Title:

Technical Briefing Notes
Work Shop 1

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1 Introduction

1.1 Aim of the project

The overall objective of the ***E-Mobility Life Cycle Assessment Recommendations*** **(eLCAr)** project supported by the European Commission under the Environment (including climate change) Theme of the 7th Framework Programme for Research and Technological Development is to support you and other practitioners working in the field of *Life Cycle Assessment* (LCA) and electric vehicle (EV) technologies in Europe, with a particular focus on the ***European Green Cars Initiative*** **(EGCI)**. The key idea is to tailor the guidelines of the *International Reference Life Cycle Data System* (ILCD) Handbook specifically to the needs of practitioners assessing EVs or their components.

The European Green Cars Initiative (EGCI)
The EGCI was launched in 2009 by the European Commission and the industry through projects in the 7th Framework Programme supporting R&D on technologies and infrastructures that are essential for energy efficiency and the use of renewable energy sources in road transport. Main focus is on the electrification of cars, however research topics also include long-distance trucks, and logistics. More than 50 collaborative research projects have been started.[1]

The need for specific guidelines
The new guidelines will provide a more standardized approach by addressing issues such as a clear definition of system boundaries in the context of EV technology which, due to the general character of the ILCD Handbook, are not specifically addressed there. It will also lead to an improved comparability of different results as a common basis for the comparison will be provided which will enable not only to assess specific components of EVs but also to put them into the context of the full vehicle and compare their overall effects with each other.

Stakeholder feedback trough workshops
In order to tailor the guidelines as much as possible to the needs of the community, feedback will be collected through various channels and, particularly, through three workshops. These briefing notes will introduce you to the concepts and ideas elaborated by the eLCAr consortium and contents of the first eLCAr workshop. We count on your participation and we will keep you informed on the further development of our work.

Moreover we invite you already to participate in the follow up discussion on our website www.elcar-project.eu where subsequent drafts of the guidelines will be published for interested stakeholders' comments, and of course to participate in our two following workshops (see the website for a tentative planning). We count on your positive impact and we are glad in advance for interesting discussions with you in the workshops and in the web.

[1] Source: http://www.green-cars-initiative.eu/public/

1.2 The first workshop

Aim of the first work shop

The workshops within the eLCAr project ensure a high integration of the stakeholder needs and expectations into the specific LCA guidelines. We present during the first workshop our ideas and underlying thoughts concerning the specific guidelines and we provide you an opportunity to give us your feedback regarding some specific topics of the future guidelines. Therefore, you are going to obtain information about these specific topics in order to further sharpen the guideline’s focus and to define a realistic technological platform of system parameters. The information will be used to define concrete and specific goals for the specific guidelines.

Aim of the briefing notes

To ensure a lively debate, the briefing notes inform you in advance about the main ideas and discussion topics for this event. This enables you to prepare yourself for the discussion, to get the main idea of the proposals for the guidelines and to give you the opportunity to discuss certain topics with our consortium or your colleagues in advance.

Overview about the work groups

Since during part of the workshop there will be the possibility to follow specific thematic sessions (in three thematic groups - see below), these briefing notes will inform you on the various topics treated in the different working groups.

The workshop will start with a plenary session to provide some background information and to outline the aim. The main work will be done in 3 working groups with the following topics:

- **Group 1: Common parameter platform - Vehicles and components**
  The first group focuses in detail on the technical aspects of e-mobility. The two main topics of this group are: the definition of a Common Parameter Platform and a detailed analysis of key components and their future trends.
- **Group 2: The use phase - Key references and parameters**
  The second group addresses the use phase focusing on the assessment of the energy consumption of electric vehicles.
- **Group 3: LCA challenges and modelling**
  The third group focuses on aspects of conducting an LCA: Best practices for conducting an LCA; specific LCA expectations concerning recommendations for LCAs of electric vehicles and their components; Questions concerning the used guidelines and their problems.

The results from the group discussions will then be presented in plenum at the end of the workshop.

2 Context of the guidelines and briefing notes

2.1 Context of the specific guidelines

Main aspects of Life Cycle Assessment

LCA assesses the environmental aspects and potential environmental impacts throughout a product's life cycle, from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave) by "compiling an inventory of relevant inputs and outputs of a product system" (ISO 14040:2006) and calculating the associated environmental impacts in terms of indicator values like, for example, CO_2-equivalentsfor Global Warming Potential. The procedure is carried out in four basic steps, which are:

(1) **Goal and scope definition:** First, system boundaries and intended application are set. Furthermore, the functional unit of the assessment is defined.

(2) **Inventory analysis**: In the second step, all material and energy flows along the processes of the product system are collected and quantified.

(3) **Life Cycle Impact Assessment (LCIA):** In the stage of the impact assessment, the contribution of the analysed material and energy flows to impact categories is calculated,

(4) **Interpretation:** This step contains the interpretation of the results and the derivation of decisions.

Decisions made during the goal and scope definition step will highly influence the informative value and reliability of an LCA. First of all, functional unit and system boundaries have to be chosen carefully in accordance with the goal of the study. Cut-off criteria, choice of impact categories and especially allocation procedures can also have a high impact on the results. During inventory analysis, data availability and quality and assumptions necessary due to data gaps are crucial. Together with the aforementioned methodological aspects (e.g. allocation rules) these should be checked for their influence on the overall results through sensitivity analyses.

The International Reference Life Cycle Data System (ILCD)

The guidelines are based on the International Reference Life Cycle Data System (ILCD) providing a common basis for consistent, robust and quality-assured life cycle data and studies. Such data and studies support coherent Sustainable Consumption and Production Action Plan (SCP) instruments, such as Ecolabelling, Ecodesign, Carbon footprinting, and Green Public Procurement. This guide is a component of the International Reference Life Cycle Data System (ILCD) Handbook. It provides technical guidance for detailed Life Cycle Assessment (LCA) studies and provides the technical basis to derive product-specific criteria, guides, and simplified tools. It is based on and conforms to the ISO 14040 and 14044 standards on LCA. The principle target audience for this guide is the LCA practitioner as well as technical experts in the public and private sector dealing with environmental decision support related to products, resources, and waste management. [2]

The specific eLCAr guidelines are based on the ILCD handbook.

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[2] Source: ILCD Handbook: http://lct.jrc.ec.europa.eu/assessment/assessment/projects#c

Modularity of the specific eLCAr guideline

The environmental performance of materials and components for electric vehicles can only be compared by looking at them in the context of the production and use of the complete vehicle. Different components (e.g. batteries, motors …) usually have various properties affecting their use in a vehicle (e.g. weight, volume, life time, energy efficiency …). While Cradle-to-Gate Life Cycle Inventory (LCI) data can be established for the production of components, full LCA studies need to consider the use and End-of-life (EOL) phase of the component. This consequently implies that environmental comparison of components of the same type (e.g. electric motors, batteries, controllers …) of a vehicle can only be done on the level of the use of a vehicle, i.e. on the level of mobility. The guidelines will thus propose a modular approach which applies a consistent set of rules for establishing unit process LCI data of material and component production as well as the use and EOL phase of electric vehicles. Many aspects of Goal and Scope definition (e.g. allocation rules, cut-off criteria, …) set for an LCA of driving electric vehicles also apply to the LCI of all the component and material productions involved.

2.2 Aim and goals of the guidelines

The guidelines which will be developed in this project should primarily be a valuable tool for practitioners who establish LCAs of EVs and their components. Indirectly, they should also help lay persons to correctly use the result of these LCAs by ensuring their comprehensiveness and comparability. And last but not least, the guidelines aim at making LCAs established for components or vehicles in one project usable for other applications by fostering “Swiss army knife” LCIs. This means that, as in the original Swiss army knife, there will always be a tool which seems superfluous for a specific task but nevertheless is indispensable for the broader applicability of the data. Even though the guidelines will be too specific to be applicable to every scope one can think of, they aim at being usable for more than 80% of all the LCAs on electric mobility which will be done (in Europe) in the next few years.

The main goals of the guidelines will be:

1. Help practitioners to establish LCIs and LCAs for EVs and their components by
    a. Providing guidance for goal dependent scope definition
    b. Providing information and generic assumptions for background systems
    c. Providing a generic methodology to calculate use phase energy consumption
    d. Providing information and generic assumptions for end-of life (EOL) treatment
2. Ensure that LCIs and LCAs established according to these guidelines are valuable also in a more generic context than just the specific project they are done for and that they are compatible with other studies:
    a. LCI data for a specific component (e.g. battery) compiled in a project shall be applicable for LCA studies of EVs and electric mobility in various contexts.
    b. LCA results for a specific component shall be directly applicable in modular LCAs of EVs as long as the scope of the component study is compatible to the scope of the vehicle study.
3. Support of LCA conducted by the projects in the European Green Cars Initiative by providing useful and applicable specific guidelines ensuring a comparability of the LCA results between the different projects.

3 Group 1: Common Parameter Platform - Vehicles and components

The target groups of this topic are experts from original equipment manufacturers (OEMs) and suppliers. They possess a detailed knowledge on vehicles and their components and are able to provide detailed information and values concerning the Common Parameter Platform (CPP).

3.1 Introduction to Group 1

Two aspects make a CPP useful for LCAs of EVs and their components. Firstly, EVs and their components are complex systems with a large variety of parameters. As these systems are still in development and can be based on different technological solutions, a large range of values can be used. Hence, the comparability of different studies is insufficient. Secondly, if a specific component which influences the complete system of the vehicle is the focus of an LCA, the complete vehicle must be assessed. E. g. a project investigating a lightweight chassis, which only has access to specific data for this component, can find average reference values for the other components of the vehicle in the CPP.

Therefore, **the goal of work group 1 is to discuss and agree on a CPP**. The function of the CPP is to give LCA practitioners generic values on key issues of vehicles (e.g. weight, range, etc.) and their components (e.g. efficiency, weight, etc.). Technologies are included, which should be used as standard assumptions, in order to enhance the comparability of LCA studies on EVs.

The values are intended to be average reference values in order to build a **full EV modularly**. The values should be representative for a near future scope, i.e. **2012-2017**. Hence, they will have to be adapted from time to time in the future. Values are given for two different vehicle classes, **micro and compact cars**.

The group focuses on the following key components and their characterization as well as future trends of the production and EOL phase. In this first workshop the whole structure of the CPP is presented, however, only technical values of the vehicle and its components are discussed. The remaining parameters are left blank.

- Vehicle
- Glider
- Drivetrain
- Li-ion battery
- Assumptions on future developments:

We invite you to have a close look at the tables of your field of interest and to compare the values with your own data sets. During the workshop we will discuss these values in detail. Parameters regarding the use phase are discussed separately in work group 2.

3.2 Modularity

The specific eLCAr guidelines will contain a **modular** description of the main components of an EV. As described before, the aim of this modularity is to give you the information to enable you to work on the component level not only to establish cradle-to-gate LCI for the components but also to test the components' environmental performance within a complete system.
The modular approach will prove particularly useful in the context of developing guidelines within the EGCI since in this initiative projects very often work on the development of a specific component rather than an entire vehicle system. Nevertheless, the guidelines will provide all information for conducting an LCA for a complete EV as well as for different components of EVs. The modular approach will therefore be reflected in the development of the guidelines on 2 different levels.

Firstly, the guidelines will be constructed so as to allow you to correctly model the particular component which is the object of your study. The modular approach described above allows to maximise transparency and to facilitate the analysis of specific contributions within the system. In this case only the modelled component is assessed.

Secondly, since many of the projects within the EGCI address the development of components for EVs, guidelines, recommendations and key information on the modular modelling of an entire vehicle will be given. Practitioners working on components of vehicles will thereby be able to analyse the overall impact of the device in a complete system. Since, in general, the objective of developing a new component is to enhance the overall performance of an entire vehicle, this feature will allow to truly assess the improvements or problems caused by a new technology.
Hence, by performing an LCA of an entire vehicle, practitioners will be able to analyse the implications of the application of a specific (new) component on the total system and study the interplay between various potential benefits or drawbacks.

Besides containing general information on EVs such as, for example, typical sizes and dimensions or driving ranges, the guidelines will describe in more detail the components shown in Figure 1.

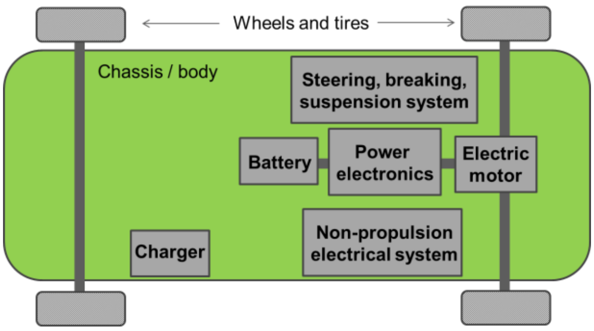


Figure 1: Decomposition of an electric vehicle

The points of discussion concerning this topic are the following:

- Can this modularity support your work concerning your LCA studies?
- Do you model only the particular component or do you include it into the whole system?
- Are the main modules of the EV shown in Figure 1 the ones that should be described in the guidelines and in the common parameter platform?

3.3 Technical aspects and development of a Common Parameter Platform

For the development of the CPP, assumptions for the following aspects have to be made:

- Typical vehicle sizes/ types
- Typical modules in battery EVs and PHEVs (sizes/ weights/ characteristics of battery, electric motor, power electronics, internal combustion engine (ICE) motor, chassis)
- Realistic vehicle performance (range, consumption)
- Electric infrastructure (charging stations)

The thesis will contain exact values for all these aspects that will be discussed in this group.

The following tables present first values for the common parameter platform. Please, check if the presented values are reasonable and can be used for a common parameter platform.

(The italic written parameters are not discussed during the first workshop.)

Table 1 – Vehicle – Main characteristics

Parameter – Vehicle	Micro (Smart type, 2 passengers)	Compact (Golf)	Stakeholder request
Weight (overall)	970kg	1500kg	
Frontal area [m2]	2	2.22	
Aerodynamic drag (Cw)	0.35	0.31	
Rolling resistance (tyres)	0.012	0.012	
Electric motor power	40kW	90kW	
ICE motor (PHEV)	0.8L	1.2L	
ICE fuel (PHEV)	Petrol	Petrol	
Battery technology	Lithium Ion	Lithium Ion	
Battery weight	200kg	300kg	
Assembly/ production electricity demand			
Assembly/ production heat demand			
Recycling electricity demand			
Recycling heat demand			

Table 2 - Glider

Parameter – Glider	Micro (Smart)	Compact (Golf)	Stakeholder request
Body (frame) weight	350kg	550kg	
Steering, breaking and suspension system (SBSS) weight	90kg	140kg	
Wheels and tires weight	40kg	65kg	
Cockpit (Seats, belts, interiors, dashboard etc.)	180kg	285kg	
Non-propulsion related electrical systems weight	40kg	60kg	
Separated materialization for body, SBSS, electrical system, wheels and tires			
Separated production electricity demand			
Separated production heat demand			
Separated EOL (electricity/ heat/ outcome materials)			

Table 3: Average characteristics for Li-Ion Batteries

Parameter – Li-ion battery	Proposed value
Specific energy density (battery including battery management system (BMS), box and cooling system, not only cell or module)	80 to 110 Wh/kg
Charging efficiency (CE)	80 to 90 %
Discharging efficiency (DE)	80 to 90 %
Overall efficiency: CE*DE	tbd
Power density	tbd
Deep cycle lifetime	5’000 cycles
Shallow cycle lifetime	200’000 cycles
Calendar life (years)	8 years
Typical capacity (Battery EV)	10 to 30 kWh
Typical capacity (PHEV)	10 to 20 kWh
Materialization	
Production electricity demand	
Production heat demand	
EOL (electricity/ heat/ outcome materials)	

Table 4 – Drive train

Parameter – Drive train	Micro (Smart)	Compact (Golf)	Stakeholder request
E-Motor weight	20kg	50kg	
E-Motor efficiency (average urban / average extra urban)	90%	90%	
ICE drivetrain weight (PHEV; engine, transmission, cooling, tank, exhaust)	120kg	185kg	
ICE motor efficiency (PHEV) (average urban / average extra urban)	28% // 33%	30% // 35%	
Power electronics weight (controller, inverter, distribution, cables)	30kg	30kg	
Power electronics efficiency (average)	92%	92%	
Transmission system weight	20kg	20kg	
Transmission system efficiency (average)	98%	98%	
Charger weight	7kg	7kg	
Charger efficiency (average)	92%	92%	
Separated materialization for all components			
Separated production electricity demand			
Separated production heat demand			
Separated EOL (electricity/ heat/ outcome materials)			

3.4 Assumptions for future developments

The following part presents some main assumptions on the future development of the following issues

- Vehicle design
- Batteries
- Lightweight scenarios
- Future technologies which may play an important role (e.g. supercapacitors)
- Future vehicle concepts (Hybrids, PHEV) concerning the build-up and used components and materials

Table 5 – Assumptions about the development of li-ion batteries

Parameter – Li-ion battery	2017	2022
Optimization type		
Specific energy density (battery, not cell or module)	250Wh/kg	400Wh/kg
Overall efficiency: CE*DE	96%	96%
Power density	tbd	tbd
Lifetime (years)	10 years (160,000 km)	10 years (160,000 km)

Table 6 – Vehicle mass reduction and lightweight technology developments

Lightweight technologies	2012-2022
Mass reduction potential	10%
Mass reduction potential – vehicle concept/ downscaling	5%
Mass reduction potential – lightweight materials	5%
Lightweight material technology	Aluminium/ plastic

4 Group 2: The use phase - Key references and parameters

4.1 Introduction to Group 2

Target groups: OEMs, vehicle manufacturers and researchers with an interest in vehicle consumption assessment.

LCA aims at assessing the resources used and emissions caused during the entire life cycle of a product. Hence, when focusing on a vehicle, the analysis of the use phase requires to identify all the environmental impacts which are related to its utilisation. A key element is the assessment of the energy required for the motion as this determines the energy which will have to be supplied to the vehicle. In our analysis of the utilization of EVs, we will focus on the situation in which the motion of the vehicle is sustained only by the battery and the electric motor since the technical complexity and variety introduced by the different hybrid propulsion systems involving internal combustion engines is outside the scope of the guidelines. In this context, determining the energy consumed by the vehicle due to its motion allows one to evaluate the electricity which needs to be generated for charging the battery. The technology used for generating this electricity (e.g. photovoltaic or coal) has a strong influence on the impacts caused due to the resources which this may require (particularly in terms of renewable vs. non-renewable sources) and the different emissions which are produced during the generation process.

However, the consumption of a vehicle depends on a large number of variables. Clearly, the type of vehicle (e.g. its weight and shape) has a major impact on its consumption. At the same time, the driving behaviour, the vehicle usage (city as opposed to rural or highway driving) or climatic conditions will, too, influence the final result. Also, the consumption of a vehicle can be determined in two ways: by a measurement on a real vehicle or on fleets of vehicles or through calculation.

In most cases, for the use phase of the LCA of a vehicle, one is interested in evaluating a consumption which is representative of an average “real world” scenario. Values which are more representative of such an average “real world” are those coming from measurements on large fleets of the same vehicle which will include a large spectrum of different drivers, driving situations and geographical locations. However, data from these measurements are rarely accessible and only describe the consumption of one specific type of vehicle.

Overall, this wide range of variables results in, either, a lack of data concerning the specific vehicle one is interested in or very different reported values of vehicle consumptions which, when used in an LCA, limit the comparability of different studies.

The guidelines which are being developed within the eLCAr project aim at supporting practitioners in 2 ways: First, by proposing a simple consumption calculation model which will allow practitioners to evaluate the consumption of the specific vehicle they are analysing. Then, by defining a set of parameter scenarios concerning, amongst other things, the driving cycles on which the consumption evaluation shall be done, the typical load of the vehicle, climatic conditions and use of heating and cooling. The idea is not to limit the freedom of the practitioners, but to define a number of representative “real world” scenarios in order to enhance the comparability of different studies.

Practitioners, who are focusing on particular use patterns of the vehicles, will obtain enough information for evaluating the consumption for their specific case.

During the workshop, a part from describing the consumption model, key parameters concerning the model and the "real world" scenarios will be proposed and discussed.

4.2 Simplified Consumption model for BEVs

Our target is the development of a simplified universal energy consumption model for BEVs for several driving patterns as well as for additional energy consumers like vehicle heating and air conditioning. The number of model parameters to describe the vehicle and the environmental conditions should be as small as possible to achieve a simple operation of the model.

Two methods will be used for the model development. First, the energy consumption of two different BEVs will be investigated by analysing measurements from a chassis dynamometer. The test results will be evaluated according to a procedure developed by the Internal Combustion Engine Laboratory of the Empa (Soltic et al., SAE Int. J. Engines, p.2395, Vol.4, 2011), describing the correlation between the mean positive wheel power which is necessary to keep the vehicle in motion and the mean electrical power provided from the vehicle battery (Willans approximation). This empiric approximation will be compared with the results of a detailed vehicle simulation model for investigating the sensitivities in the vehicle parameters.

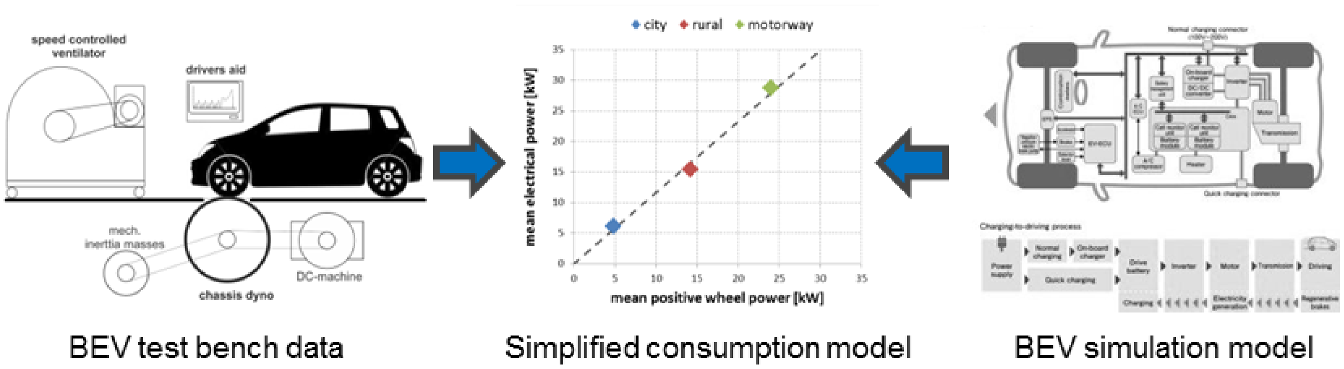


Figure 2: Input models for the simplified consumption model

4.3 Points of discussion

During the workshop, several questions with important relevance on the output of our consumption model will be discussed. This includes especially the definition of which vehicle shall be analysed for the consumption models and the "real world" conditions or the use conditions of the model.

The idea is to define a set of default values for the vehicle parameters, driving pattern description and climatic conditions which will be included in the model, but to also leave the possibility for the practitioner to use specific data (e.g. specific vehicle and/or driving pattern data). The definition of the set of parameters will occur starting from an ensemble of proposed values which will be discussed during the workshop.

Apart from some specific vehicle parameters like typical luggage and passenger load, object of discussion will also be the definition of 3 specific driving profiles (city, rural and motorway) and use patterns concerning cooling and heating with respect to different geographical zones and temperatures. Some example values can be found in section 4.4.

4.4 Proposal for standard “real world” values for BEVs

Vehicle

Vehicle parameter (driving resistance):	Standard Compact (e.g. VW Golf VI), Micro (e.g. Smart) – Will be defined within Working Group 1.
Vehicle mass (including battery):	1500 kg/ 970kg – Will be defined within work group 1.
Passenger weight:	75kg
Number of passengers:	1/2/3
Additional vehicle load (luggage etc.):	50 kg

Driving pattern

Driving profile (vehicle usage):	CITY (60% city, 20% rural, 20% motorway) RURAL (20% city, 50% rural, 30% motorway) M.WAY (20% city, 20% rural, 60% motorway)
Heating:	defined approach acc. to temperature profile for north, middle and south Europe
Air conditioning:	defined approach acc. to temperature profile for north, middle and south Europe
Annual driving distance (BEV):	10’000 km

5 Group 3: LCA challenges and modelling

5.1 Introduction to Group 3

The third group focuses on methodological aspects of conducting an LCA:. The target group for this topic are LCA practitioners and, to a lesser extent, LCA commissioners.

LCA is a systematic approach to holistically assess a decision, product or service. This means that all potential environmental impacts related to or caused by the decision, product or service including all the up- and downstream processes in the whole production chain. LCA takes a functional perspective which means, that it does not just look at a product but rather at the function of the product and that comparisons are only allowed on the level of functional equivalence.

The approach is defined in a set of ISO Standards (mainly ISO 14’040 / 14’044) which are further elaborated in various guidelines, e.g. in the ILCD Handbook. The ISO standard and the ILCD Handbook have to be applicable to all possible situations to which LCA should be applied. Consequently, they are rather lengthy and unspecific in many aspects. They often need to give various options since more specific guidance would not be applicable for all potential uses. This can lead to the situation that different practitioners following the same guidelines to calculate an LCA for the same system with the same goal come to significantly different results.

The handbook to be established in this project is focussing on EVs with their components and use and thus can be more specific than the ILCD Handbook in many aspects. Such a cookbook type of guidance is obviously not suited to all potential situations in which LCA might be used but it might be applicable to 80% of the cases.

The aim of this group is to determine how to deal with the key choices to be made in LCA of EVs. As a result we expect a list of topics where we can give specific advice. Therefore, we first have to look at the procedure of establishing LCAs (Figure 3) and the choices to be made in this process.

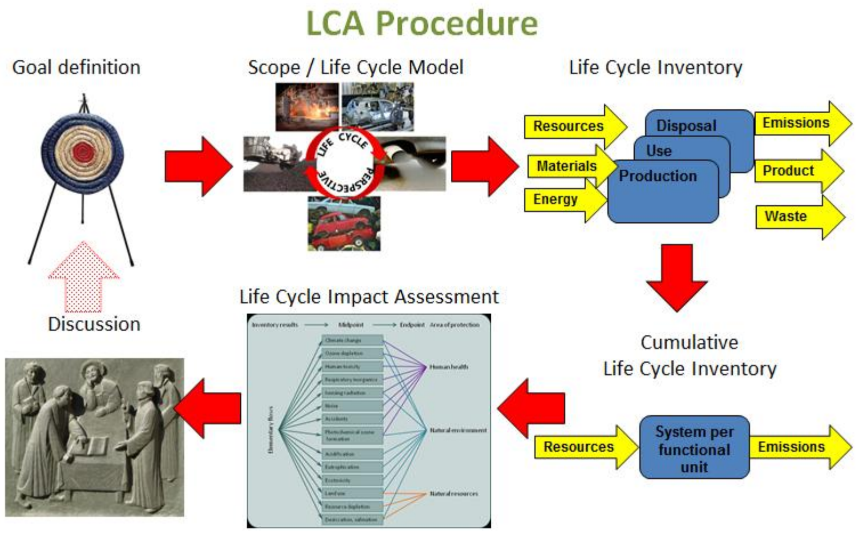


Figure 3: generic LCA procedure according to ISO 14’044 and to the ILCD Handbook

The most important choices are made in the first two steps: The goal definition basically determines all the subsequent steps. It guides the details of the scope definition and thus of the life cycle model to be established which again determine the data requirements and the impacts to be assessed.

We hypothesise that the goal of most LCA studies in the electric mobility context either involves a comparison and / or aspects of eco-design.

Consequently and since electric mobility is an emerging technology, one can presume that most of the studies in this field are decision related. It also implies that **LCAs of vehicles or components always have to account for the context in which the vehicles or components are used**.
The function which finally should be provided by a battery or an electric motor is mobility. Thus, a comparison of e.g. traction batteries for electric cars can only be done in the context of a car (including production, use and EOL) since several properties like the battery weight, its capacity or its power output determine the energy consumption and the range of the car while e.g. the materials contained in the battery determine the EOL steps (cf. Figure 4).

The implications for the **functional unit** are clear: **it needs to include all the properties that are relevant in the context of mobility.**

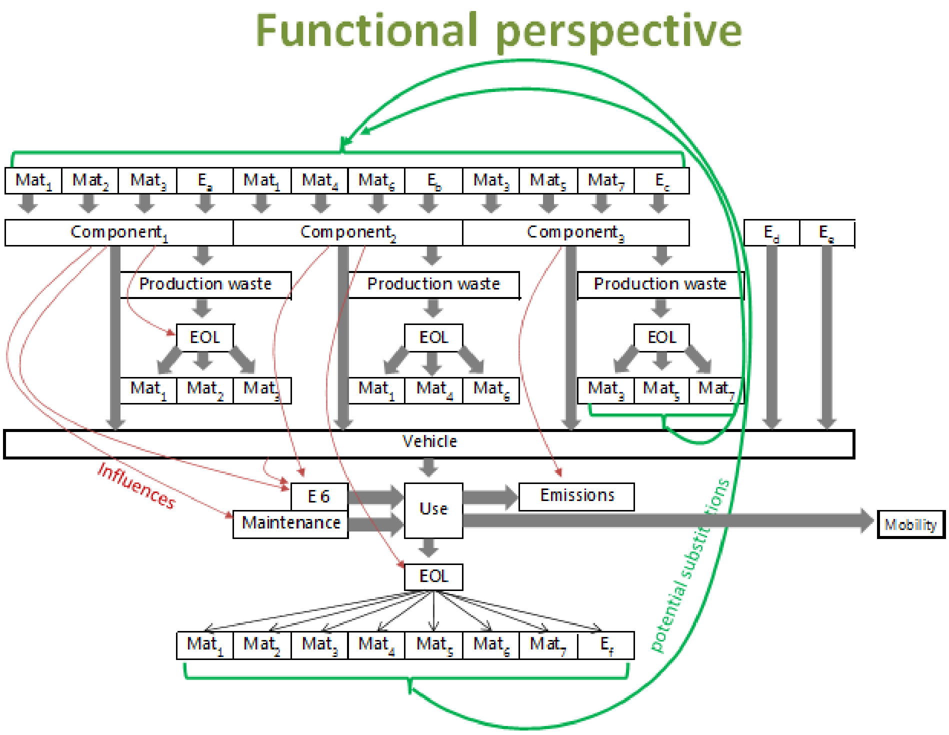


Figure 4: influences of the properties of components on the functionality. "Mat" stands for "material, "E" for "energy"

5.2 List of topics

In this group we are going **to discuss** the hypotheses made above and the implication of them (or of the adapted hypotheses) on the following issues from goal and scope definition:

- **Goal definition / decisional context:**
  - What have the goals of most LCA studies for EVs, their components and use in common?
  - Which decisional contexts (according to ILCD Handbook) are relevant?

- **Modelling principle:**
  - Attributional or consequential?
  - Criteria for the choice of the principle

- **Dealing with multi-functionality:**
  Allocation or system expansion.
  - Are there situations where system expansion is not possible?
  - How to find appropriate substitutes in specific situations?

- **System boundaries:**
  - Definition of boundaries and quantitative cut-off criteria

- **Reproducibility, robustness and transparency:**
  - How to ensure reproducibility of results and thereby data collection and modelling (two practitioners doing the same study should come to the same conclusions!)?
  - How to improve stability of conclusions?
  - How to deal with the conflict between transparency and confidentiality?

- **Primary and secondary data:**
  - definition of foreground / background system

- **Relevant impacts**
  - Impact assessment methods
  - Inventory flows to be included

6 Annex

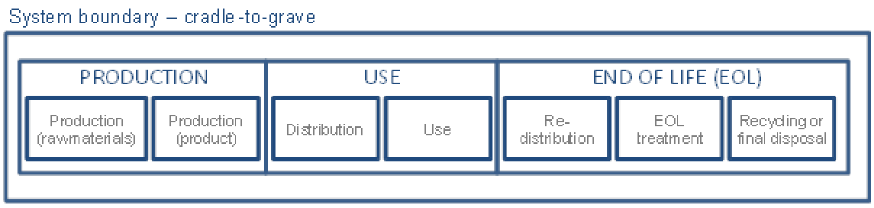
6.1 Terms and definitions

Allocation[3]
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 modelling[4]
LCI modelling frame that inventories the inputs and output flows of all processes of a system as they occur. Modelling process along an existing supply-chain is of this type.

Categorization of the production, use and end-of life phase

Cradle to grave



Comparative life cycle assessment[4]
Comparison of LCA results for different products, systems or services that usually perform the same or similar function.

Consequential modelling[4]
LCI modelling principle that identifies and models all processes in the background system of a system in consequence of decisions made in the foreground system

Cut-off criteria[3]
Specification of the amount of material or energy flow or the level of environmental significance associated with unit processes or product systems to be excluded from a study

Functional unit[3]
Quantified performance of a product system for use as a reference unit

Impact category[3]
Class representing environmental issues of concern to which life cycle inventory analysis results may be assigned

International Reference Life Cycle Data System (ILCD)[4]
The ISO 14040 and 14044 standards provide the indispensable framework for Life Cycle Assessment (LCA). This framework, however, leaves the individual practitioner with a range of choices, which can affect the legitimacy of the results of an assessment. While flexibility is essential in responding to the large variety of questions addressed, further guidance is needed to support consistency and quality assurance. The International Reference Life Cycle Data System (ILCD) has therefore been developed to provide guidance for consistent and quality assured Life Cycle Assessment data and studies. The ILCD consists primarily of the ILCD Handbook and the ILCD Data Network.

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[3] Source: EN ISO 14040:2006;
[4] Source: JRC, ILDC Handbook – General guide for LCA PROVISIONS, 12 March 2010

	The development of the ILCD was initiated by the European Commission and has been carried out through a broad international consultation process with experts, stakeholders, and the public.
Life Cycle Assessment (LCA)[4]	Life Cycle Assessment (LCA) is a structured, comprehensive and internationally standardised method. It quantifies all relevant emissions and resources consumed and the related environmental and health impacts and resource depletion issues that are associated with the entire life cycle of any goods or services ("products"). Life Cycle Assessment is a vital and powerful decision support tool, complementing other methods, which are necessary to help effectively and efficiently make consumption and production more sustainable.
Reference flow[3]	Measure of the outputs from processes in a given product system required to fulfill the function expressed by the functional unit
Substitution[4]	Solving multifunctionality of processes and products by expanding the system boundaries and substituting the not required function with an alternative way of providing it, i.e. the process(es) or product(s) that the not required function supersedes. Effectively the life cycle inventory of the superseded process(es) or product(s) is subtracted from that of the analysed system, i.e. it is "credited". Substitution is a special (subtractive) case of applying the system expansion principle.
System boundary[3]	Set of criteria specifying which unit processes are part of a product system
System expansion[4]	Adding specific processes or products and the related life cycle inventories to the analysed system. Used to make several multifunctional systems with an only partly equivalent set of functions comparable within LCA.
System[4]	Any good, service, event, basket-of-products, average consumption of a citizen, or similar object that is analysed in the context of the LCA study. Note that ISO 14044:2006 generally refers to "product system", while broader systems than single products can be analysed in an LCA study; hence here the term "system" is used. In many but not all cases the term will hence refer to products, depending on the specific study object. Moreover, as LCI studies can be restricted to a single unit process as part of a system, in this document the study object is also identified in a general way as "process / system"

6.2 Abbreviation

BEV	Battery electric vehicle
BMS	Battery management system
CE	Charging efficiency
CPP	Common Parameter Platform
DE	Discharging efficiency
EGCI	European Green Cars Initiative
eLCAr	E-Mobility Life Cycle Assessment Recommendations
EOL	End-of-Life
EV	Electric vehicle
ICE	Internal combustion engine
ILCD	International Reference Life Cycle Data System
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory Analysis
LCIA	Life Cycle Impact Assessment
OEM	Original equipment manufacturer
PHEV	Plug-in hybrid vehicle
SBSS	Steering, breaking and suspension
SCP	Sustainable Consumption and Production Action Plan