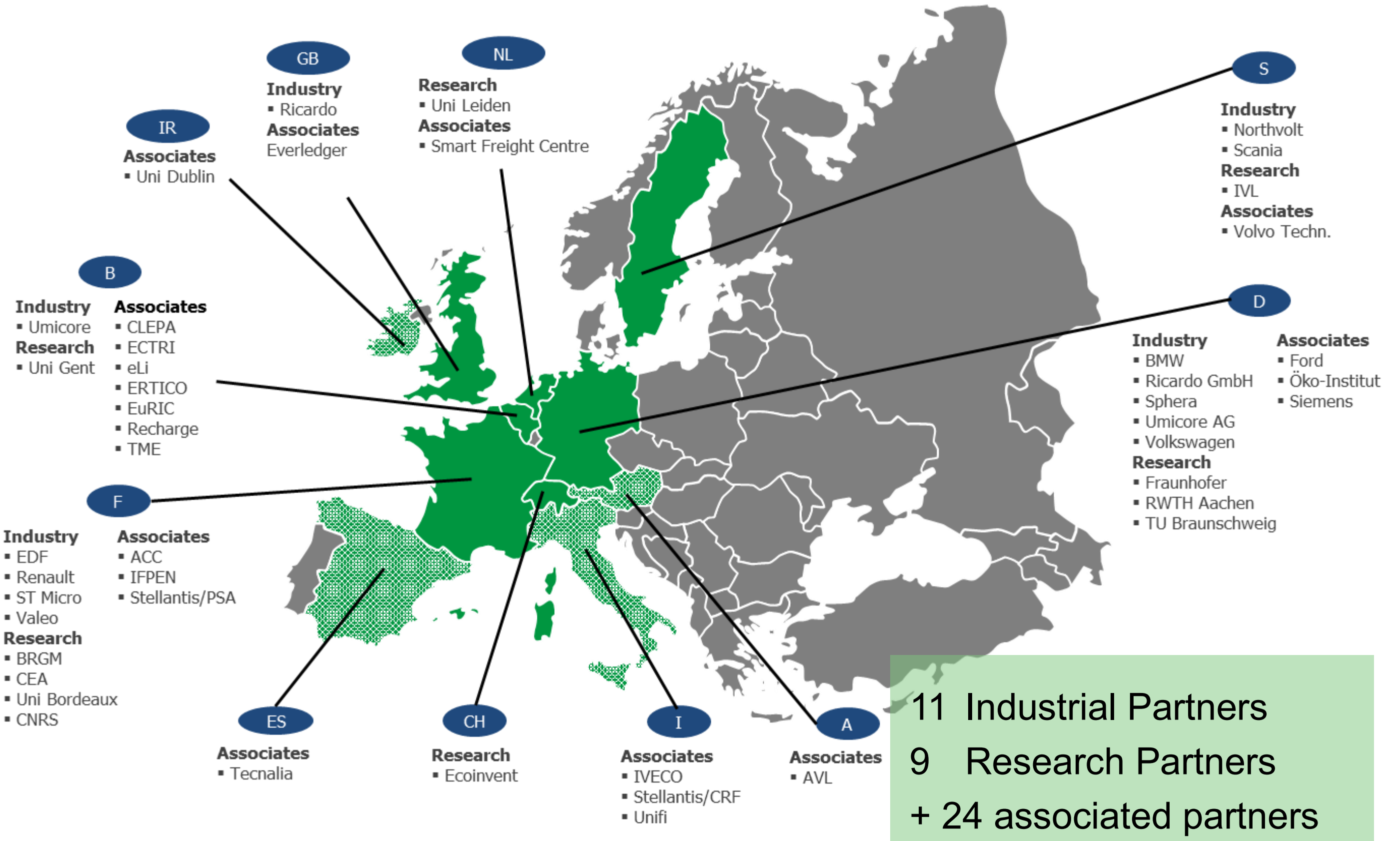
Examples for S-LCA requirements

- Social LCA provides complementary information by addressing social aspects leading to a more comprehensive understanding of the products' life cycle impacts.
- S-LCA assesses social and socio-economic impacts.
- S-LCA collects additional information on organization related aspects along the life cycle.
- Relevant environmental / social issues to be considered in the case addressed have to be defined in Goal & Scope.

Stakeholder Category	Mandatory Impact Subcategory	Impact Subcategory Indicator
Worker	Freedom of association and collective bargaining	Right of Association, Right of Collective bargaining, Right to strike
	Child Labour	Children in employment, total
	Fair salary	Minimum wage, per month and Living wage, per month
	Social Benefits /Social Security	Social security expenditures
	Forced Labour	Overall country sector risk forced labour and Forced labour risk (Global Slavery Index)
	Working Hours	Weekly hours of work per employee
	Health and Safety	Rate of fatal accidents at workplace and Rate of non-fatal accidents at workplace
Local Community	Respect of Indigenous Rights	Presence of indigenous population
Society	Corruption	Corruption Perception Index (CPI)

TranSensus LCA

Partners & Assosciates



11 Industrial Partners
9 Research Partners
+ 24 associated partners
+ 2 Advisory Boards with 16 additional stakeholders

Industrial Partners:

4 OEMs, 2 Suppliers & engineering provider, 1 battery manufacturer, 1 energy provider, 1 material- and recycling provider, 1 electronics, 1 life-cycle database provider

Research Partners:

4 RTOs, 5 universities

Associates:

6 OEMs, 1 large industry, 1 battery manufacturer, 1 engineering provider, 1 digitisation provider, 2 RTOs, 2 universities, 7 associations

Keep in touch with us and check out the latest **publications and results** on our way towards a commonly accepted and applied single LCA approach for zero-emission road transport.

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