Work Package (WP) No: 3

Title:

D3.2

Methodological and legal implications of revised guidelines

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Date: 26.01.13

Version: v9

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013).

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D3.2

Methodical and legal implications of revised guidelines

1 Introduction

This report deals with the implications (with respect to qualitative and legal implications) of the newly developed guidelines and their practical application.

The impact of new guidelines on the conduction of LCA regarding quality and usability is analyzed using the evaluation criteria defined in D3.1. Chosen criteria and a detailed description of possible effected categories have been presented in deliverable D1.3. The approach for the determination of evaluation criteria has been divided into two aspects:

- the quality of LCA studies and
- the usability of the guidelines.

The first part "**quality of LCA studies"** analyses the change of LCA results due to the application of the guidelines. The impact of the guidelines can be measured for example by assessing the possible spread of the final LCA results such as the GWP spread. The evaluation of the guidelines according to the evaluation criteria from D1.3 shows a reduced band width of the results of the LCA. These results are compared to the LCA results using different degrees of freedom without guidelines. The differences show the impact of the guidelines and allow an assessment of the guidelines.

The second aspect, the **usability,** contains all factors defining the usefulness and handling of the guidelines for the users. The factors assess qualitative aspects such as comprehensibility and accuracy.

Furthermore, the implications for environmental and innovation policies – for instance due to systematic shifts in the emissions' allocation arising from the guidelines tailored to electric vehicles – will be investigated using the results of the use case applications.

2 Quality of LCA studies

2.1 Qualitative assessment

One goal of this qualitative investigation is to assess the **completeness** of studies, because this determines quality and reproducibility of a study. Moreover, it reflects whether a conducted LCA study is created comprehensible and transparent. For this assessment studies needs to be reviewed for missing information in order to further analyze if the observance of the guidelines entails improvement potential for these parts. Based on the completeness of a study, conclusions can be drawn about the quality and improvement potential of specific guidelines.

2.1.1 Varying provision of information in existing studies

For the analysis of missing information of existing studies listed in D3.1, studies providing relative detailed information about the LCA conduction have been analysed regarding available and missing information within the studies. Depending on the goal and the scope of the studies, the provided information and the detail of these information change significantly. The following lists show aspects that normally are available in LCA studies as well as missing aspects that are not always available even if necessary.

Information available in studies

- Goal/intended application: Goal, reasons for carrying out the study, by whom, application field (basic scenario), comparisons intended
- Functional unit
- Product system: general description (vehicle classification, propulsion technology, weight, consumption, lifetime range, battery technology)
- Users behavior
- Life cycle phases: Production, Use, EOL
- Production phase: Battery production, raw material acquisition,
- EOL: recycling of the battery, Use of transport services
- Impact categories: Resources utilization, global warming, acidification, eutrophication, carcinogenic
- Valuation: EPS,ET (global warming, acidification, eutrophication, Carcinogenic)
- Documentation of remaining data gaps
- LCA modification
- Usage of SI Units
- Conclusions, limitations and recommendations

Missing aspects

- Limitations of use of the LCA study
- System boundaries: Geographical frame, time frame, charging infrastructure
- Missing impact categories: Human toxicity, ionizing radiation, respiratory inorganics, climate change, land use, Eco toxicity
- Category endpoints: Damage to human health, Damage to ecosystem, Depletion of natural resources
- Identification of resources: renewable, non- renewable
- System boundaries: road and charging infrastructure
- Scope and data representatives: geographical, time-related
- Reporting form, reporting level
- Use phase: Electricity network used for delivering the electricity with which the battery is charged
- Solving multifunctionality
- Allocation method: Which allocation rule is applied in which part of the system?
- Electricity mixes and distribution networks

These lists are not representative due the high variance in the given information in LCA studies and the varying goals of the publication of the studies. Nevertheless, most LCA studies do not publish every important LCA detail due to different aims of the publication. The usage of the eLCAr guidelines shall improve the completeness of LCA to support transparency, quality and reproducibility of the studies and to ensure comparability between different projects especially for the projects within the European Green Cars Initiative. Moreover, detailed information reflects whether a conducted LCA study is conducted comprehensible and transparent.

The change of studies conducted with or without the eLCAr guidelines is not assessable without a study that actually used the eLCAr guidelines. Therefore, based on the information that should be given in a LCA study due to the ILCD Handbook, the eLCAr guidelines demand the provision of detailed information regarding various part of the LCA. If a study is conducted following the eLCAr guidelines, all relevant information will be given.

To support the practitioners conducting a LCA study, a checklist containing all relevant information that should be given in the study is provided in the following. The list will be available as a separate download file on the website.

2.1.2 Checklist

In order to find missing information, the following table has been developed containing important aspects of an LCA study which are required due to the ISO 14040 series and the ILCD handbook. The table has been expanded due to information given in the finalized eLCAr guidelines.

Goal/Intended application	What is the intended application?	
	Wherefor? (Application field)	Micro-level
		Macro-level
	Who is the audience to whom the results are communicated?	
	Is the audience internal, restricted external or public?	
	Comperative assertion intended?	
	Are there limitations for the use of the LCA Study?	
	What is the reason for carrying out the study?	
Product system	General description	Vehicle classification
		Propulsion technology (BEV, HEV, PHEV)
		Weight
		Consumption
		Lifetime
		Range
		Location and time horizon of the study
	Features/Components incl. Weight	Battery
		Electric motor
		Power electronics
		Non propulsion electrical system
		Vehicle body
		Steering, braking and suspension system
		Wheels and tires
		Transmission system
		Cockpit related equipment
		For serial PHEVs: internal combustion engine (ICE) system
System flow chart and system boundaries (incl. written description)	Performance Indicators	Mass
		Energy
		Environmental relevance
		Other/Further
	Life cycle phases	Production
		Operation/Usage
		End-of-Life
	Operation/Usage	energy consumption
		electricity network
		specific electricity mix
		road infrastructure

		Non-exhaust emissions
		maintenance of the vehicle
	End-of-Life	Dismounting of vehicle
		Recycling of battery
		Recycling of electric motor
		Recycling of power electronics
		Recycling of wheels and tyres
		Shredding of residual car body
		Raw material demand
		Energy carrier demand
		Demand of auxiliaries
		Use of transport services
		Waste flows
		Emissions
	Foreground/Background	
	Functional unit	
	unit process of the foreground system	Infrastructure
		Energy carriers, specifying type and amount:
		Electricity: the specific electricity mix used for the production process shall be identified
		Heat: the relevant properties and sources of heat shall be identified.
		Raw material inputs (e.g. steel, specific plastic types, etc.)
		Ancillaries / consumables needed for production (e.g. water, chemicals, etc.)
		Specific emissions to air, water and soil produced by the process
		Output and type of wastes and their treatment services
		Output of scrap suitable for reuse or recycling
		Transport services
	Time-frame	
	Geographical scope	
Allocation Approach	Which allocation rule is applied in which part of the system? (Selection)	System expansion
		System reduction
		Mass
		Energy
		Economic value
		Other (Exergy…)

Materialisation	Foreground data (Primary data)	Measured data?
		Which database?
		Other sources
	Background data	Which database?
		Other sources
Impact Assessment LCIA	Impact categories	Human toxicity
		(Ionising) radiation
		Carcinogen
		respiratory diseases
		Climate change
		(Stratospheric) ozone depletion
		Acidification (soil, water)
		Eutrophication (soil, water)
		Ecotoxicity (fresh water, sea, land)
		Photochemical ozone formation (Summer Smog)
		Land use
		Resources consumption (mineral, fossil and renewable energy resources, water…)
		Other/Further
	Category endpoints	Damage to human health
		Damage to ecosystem
		Depletion of natural resources
	Avoid single score methods	
	Characterization factors (Specification of the specific factors)	
	Weighting	
	Normalisation	
	Assessment methods (Selection)	CML01/02
		IMPACT2002+
		Ecoindicator 99 (incl. perspective)[1]
		ReCiPe (incl. level and perspective)[2]
		EDIP97/2003
		CED

[1] Hierarchist, Egalitarist, Individualist; Eco system quality, Resources, Human health

[2] Midpoint-Level, Endpoint-Level; Hierarchist, Egalitarist, Individualist

		CExD
		Other/Further…
Review needs	Review type: Decide which type of review is to be performed as minimum.	
	Reviewer(s): It is recommended to decide at this point who is/are the reviewer(s).	
Reporting	Form of reporting	Detailed report
		Data set
		Data set plus detailed report
		Non-technical executive summary
	Level of reporting	Internal
		External (but limited, well defined recipients)
		Third-party report, publicly accessible
		Report on comparisons, publicly accessible.

The checklist gives a quick overview and allows checking if all relevant points are considered and described in the study. Missing points and assumption within the study can be identified and added leading to a better quality of conducted and published LCA studies. Moreover, the quality of reports and studies can be enhanced.

Studies using the eLCAr guidelines will contain the most important LCA aspects that have to be mentioned in publications.

2.2 Quantitative assessment

The quantitative evaluation requires a different approach for the assessment compared to the qualitative evaluation. This approach shows the importance of using the guidelines. The aim is to show a quantitative improvement of the quality and the comparability of the results from different studies based on D3.1.

2.2.1 Impact categories and indicators for LCIA

For conducting a LCA for the two applications, which have been identified in Deliverable D3.1, and for the evaluation of the results, impact categories and impact indicators have to be selected.

Several indicators can represent a category. The material flows from the simulations are assigned to these indicators by the CML-Method. Additionally (not shown in the figures) a cumulative energy evaluation method was used, which is named “Resources” hereafter and shows the use of energy resources. Figure 1 and Figure 2 show the evaluation of all available indicators for the reference use case (all parameters set to the reference value, see Table 1).

Parameter	Value	Unit
charging efficency	90	%
consumption	0,2	kWh/km
number of cycles	1500	
energy density	100	Wh/kg
functional unit	180000	km
max. depth of discharge	80	%
electricity mix	UCTE	
range	120	km/cycle

Table 1: Parameters in the reference case

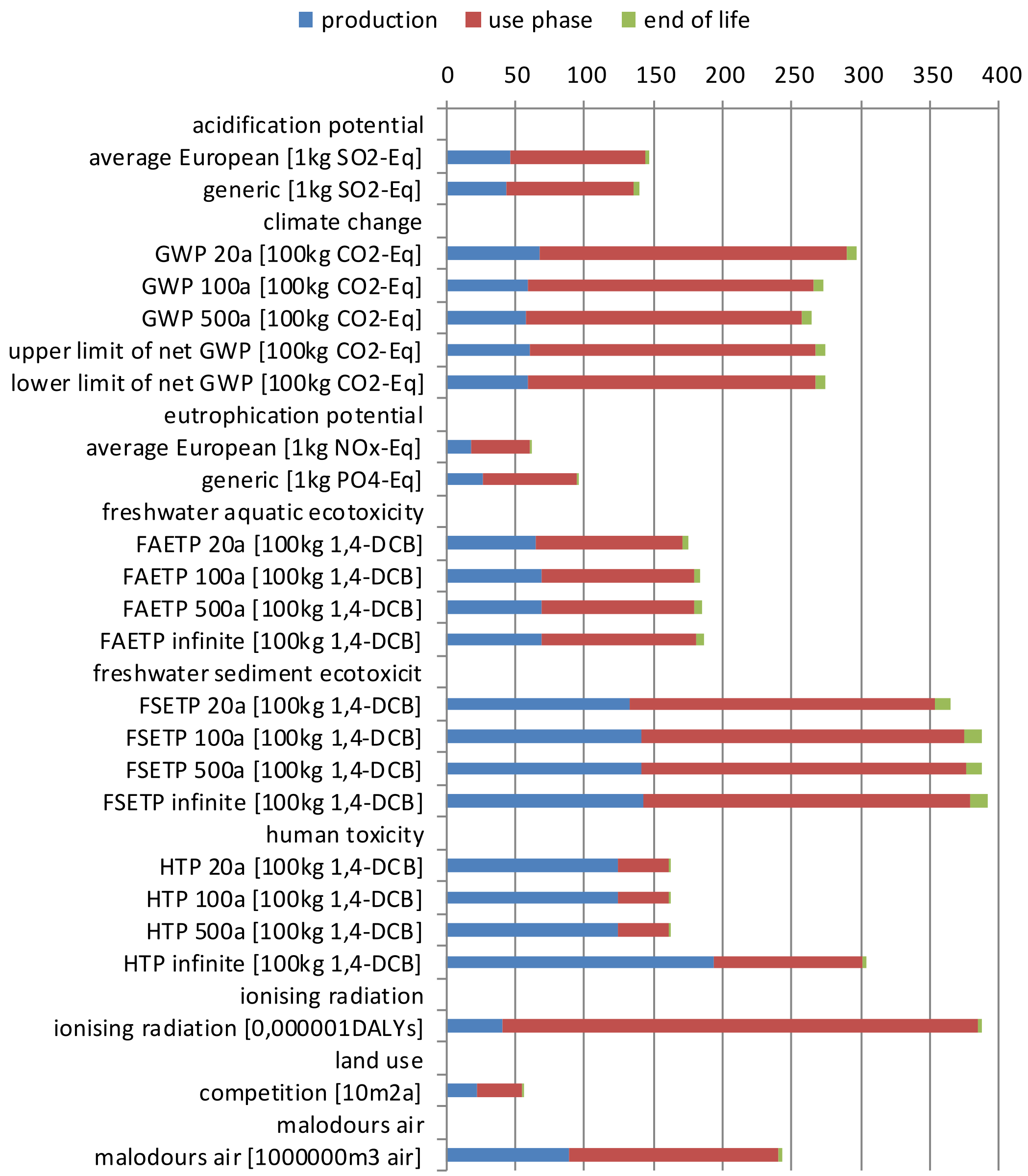

Figure 1: Categories of the Impact Assessment Method (Part 1)

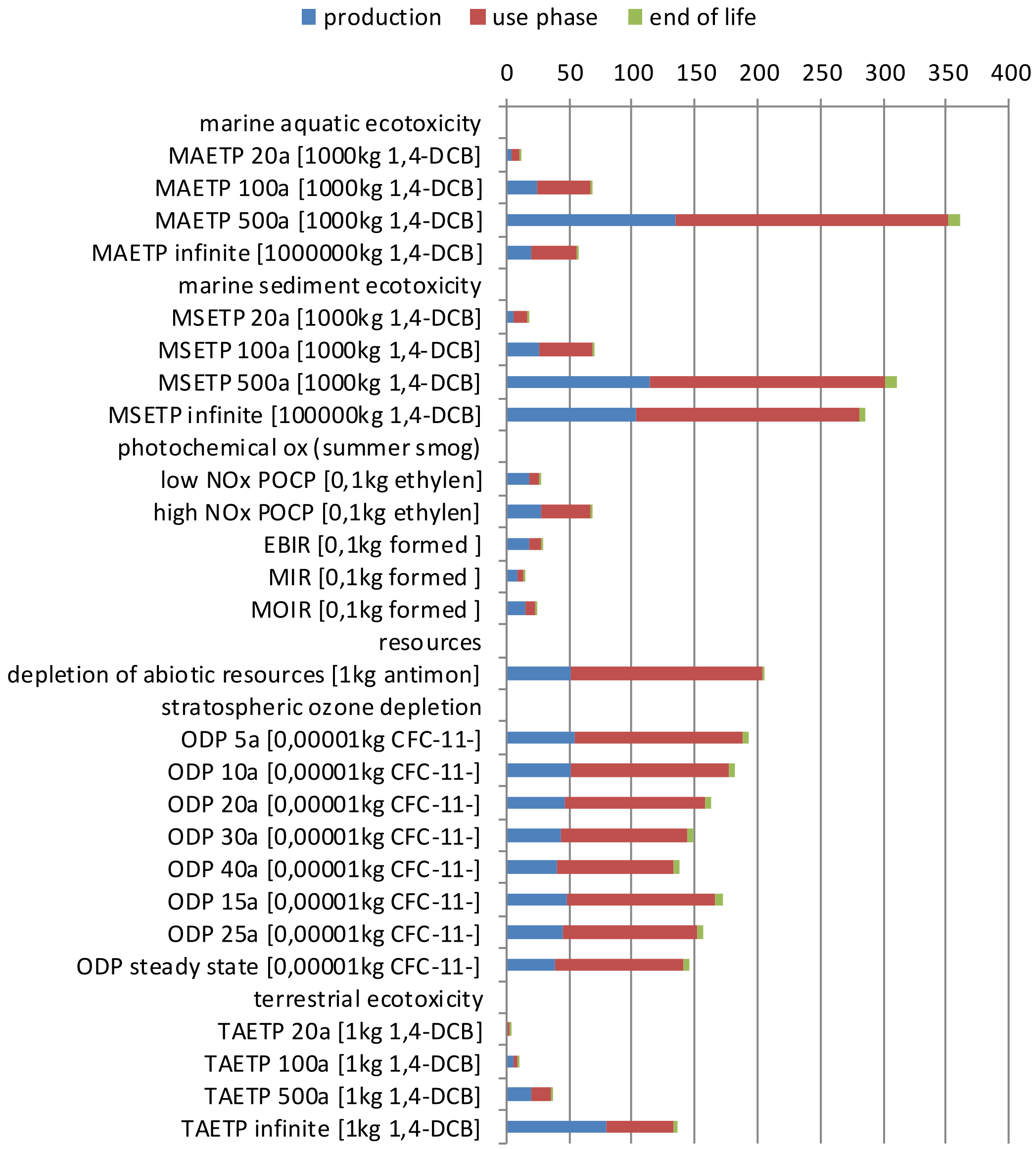

Figure 2: Categories of the Impact Assessment Method (Part 2)

2.2.2 Shares of LCA phases

In order to determine the most relevant life phases for the 2 applications mentioned in deliverable D3.1 a LCA has been conducted for the total life cycle of an electric vehicle, from production to the use phase to the end of life phase. The impact of such a vehicle life cycle has been analyzed regarding the global warming potential, acidification, eutrophication and the use of resources as extractions of the CML2001 method presented in chapter 2.2.1.

Figure 3 shows the global warming potential of a vehicles life phase. Hereby the use phase takes up only three quarters of the total global warming potential for the reference case using the UCTE electricity mix. One quarter is shared by the production and the end of life phase, where the vehicle parts have to be disposed. Despite of the batteries weight and size compared to the vehicle, it takes up 30% and 40% of the production and end of life global warming potential.

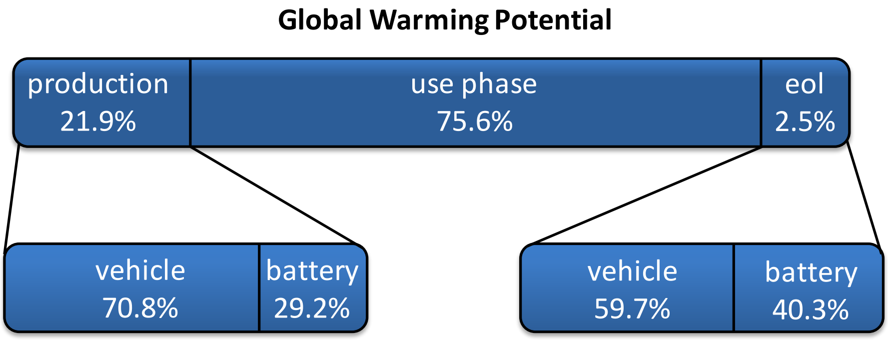

Figure 3: Shares of GWP used by life phase

Acidification is caused by acids that contribute to death of fish and forests, damage on buildings etc. The most significant man made sources of acidification are combustion processes in electricity and heating production, and conventional transport. The results in Figure 4 show the major part of acidification in the use phase, caused by electricity generation for charging the vehicle. Conspicuous is also the large share of the battery disposal in the end of life phase in acidification which is caused by the acidic contents of the battery (in this case the Li-ion battery).

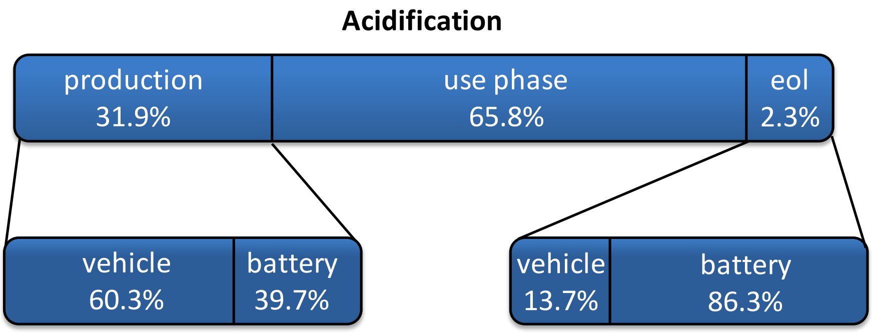

Figure 4: Shares of Acidification used by life phase

Eutrophication causes algal bloom in inlets and springs causing oxygen depletion and death of fish. Emissions of nitrogen to the aquatic environment, especially fertilizers from agriculture contribute to eutrophication. Also oxides of nitrogen from combustion processes are of significance. This can be seen in Figure 5 where the end of life phase only causes a relatively small proportion of eutrophication. Combustion processes in the production phase and electricity generation for vehicle charging cause the largest share.

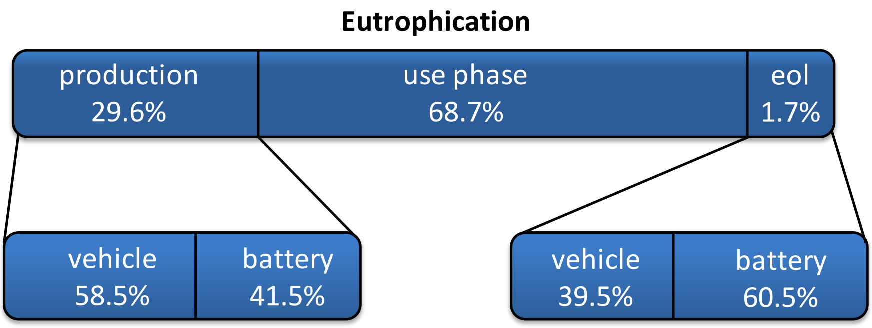

Figure 5: Shares of Eutrophication used by life phase

Finally, Figure 6 shows the use of resources by the three life phases. All Indicators, but especially the resources-indicator, shows the largest share in the use phase. The use phase has a significant impact and therefore has to be assessed very detailed and with care in the following part of this document.

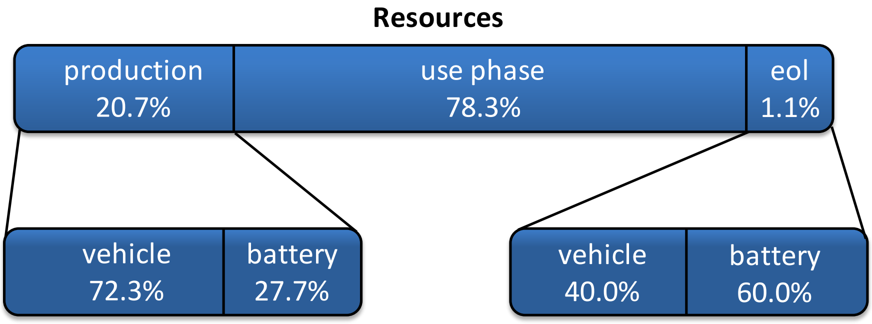

Figure 6: Shares of Resources used by life phase

Figure 7 shows an alternate presentation of the results grouped by system components. Again it shows the importance of an adequate modeling of the electricity generation and the use phase of electric vehicles. But also the battery has to be considered, especially if acidification and eutrophication are of interest.

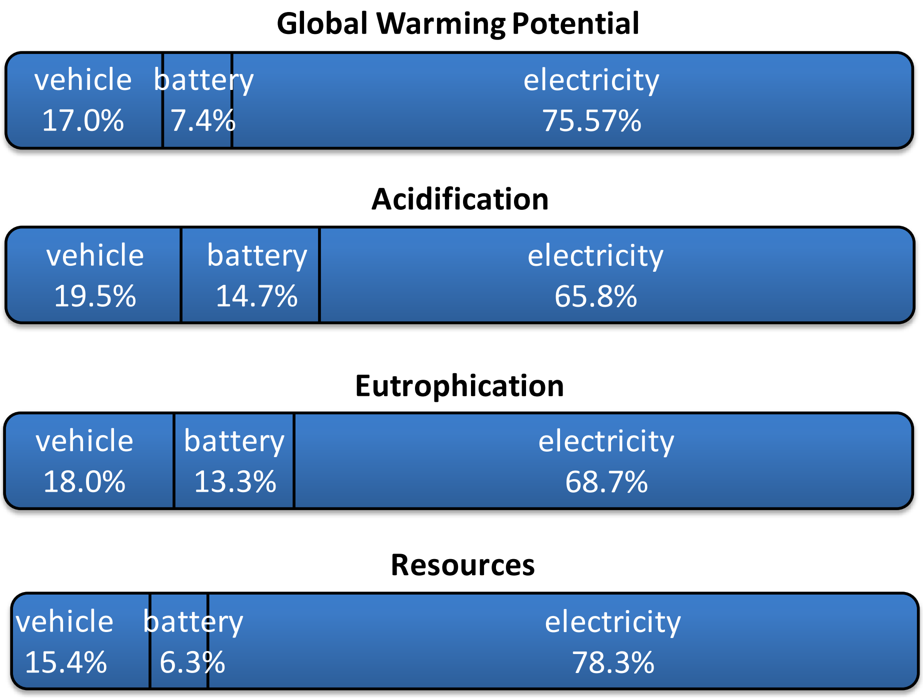

Figure 7: Shares of Impact Categories by system components

2.2.3 Effect of use-phase-related guideline parameters (Application 1)

As shown in the previous section, the use-phase of the vehicle is the most important phase to consider with the highest impact on the LCA results. Therefore three use-phase related parameters (Charging Efficiency, Functional Unit and Vehicle Consumption) have been varied. The impact of the electricity mix has been analyzed separately in chapter 2.2.5 and chapter 2.2.6.

Charging efficiency

The investigations show, that the LCIA-indicators are much more sensitive on use-phase related parameters. For example the efficiency in charging the vehicles battery affects the results in almost proportional relation (~8% increase of the indicators in consequence of 10% variation of the charging efficiency).

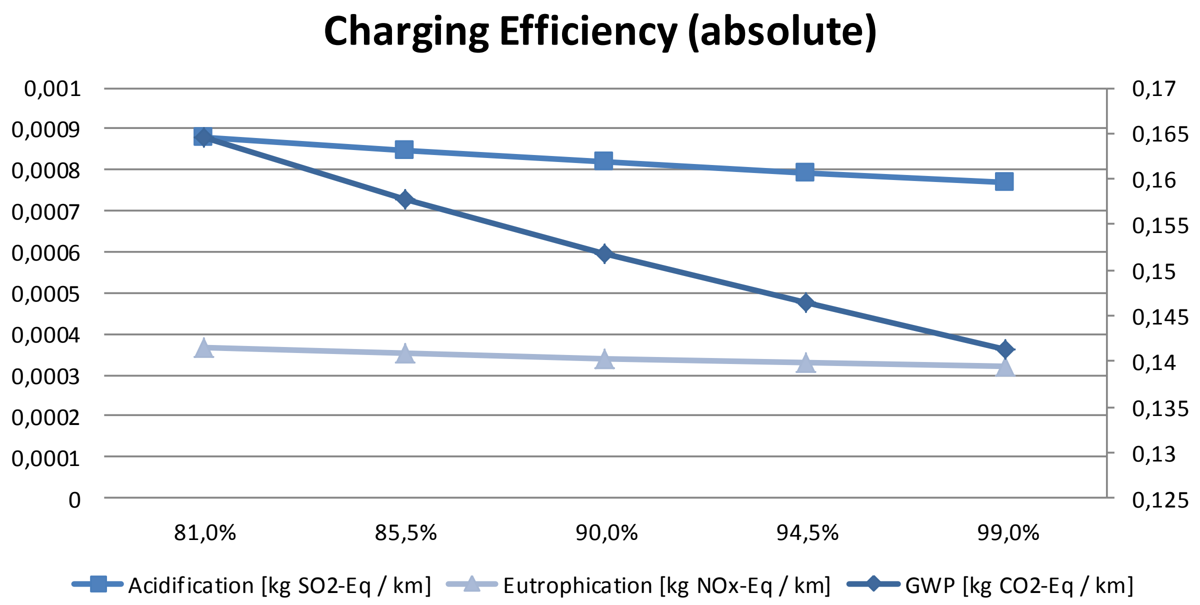

Figure 8: Impact of Battery Charging Efficency on LCA Indicators (GWP on secondary axis)

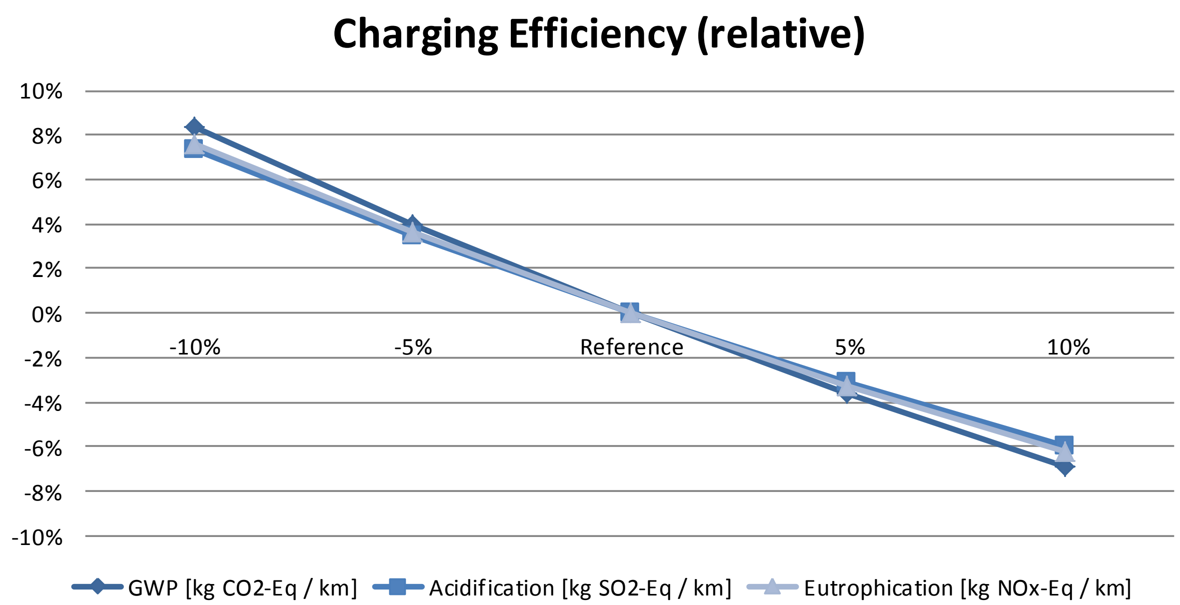

Figure 9: Relative impact of Battery Charging Efficency on LCA Indicators

Functional unit

The functional unit represents the total driving distance of a vehicle in its life cycle. In the reference case the battery was designed to meet the total driving need of the vehicle. Therefore increasing the functional unit makes it necessary to install a second battery during the vehicles life time. This can be seen in the following two diagrams. Besides that the sensitivity of the indicators on the functional unit is less than on charging efficiency, but more than on battery related parameters that are presented in chapter 2.2.4.

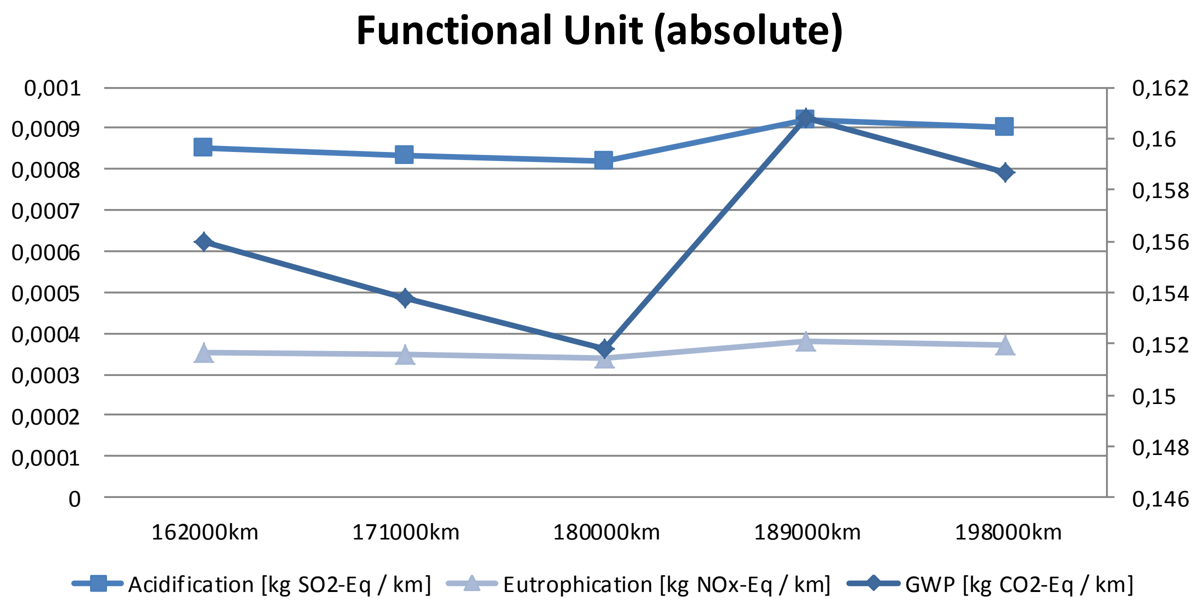

Figure 10: Impact of the Functional Unit on LCA Indicators (GWP on secondary axis)

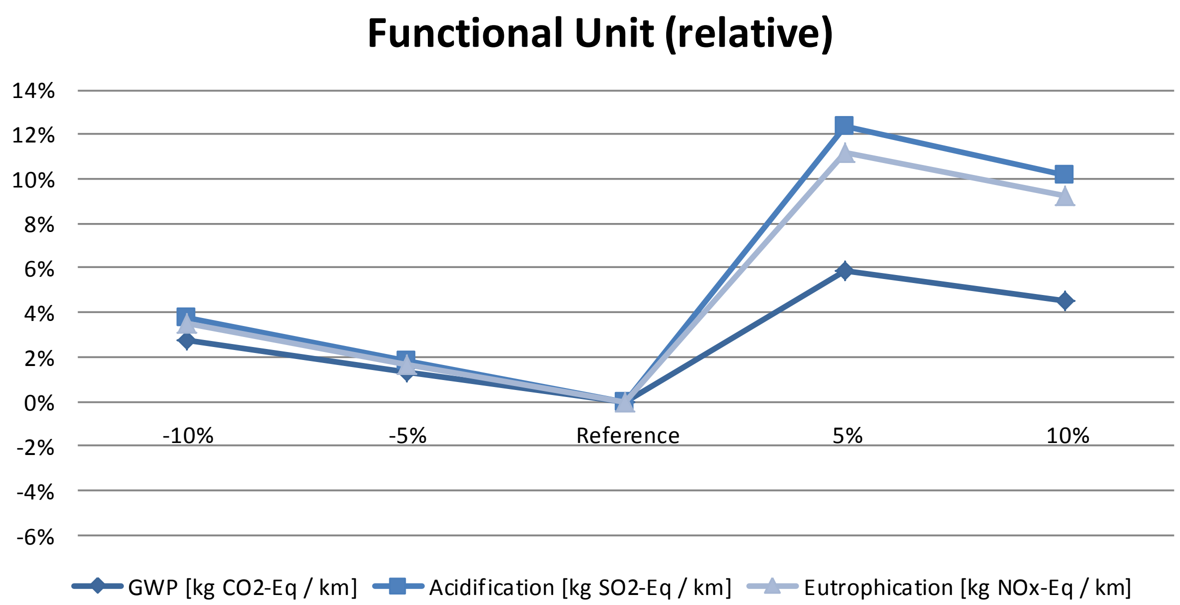

Figure 11: Relative impact of the Functional Unit on LCA Indicators

Vehicle consumption

Finally the sensitivity on the consumption of a vehicle has been investigated. Figure 12 and Figure 13 show that the indicators are most sensitive on the consumption parameter compared to all other parameters. An increase of 10% of the consumption parameter results in an increase of more than 8% of the indicators. Therefore this parameter in particular has to be chosen very carefully in Life Cycle Assessments.

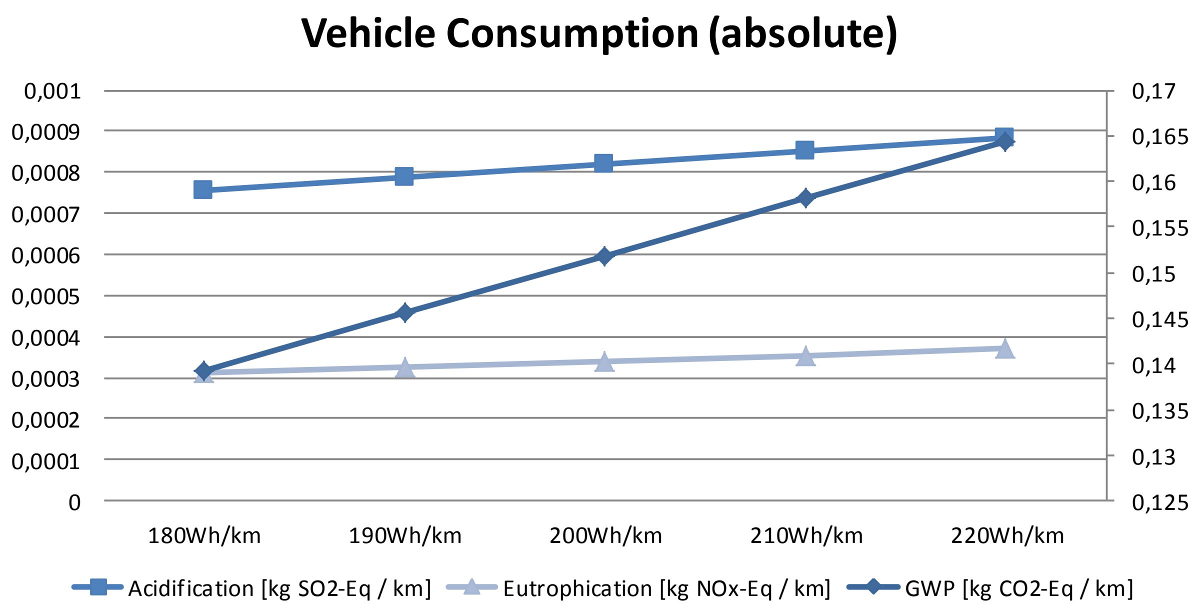

Figure 12: Impact of Vehicle Consumption on LCA Indicators (GWP on secondary axis)

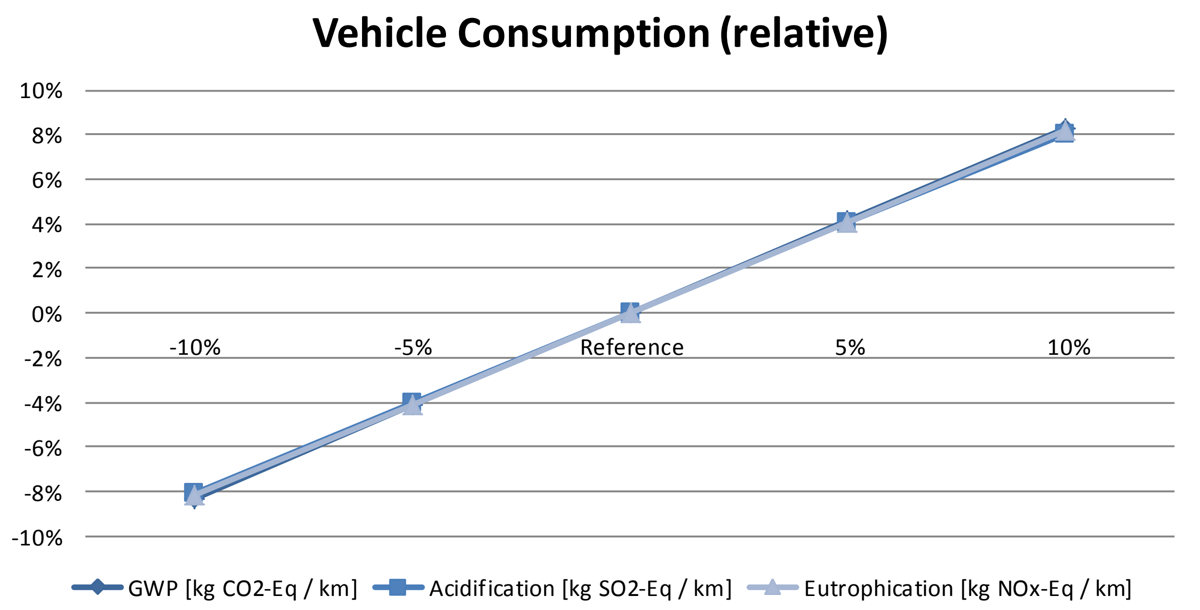

Figure 13: Relative impact of Vehicle Consumption on LCA Indicators

Summary

Due to the direct link between the charging efficiency, EV consumption and the functional unit, these values have a significant impact on the use phase of the EV. However, this impact on the final results depends on the chosen electricity mix. If a renewable energy dominated electricity mix is chosen, for example Norway, the impact of the use-phase relevant assumptions is very low because the use-phase becomes insignificant for the total LCA results. However, an electricity mix with a high share of coal power plant enhances the impact of these assumptions.

2.2.4 Effect of use-phase-related guideline parameters (Application 2)

The guidelines define a set of parameters, which should be used for LCAs of electric vehicles. To show the importance of the eLCAr guideline and the effects of not sticking to it, several parameters have been varied. Due to the importance of detailed battery modeling (as a result of the last section) two battery-related parameters (Energy Density and Driving Range) have been varied.

Battery energy density

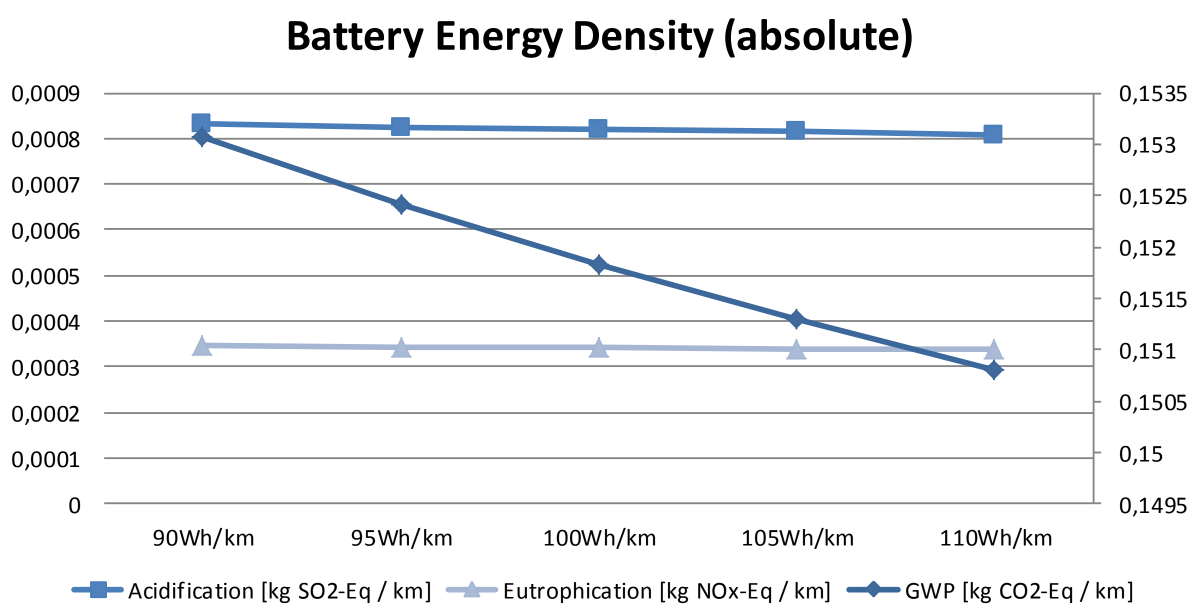

Figure 14: Impact of Battery Energy Density on LCA Indicators (GWP on secondary axis)

Changing the Battery Energy Density has an effect on battery production (size, weight) and on the use phase (transport of the additional weight). But as shown in Figure 15 this relation is far away from being a proportional relation. A decrease of 10% in energy density (90Wh/kg instead of 100Wh/kg) results in approximately 1-2% change of the indicators.

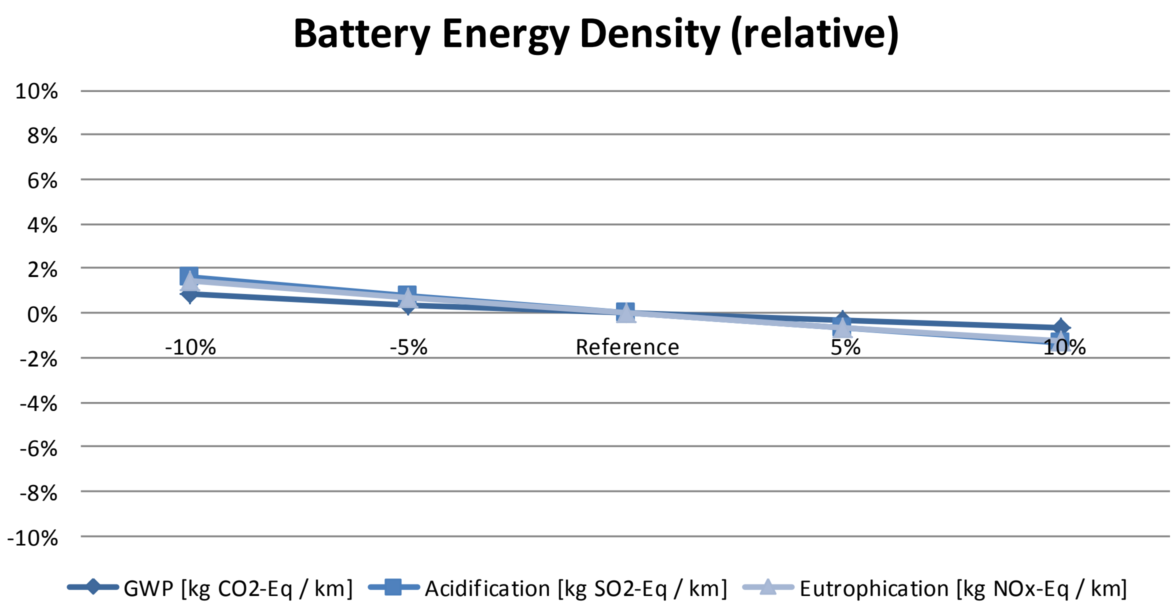

Figure 15: Relative impact of Battery Energy Density on LCA Indicators

Driving range

We get similar results for the variation of the vehicle driving range. 10 percent more possible driving distance per cycle results in an increase of 1-2% of the indicators (see Figure 17).

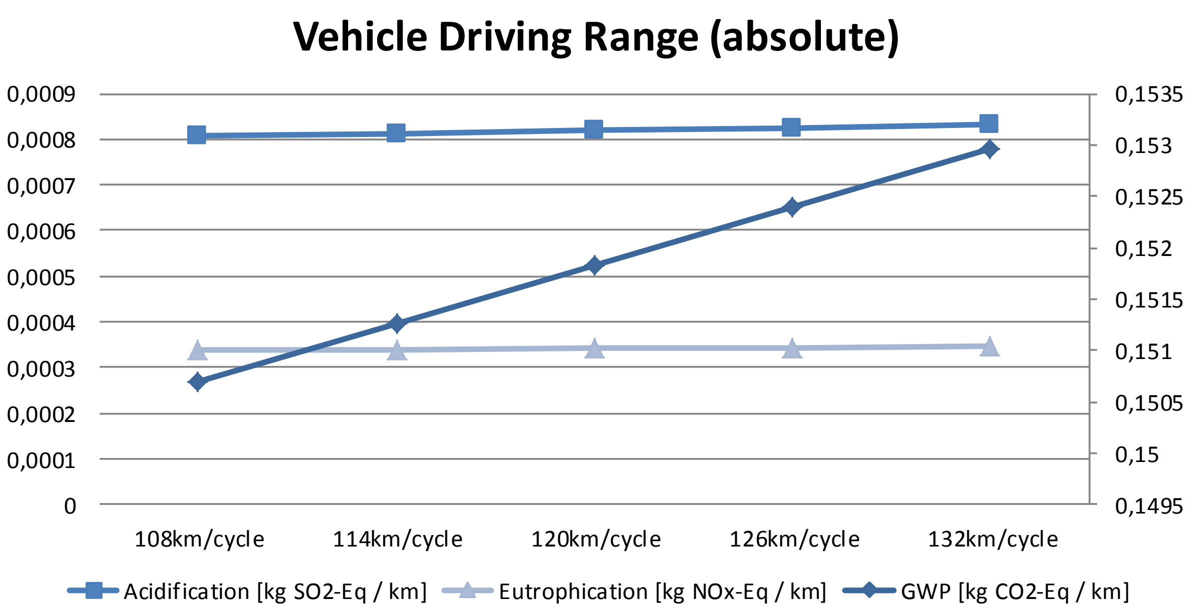

Figure 16: Impact of Vehicle Driving Range on LCA Indicators (GWP on secondary axis)

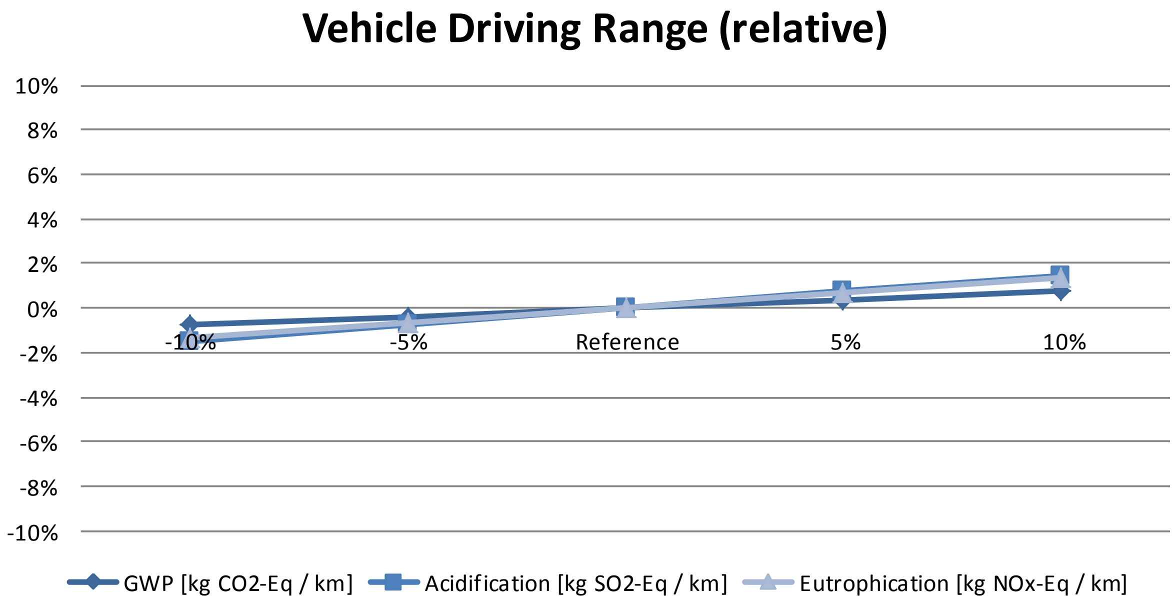

Figure 17: Relative impact of Vehicle Driving Range on LCA Indicators

Summary

The variation of parameter for the battery in application 2 shows only a small impact on the overall LCIA results. However, depending on the battery type and variation in the battery production or EoL the impact on the results for the battery can be influenced and improved leading to reduced emissions for the EV.

2.2.5 Effect of the electricity generation mix

This section show the effect of using a national electricity generation mix instead of the UCTE-mix as suggested in the guidelines and compare the results with some exemplary national electricity mixes within Europe.

As shown in chapter 2.2.1, the impact of the use phase is very significant for the LCA of EV. Moreover, the choice of the electricity mix dominates the emissions of the use phase as shown in D3.1 and in the third eLCAr workshop. To extend the analysis of this impact, the absolute results shown in Figure 18 have been complemented by a sensitivity analysis in Figure 19.

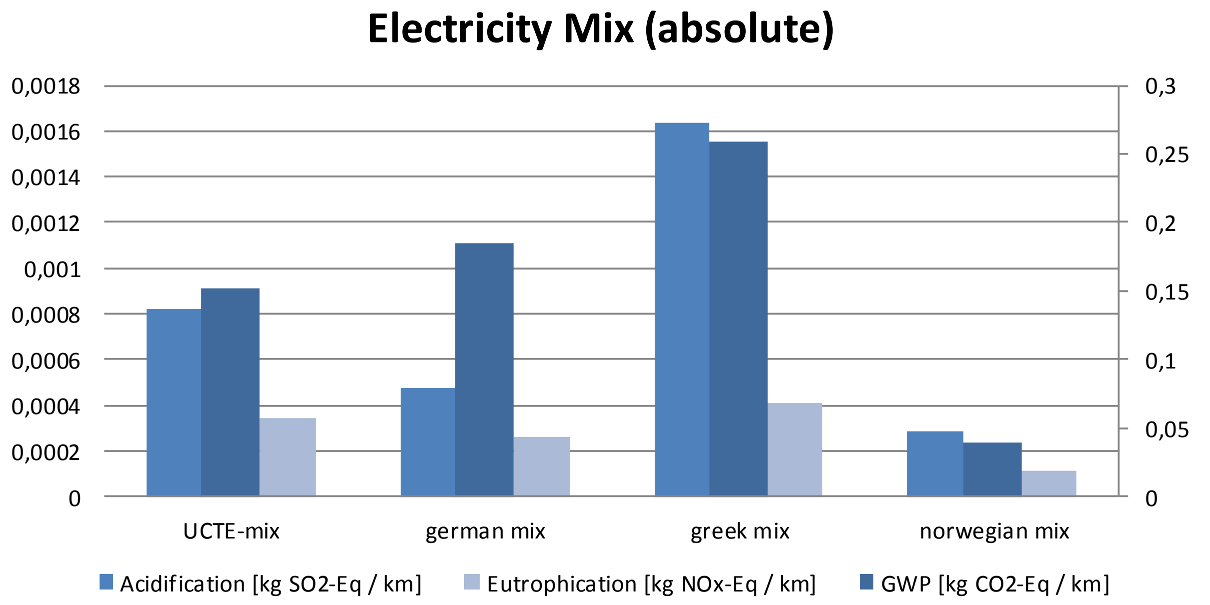

Figure 18: Impact of the generation mix on LCA Indicators (GWP on secondary axis)

The results shown in Figure 19 change up to 100% compared to the reference case with UCTE-electricity mix. Therefore, it is essential to use the same generation mix in studies to keep them comparable as in the eLCAr guidelines presented.

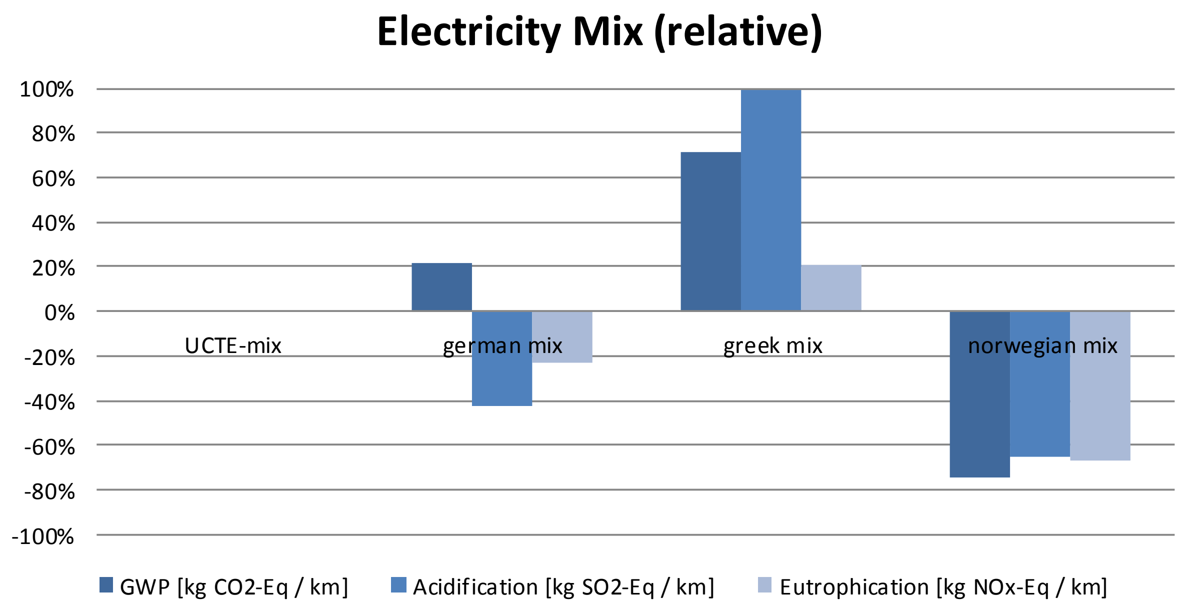

Figure 19: Relative impact of the generation mix on LCA Indicators

For further scenarios different electricity mixes can be used, especially regional technology mix. Nevertheless, the comparison of result between different LCA studies is significantly enhanced, if the UCTE mix according the eLCAr guidelines is used.

The change of the use electricity mix reduces the impact of other parameters on the LCA results. Figure 20 shows the impact of a variation of the consumption if different electricity mixes are used.

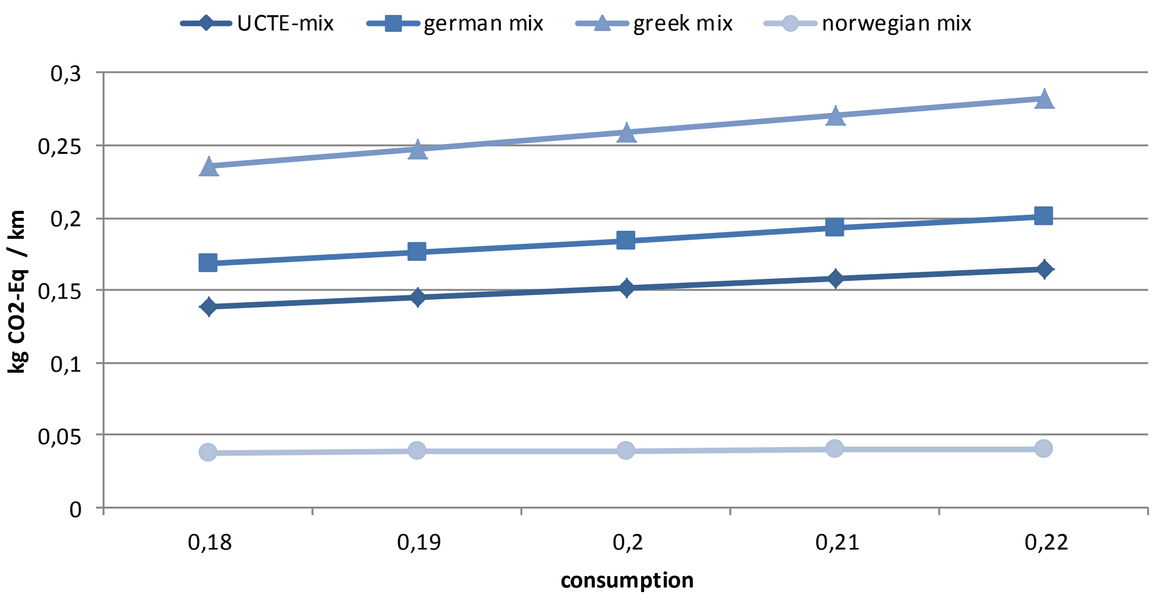

Figure 20: Impact of the consumption value for different electricity mixes on the GWP (on secondary axis)

Figure 22 clarify that the used electricity mix influences the importance of the assumptions during the use phase. If the emissions of the electricity mix is very low, a variation of the use-phase relevant indicators leads only to a small change of around 3 % by a 10%-rise of the consumption value. By the usage of other electricity mixes with higher emissions, the impact is nearly the same and shows a high correlation between the use phase relevant indicators and the LCA results. Therefore, the need for an accurate determination of data during the use phase is very high for electricity mixes with high emissions. The impact is much lower for environmental friendly electricity mixes such as the Norwegian electricity mix.

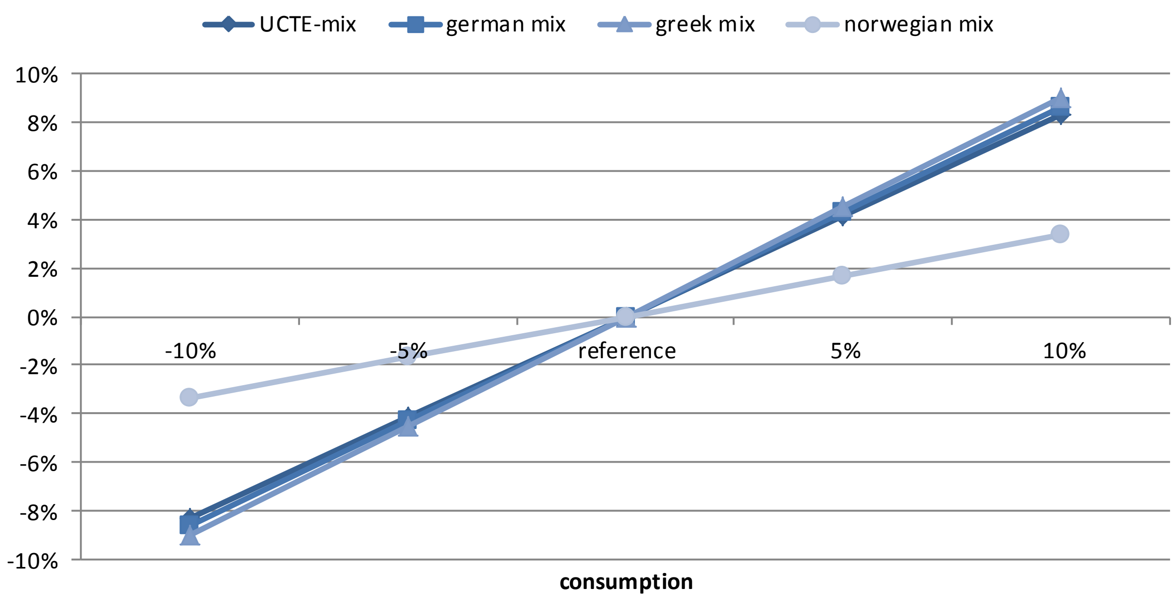

Figure 21: Relative impact of the consumption value for different electricity mixes

2.2.6 Marginal technologies for the electricity consumption

The guidelines presented as well the proposal for Situation B studies to use marginal technologies for the electricity mix. A heuristic approach for the determination of the marginal technology for EV is presented in the guidelines. Depending on the country, the charging strategies and the chosen timeframe, the approach results in different marginal technologies. Therefore, the impact of the choice of a marginal technology is presented in Figure 22.

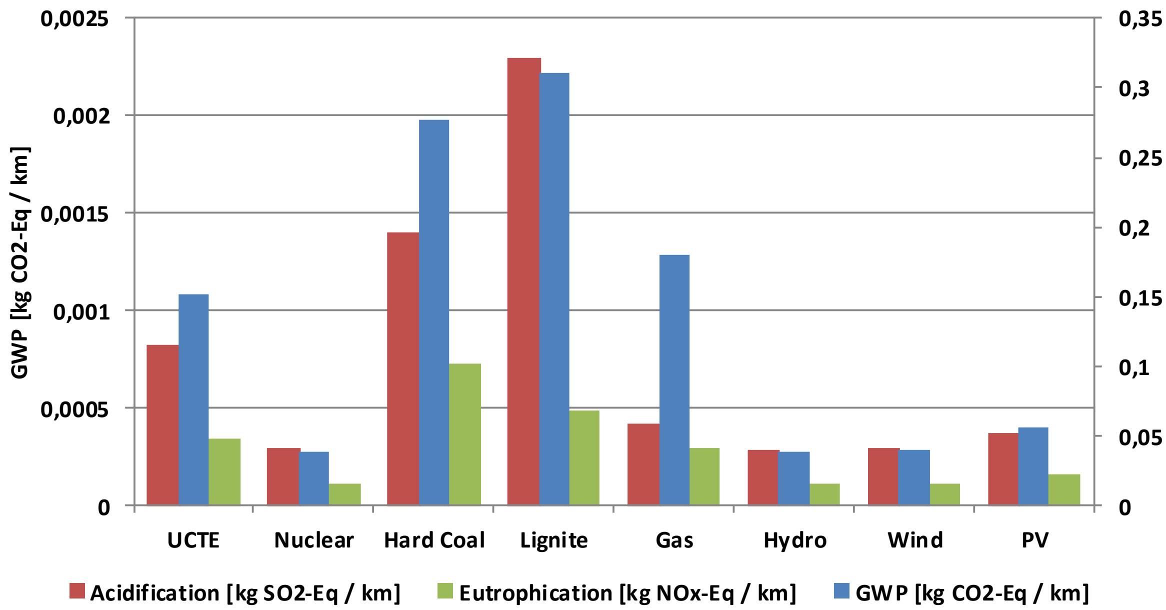

Figure 22: Comparison of marginal technologies within the UCTE for application 1, reference case, (GWP on right axis)

The relative change is presented in Figure 23 in comparison to the UCTE mix. Depending on the marginal technology, the impact on the LCA results can be very significant.

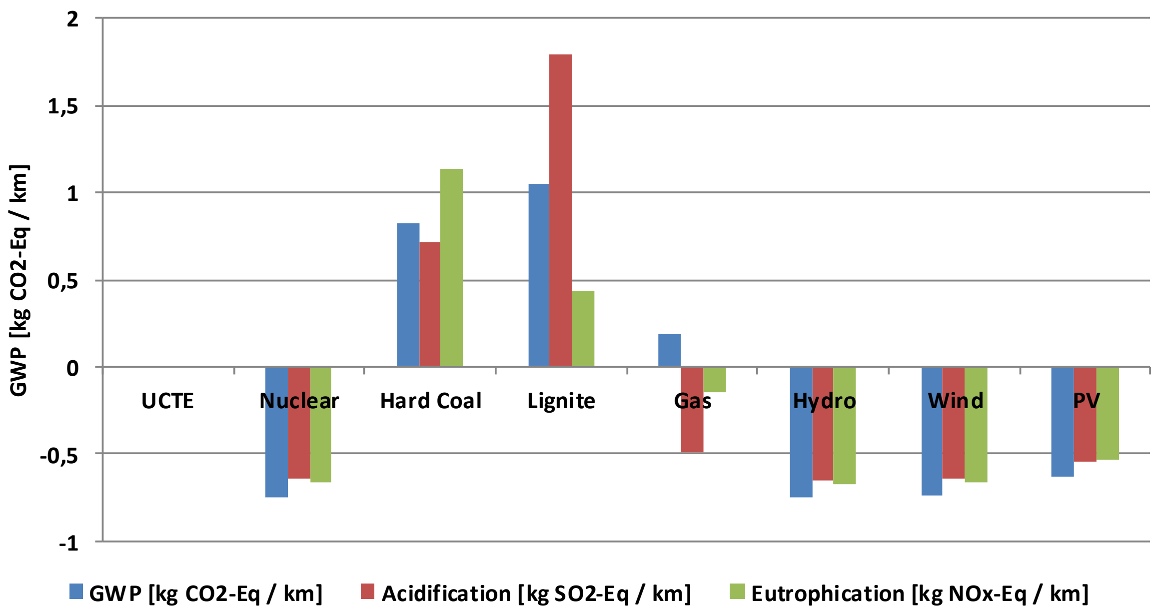

Figure 23: Comparison of marginal technologies within the UCTE for application 1, reference case

Figure 24, Figure 25 and Figure 26 clarifies the high relative impact on the LCA results for the usage of different marginal technologies. Depending on the marginal technology, the importance of the different life cycle phases of EV can change. For some cases e.g. hard coal, the use phase emits more than 80 % of the GWP emissions of an EV. For nuclear power, the percentage of GWP emissions from the use phase is reduced to 5 % resulting in a very high importance of the EV production phase.

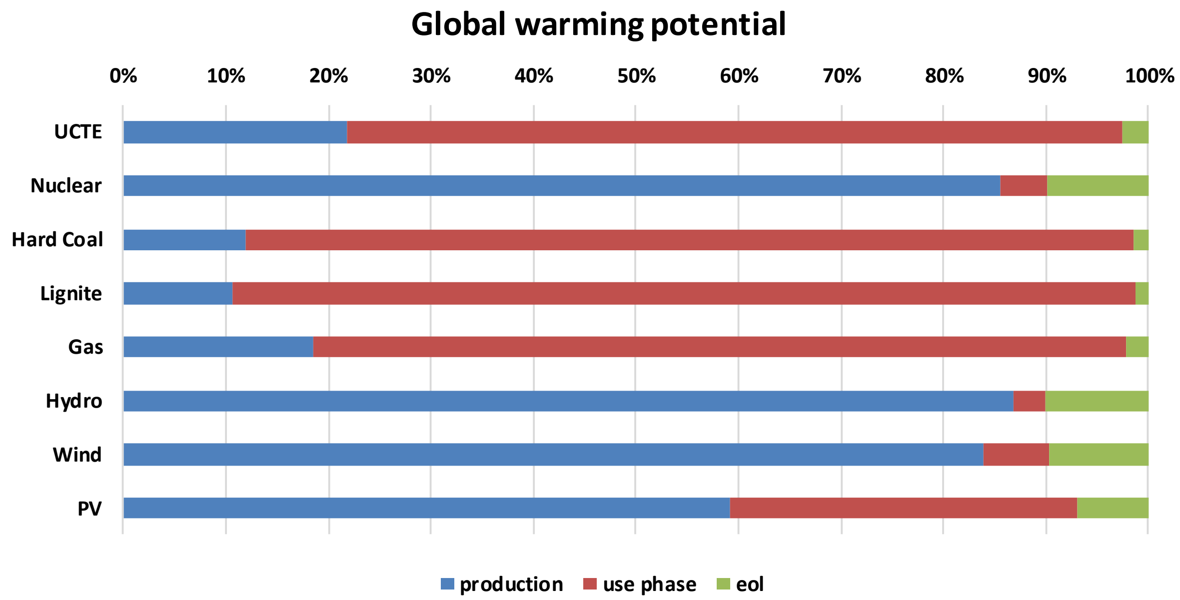

Figure 24: Impact of different marginal technologies on the global warming potential of the life cycle phases of an EV

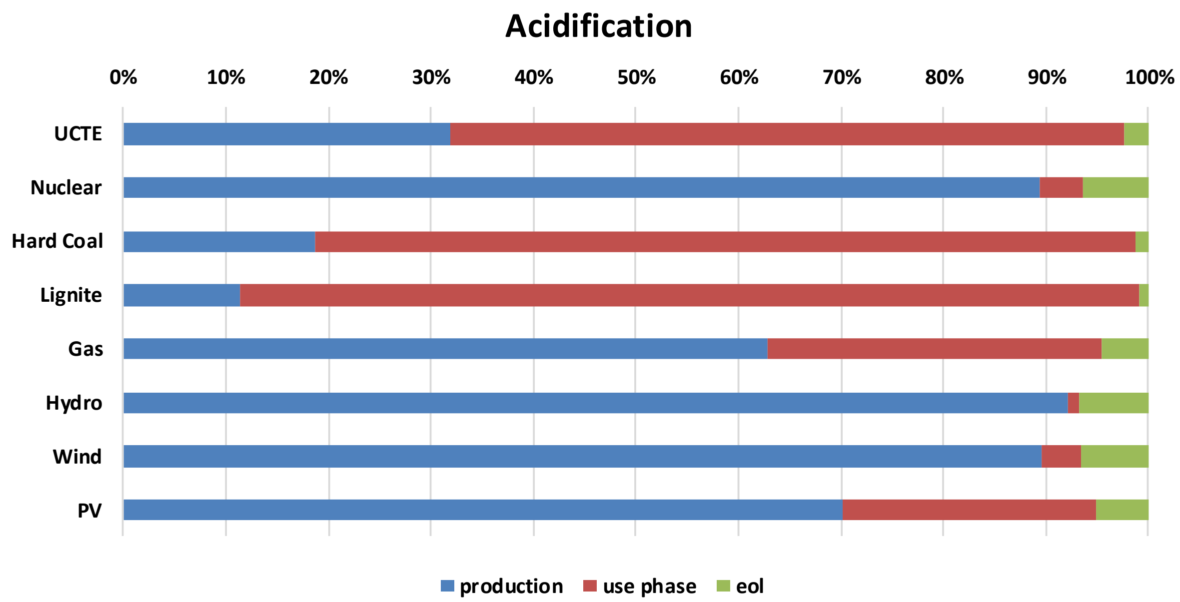

Figure 25: Impact of different marginal technologies on the acidification of the life cycle phases of an EV

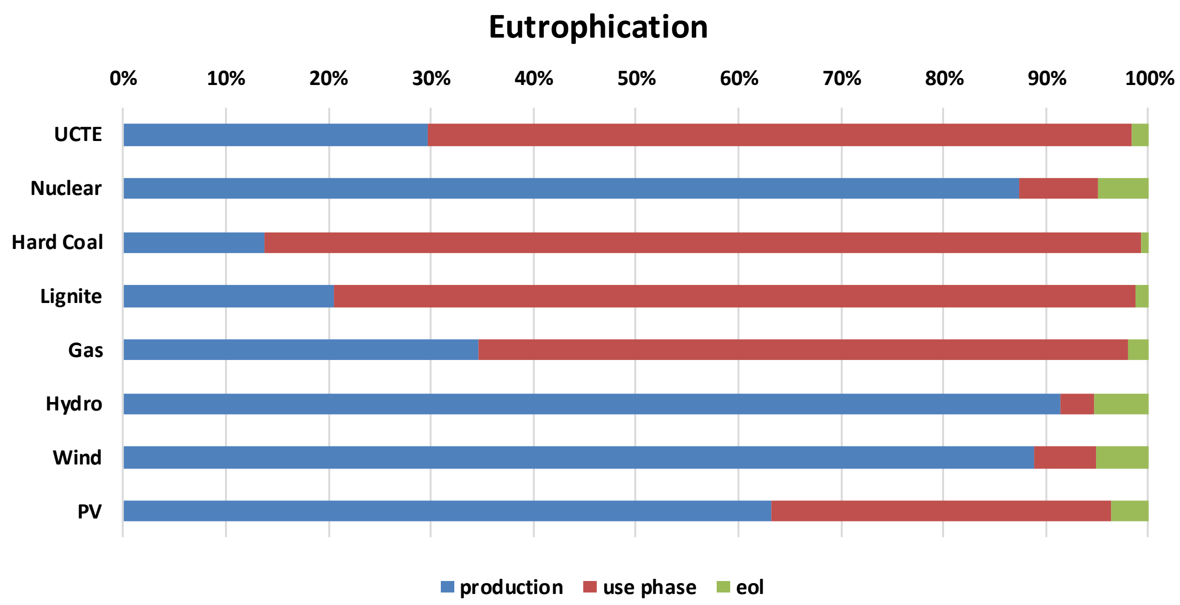

Figure 26: Impact of different marginal technologies on the eutrophication of the life cycle phases of an EV

The choice of a marginal technology has as well as country specific electricity mixes a high impact on different LCA result, not only on the GWP potential. The usage of nuclear, hydro, and wind energy reduces the impact of the use phase to a minimum. In these cases, the production phase and the end-of-life phase are dominating the emissions leading to the lowest possible LCA results for EV. The usage of hard coal and lignite power plants results in the worst LCA results for EV with the highest emissions. The use case is then dominating the other life cycle phase. In this case, small changes in the assumptions for the use phase presented in chapter 2.2.3 have even a higher impact on the final results.

This means that the determination of marginal technologies should be executed very carefully and if possible by experts. The usage of electricity market models enables a detailed assessment of the marginal technologies leading to a mix of technologies depending on the integration of EV and the usage of charging strategies.

Due to the uncertainties regarding these aspects, no simple heuristics for the determination of the marginal technologies can be presented. Nevertheless, with the in the guidelines presented approach is it possible for the practitioners without expert knowledge in the electricity production sector to determine at least the most probable marginal technology and to include the alternatives in a sensitivity analysis.

2.2.7 Data quality

The quality of an LCA study depends highly on the data quality used to conduct the study. Often important data is not available in LCA databases such as the ELCD database. For electric vehicles and their components, battery data is often not available especially regarding the life time or charging behavior. Moreover the use of primary and secondary data is often not directly reported in some studies leaving a high uncertainty regarding the presented LCA results. The reduction of uncertain secondary data for the foreground and background system improves the quality of conducted LCA studies directly. The confirmability of the results due to improved data quality allows an easier comparison of different studies.

A coordinated approach regarding secondary data, especially to reduce uncertainties of certain components of EV, increases the comparability of different studies. Provisions regarding the geographical scope and time scope, such as data for the electricity (e.g. Europe in 2010) cause a unification of presented results in studies through Europe. Studies conducted in different countries normally using their country specific secondary data will be comparable at least in one scenario that is presented in the results.

For many parts of an LCA input data can be taken from libraries like the ecoinvent v2.2 database with over 4.000 inventory data records or the ELCD database. These databases cover many basic processes in production, use phase and end of life. It also contains the UCTE-electricity mix which can be taken as reference to produce European-wide comparable results. Parameters regarding electric vehicles which can be used cover production and disposal of vehicles and batteries and vehicle operation. This is especially useful for LCA studies assessing only certain components of an EV.

Very specific data for an LCA of EVs, which are not covered by such a database, should be taken from other often used sources and should also be clearly references. A source for such data can be the Common Parameter Platform from deliverable D3.1.

2.3 Spread of final LCA results

Up to now the sensitivity of an LCA on one single parameter has been tested only. It remains to be investigated which spread of the results can occur, if multiple parameters differ from the proposed values in the eLCAr-Guidelines.

Therefore a parameter study has been conducted, where all parameters including the electricity mix for the presented countries (Norway, Germany, Greece) have been varied between “Low” (-10%), “Reference” (form the guidelines) and “High” (+10%). For every possible combination of the parameters a complete life cycle has been simulated and the corresponding global warming potential has been evaluated. Figure 28Figure 27 shows the frequency distribution of GWP for all parameter combinations.

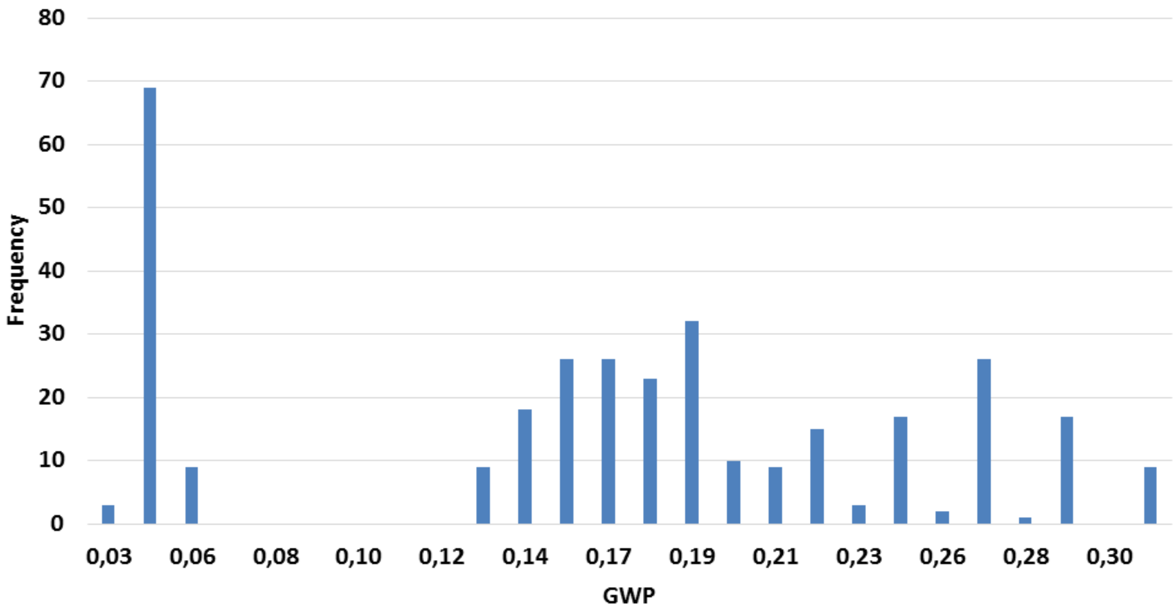

Figure 27: Spread of final LCA results (GWP in kg CO2-Eq/km)

It can be seen a large spread of the results caused mainly by the different electricity mixes. In contrast to that, Figure 28 shows the results with the parameter for the electricity mix excluded (The electricity mix remains at the reference value which is the UCTE-mix). This again shows the importance of carefully choosing an electricity mix for LCA-studies.

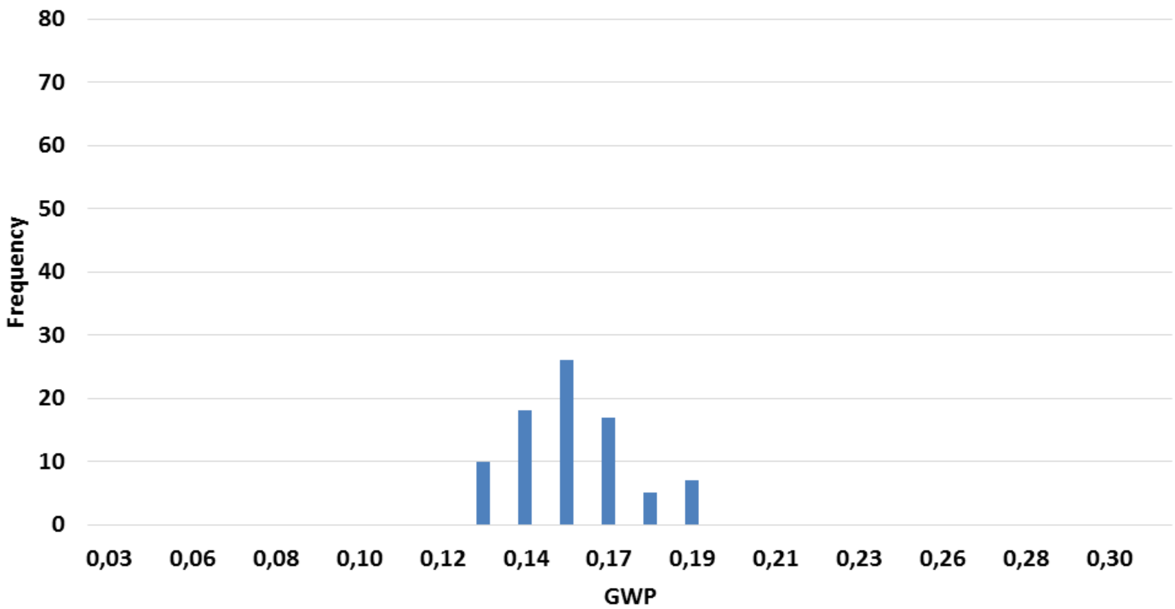

Figure 28: Spread of final LCA results with only UCTE-mix (GWP in kg CO2-Eq/km)

In Figure 28 we can see the peak at approx. 0.152 kg CO2-Eq / km, which is the reference case for the UCTE-mix. But we also see that spread of +-20% appeared for a noteworthy number of parameter combinations. This shows that besides the electricity mix also the other parameters have a significant impact on LCA-results and should be determined carefully following the eLCAr guidelines.

2.4 Evaluation of studies due to the use of the guidelines

As a conclusion of this section it can be stated that the guidelines (regarding the choice of parameters) can help to produce comparable studies. The effect of deviating assumptions in different studies has been analyzed for the two applications of Deliverable D3.1. The first one covers the LCA for an electric vehicle and the second one the LCA for a battery of an electric vehicle.

Regarding vehicle related parameters a 10% error in parameter assumptions can result in a variation of the results of up to +-8%. Regarding battery related parameters a 10% error can end up in variations of the results of +-2%. In a combined consideration of all possible parameter value variation combinations (low, reference and high) it was figured out, that a 10% error range of the input parameters can result in up to 20% variation of the final results.

The biggest effect comes from the choice of an electricity mix. The results change up to 100% compared to the reference case with UCTE-electricity mix if national electricity mixes are used. Therefore, it is essential to use the same generation mix in studies to keep them comparable.

3 Usability

After the analysis of the impact of the eLCAr guidelines regarding the quality of the studies, the usability of the guidelines is analyzed in this chapter. The usability of the guidelines is important for the evaluation of effects of LCA studies because only if guidelines are understandable and usable an impact can be determinable.

3.1 Usability requirements of the stakeholders

The requirements of the stakeholders regarding the eLCAr guidelines have been assessed during the three eLCAr workshops. The basis was the first workshop defining the current LCA approach of the practitioners and their problems and obstacles regarding the usage of the ILCD handbook.

The ISO 14'040-series is the most used guideline for conducting LCA for EV and their components in the analyzed studies. The answers from WS1 described in D1.3 in the discussion of group 3 confirm the results of the analysis of different studies. Most of the participants of the workshop are using the ISO 14'040 series directly.

The WS1 participants stated that they are not using the ILCD handbook. This was supported by the literature analysis. The practitioners do not use the handbook instead they use particularly the ISO norms. The complexity (e.g. the number of cross-references) and volume of the ILCD handbook is the main reasons for refusal. The practitioners prefer a guideline which is short and straight forward and provides useful and supporting examples for the application.

To comply with the requirements of the stakeholders, the new eLCAr guidelines are analyzed regarding its usability according the following aspects:

- Reduction of complexity
- Accuracy
- Duration of the training period
- Comprehensibility
- Easy handling

The expectations regarding new guidelines are that they can be easily used with a short training period and that the volume of the guidelines is compact with a reduced complexity compared to the ILCD handbook.

The evaluation factors for the usability are very subjective as described before and can only be assessed with help of the practitioners. Therefore, the feedback from the practitioners during the workshops is used for this assessment as well as a comparison between the eLCAr guidelines and the ILCD handbook.

3.2 Reduction of complexity

The complexity is an important criterion regarding the practicability of guidelines. It indicates whether the instructions can be understood intuitively or how great the effort would be in order to understand them and how much knowledge is required for it. One aim of the eLCAr guidelines is to reduce the complexity of the ILCD handbook for accomplishing a LCA.

3.2.1 Required knowledge to use the guidelines

The usage of the eLCAr guidelines requires a fundamental knowledge of the aim of a LCA and the existence of the ISO 14040 and 14044:2006 norms and the ILCD handbook. The introduction given in the eLCAr guidelines explains the context of the guidelines regarding the ISO norms and the ILCD handbook.

Moreover, chapter 2 “Key definitions” and chapter 3 “Brief introduction to LCA (ILCD)” provide a basis introduction to the topic LCA. This introduction aims at practitioners who seldom conduct LCA studies and need a short reminder regarding the basic LCA approach. This short introduction of 9 pages lowers the entry threshold for practitioners without a sophisticated LCA knowledge to use the guidelines. Experienced LCA practitioners can skip these pages and go to the detailed parts of the eLCAr guideline from chapter 5 to chapter 10.

In the main chapters 5-10 each step for the conduction of a LCA studies for EVs and their components is presented in a detailed and comprehensive manner. The ILCD Handbook is the starting base for each provision and therefore shortly cited in the guideline. Before each provision, detailed explanations and relevant approaches are presented supporting the statement of the provision. Due to this explanations, important information for each provision are available for each practitioner independent from the practitioner’s previous knowledge level.

Due to these explanations at the beginning and before every provision, the required knowledge level for the first usage of the guidelines is quite low. Particularly, the practitioners do not have to read the ISO 14040 norms or ILCD Handbook in advance of the usage of the guideline.

3.2.2 Required provisions from the ILCD

Despite the fact that the practitioner do not need to read the ILCD Handbook in advance, the practitioners need sometimes the ILCD Handbook for further information that could not be included in the eLCAr guidelines. The number of this crosslinks to the ILCD Handbook should be quite low and only be required for more detailed and very specific information or approaches that would be only repeated from the ILCD Handbook without further specifications.

As mentioned before, each provision is based on the ILCD Handbook and a summary of the relevant ILCD aspect is given in the eLCAr guidelines. The following list contains the aspects of the ILCD that have a crosslink from the eLCAr guidelines and the reason for this crosslink.

Table 2: Crosslinks from the eLCAr guideline to the ILCD Handbook

No.	Topic/Provision of the eLCAr guidelines	ILCD reference	Explanation
1	5.3 Reasons for carrying out the study and decision context	5.3 of the ILCD Handbook	Important distinction between the decision context necessary. More information on the distinction between Situation A and B available in ILCD Handbook.
2	5.5 Comparisons to be disclosed to the public	5.2.5 of the ILCD Handbook	More information about exceptions and further restrictions regarding the comparative assertion intended to be disclosed to the public.
3	Provision 6.1.1: Consistency and reproducibility	6.2.1 “Consistency of methods, assumption and data”; 6.2.2 “Reproducibility” of the general ILCD handbook	**Direct crosslink** to the ILCD Handbook, no specific adaption regarding EV required
4	6.2 Function, Functional Unit and reference flow, Provision 6.2.1	Paragraph and Provisions 6.4	More information and definitions on general functional units and reference flows. The specific case for electric vehicles is included in the eLCAr guidelines. Components which could be separately analyzed have to use the provision given in the ILCD Handbook.
5	6.3.2 Multifunctionality	Provision 6.5.4 of the ILCD Handbook	Special cases regarding multifunctionality are discussed in the general ILCD Handbook.
6	Provision 6.3 “Life Cycle modeling framework”	Provisions 6.5.4 of the general ILCD Handbook	The provision 6.3 of the eLCAr guideline is a summary of the 6.5.4 provision of the ILCD. For specific cases a crosslink to the ILCD is used.
7	6.5 Preparing the basis for the impact assessment	Paragraph 6.7 and chapter 8 of the general ILCD Handbook plus 2 specific ILCD documents regarding LCIA and LCIA in the European context	Outside the eLCAr scope is to detail the LCIA phase. For more information and background of LCIA, the reader is referred to more specific documents. Recommendations for the approach are given.

8	Provision 6.7 Comparison between systems	Box 6.10 "Comparison between systems" of the general ILCD Handbook	Since most of the recommendations on comparisons concern general aspects, provisions of the ILCD Handbook are used. **Direct crosslink**
9	6.8 Identifying critical review needs	Special ILCD documents: "Review schemes" and "Reviewer qualification"	Specific guidance regarding the review process is given in the specific documents and linked from the eLCAr guidelines.
10	7.1.1.1 Identifying processes within the system boundary in vehicle production	Paragraph 7.4.2.2 of the general ILCD Handbook	ILCD Handbook provides techniques for reducing processes into single, separate unit processes.
11	7.1.1.2 Background changes in Situation B	Chapter 7.2.4 of the general ILCD Handbook	Topic-independent methodology is provided in the ILCD Handbook for Situation B.
12	7.1.1.4 Data collection, Chapter and provision	7.4.2.2 of the general ILCD Handbook, "ILCD Nomenclature and other conventions"; 7.4.3.2 to 7.4.3.4	General techniques to isolate processes during the data collection phase and the nomenclature of the processes are provided in the ILCD; ILCD provisions regarding special emissions
13	7.1.2.1.4 Recommendations on electricity mixes	Chapter 7.7 of the ILCD handbook	Explanation of the production mix, consumption mix and supply mix is given.
14	7.3 Solving multifunctionality	ILCD Handbook, chapter 14.5	The recyclability substitution approach is described in the ILCD Handbook for Situation A and B as possible solution for multifunctionality.
15	Provision 7.2 Solving multifunctionality	Provision 7.9.3 and Annex 14.4 of the general ILCD Handbook	Description of the allocation approach if neither subdivision nor system expansion can be applied.
16	8 Life Cycle Impact Assessment	Chapter 6.3.3 in the general ILCD Handbook	Description of quantitative cut-off rules.
17		Chapter 9.3.2	Checking of the completeness of the inventory
18		Chapter 8.3 and 8.4	Description of provisions on normalization

			and weighting
19		Chapter 8.2	Description of frequent errors when calculation LCIA
20	9 Life Cycle Interpretation	Chapter 9 of the general ILCD Handbook	The LCI cannot be adapted to electric vehicles. Therefore the explanations, recommendation and provisions of the ILCD fully apply. **A summary is given in the eLCAr guidelines with key aspects and reproduced provisions.**
21		Annex A: 12.3 Data quality indicators of the general ILCD Handbook	Detailed guidance on data quality quantification.
22	10 Reporting	Chapter 10 of the ILCD Handbook	Chapters from the ILCD Handbook are completely taken from the ILCD and included in the eLCAr guideline.

The number of links from the eLCAr guidelines to the ILCD Handbooks shows that the ILCD Handbook is the basis for the eLCAr guidelines and provides important methodologies and explanations. This connection is used in the eLCAr guidelines for the provision of general information that need no specification to EV.

If the eLCAr guidelines do not specify the provisions of the ILCD, these provisions are cited in the guideline to reduce the need for the practitioner to use more one document. Nevertheless, only in one case (no. 3, provision 6.1.1) the practitioner has to use the general ILCD handbook. In the other cases, the links to the ILCD Handbooks are used to give the practitioner the possibility to gain more information of the specific topic or to provide specific methodologies for processes that are not in the focus of the eLCAr guidelines. The links are necessary to broaden the possible audience of the eLCAr guidelines.

During the conduction of the LCA for EV and their components, the eLCAr guideline document contains all required provisions for the user. This aspect eases the conduction of LCA for EV for the practitioners because the complex and extensive ILCD Handbooks have only to be used to gain detailed and specific information.

3.2.3 Conclusion

The complexity for the conduction of a LCA study for EV and their components is reduced due to the usage of the eLCAr guidelines. Only the eLCAr document is needed for the conduction. To gain more information, links to the ILCD guidelines are provided to support the interested practitioner finding relevant information. Moreover, the practitioners do not need much previous knowledge before they start to use the guidelines and the guidelines can be read while the user is conducting his study.

3.3 Accuracy

A high accuracy of guidelines reduces the probability for misunderstandings and errors. The transferability and generality of the ISO 14040 series can be accomplished by general instructions for the conduction of an LCA. However, due to this generality the ISO norm cannot provide detailed and accurate instructions for the conduction of an LCA. Even the very specific ILCD guidelines are designed for all topics and areas of LCA and therefore not accurate in every aspect of the given provisions. An increase of the accuracy in the provisions of guidelines reduces the probability for misinterpretations and hence reduces the range of variance within LCA studies as described before. Therefore, the eLCAr guidelines are designed in a specific and accurate way.

The eLCAr guidelines contain specific and accurate provisions, especially for the goal and scope definition and the LCI phase. In these chapters the accuracy of the provisions is supported by using detailed explanations of the provisions as well as short examples. The examples reduce the probability for misunderstandings and user errors and support the comprehensibility of the compact provisions in the guideline. Table 3 presents the provisions and chapters with the most specific descriptions regarding EV and their components. Only the provisions directly taken from the ILCD Handbook are not further specified (see list in chapter 3.2.2).

Table 3: List of very specific provisions for LCA of EV and their components and examples

No.	Specific topic or provision	Enhanced accuracy compared to the ILCD Handbook
1	Provision 5 – Goal definition	Extended provision based on the ILCD (aspect II) for the specific vehicle focus in the foreground system. **Specific example** for the goal definition (5.7 Goal definition examples) for a comparative LCA of batteries for EV.
2	6.2.1 Functional units for e-mobility applications	Specific example how to achieve identical functionality for comparison of non-identical products. - Functional unit - Reference flow
3	6.4 System boundaries	Presentation of relevant vehicle components and system boundaries as well as specific provision for system boundaries for e-mobility applications and cut-off criteria.
4	6.10 Scope definition example	In chapter 6.10 an extensive example for the scope definition is presented.
5	Chapter 7: Life cycle	All provisions given in chapter 7 are very specific regarding the LCA of EV

	inventory analysis	and their components. They are not listed separately. The provisions contain detail descriptions of processes and components and refer to the common parameter platform if the user does not have all needed parameters for the LCA assessment.
6	7.1.1 Production phase	**7.1.1 Production phase** containing specific LCI information for - Identification of main processes - Planning data collection - Data collection - Recommendations for the o battery production, o body production, o electric motor production, o SBSS, transmission and ICE for serial PHEVs production o Tyres and wheels o Production of modules within the cockpit o Power electronics and non-propulsion electrical system production
7	7.1.2 The use phase	**7.1.2 The use phase** contains very specific methodologies and provisions for EV regarding the following aspects - Consumption calculation methods - Description of the use phase framework - Recommendation of the electricity mixes - Distribution networks
8		**Example**: for the energy consumption calculation → Very detailed example for the determination of the energy consumption using an advanced calculation method presented in the eLCAr guidelines supporting practitioners to determine realistic energy consumption values.
9	7.1.3 End-of-life phase	**7.1.3 End-of-life phase** contains very specific processes for EV and their components describing the recycling processes very detailed and giving advises regarding future processes. - Identifying processes within the system boundary of the EoL phase - Recommendations for the o EoL of batteries o EoL of electric motors o EoL of electronics o EoL of tyres and wheels o EoL of residual car body

Table 3 contains the most specific provisions and examples in the eLCAr guidelines. They deal with the most critical aspects in LCA analysis and support the practitioner during the conduction of the LCA. Especially the concrete methodology during the LCI phase such as the definition of the system boundaries, the consumption calculations methodology and the approach for the end-of-life phase provides concrete approaches that can be easily followed. Normally, complex aspects are divided into more easy steps and the practitioner are supported by examples and best practice advices.

The eLCAr provisions of these chapters are quite accurate compared to the ILCD handbook (ILCD 2010) and possess a reduced complexity because specific approaches are presented focusing the guidelines on EV and their components.

3.4 Enhancement of the usability for the practitioner

The usage of the guidelines should be as easy and uncomplicated for the practitioner as possible. Therefore, different aspects of the eLCAr guidelines regarding the enhancement of the usability are examined.

3.4.1 Duration of the required trainings period

A further evaluation factor is the training period that reflects the effort and time exposure which is necessary for the comprehension of the guidelines. The evaluation for this factor is difficult because these aspects can only be evaluated by practitioners. Due to the fact that the final guidelines and the training material are only available at the end of the project duration, an extensive testing of the guidelines and training materials cannot be conducted within the project. However, a first indication of the required trainings period can be given based on chapter 3.2.1 - Required knowledge to use the guidelines and some quantitative aspects of the guideline document such as the number of pages and provisions.

A simple indicator describing the usability of the eLCAr guidelines is the number of pages. To ensure a high usability, the specific guidelines should have around 100 pages. A significant higher number of pages reduce the usability because the practitioners do not want to read hundreds of pages. The detailed LCA description (chapter 5-10) of the eLCAr guidelines has around 100 pages, the complete eLCAr guidelines have around 130 pages. Compared to more than 400 pages of the general ILCD Handbook, the eLCAr guidelines are still very compact and readable. Moreover, the provisions are highlighted and experienced practitioners can skip the explanations between the provisions. There are 34 provisions in the eLCAr guidelines that should be read by every practitioner. A separate document only containing the provisions would have around 29 pages. This is a very compact guideline for experience practitioners.

The practitioners do not need to read the eLCAr guidelines at once before they start to use them for the conduction of a LCA study. Every chapter can be used separately reducing the entry threshold for new users of the guidelines. Therefore, the trainings period for the practitioner is quite short.

The developed trainings material and sample application available on the eLCAr website helps the practitioner to focus on aspects he is not familiar with. The practitioner can choose the online training program to reduce the number of pages, provisions and explanations he would have to read by using only the guideline document. This makes it easier for the practitioner by reducing the required duration of the trainings period. Especially the aspect, that the practitioners do not have to read the ILCD guidelines as a knowledge basis in advance to understand and use the eLCAr guidelines helps to reduce the entry threshold for conduction of LCA studies according the ILCD handbook.

3.4.2 Comprehensibility

Supporting a short duration of the trainings period and the accuracy of the guidelines is the aspect of the comprehensibility. Therefore, the guidelines are clear and direct verbalized to enhance the comprehensibility for the guidelines user in Europe. Moreover, to ensure a correct usage of language, a proof reading of the guidelines after their finalization will support the comprehensibility and reduce the risk of misspelling or misleading phrasing.

Independent of the linguistic aspects, the eLCAr guidelines support the comprehensibility for the practitioner by providing key definitions at the beginning to avoid misinterpretation of technical expression. Moreover, every technical expression is explained at the beginning, in the annex or during the explanations of each provision.

For some specific topics that could not be included in the eLCAr guideline e.g. due to the complexity of the methodology, a bibliography is attached to the guidelines providing further reading material.

In summary, the structure and the phasing of the guidelines as well as the additional material for further reading enables each practitioner to use the guidelines without any circumstances ensuring a high comprehensibility.

3.4.3 Easy handling

The practitioner can easy handle the eLCAr guidelines due to the following criteria:

Table 4: Criteria for the assessment of the eLCAr guideline handling

No.	Criteria	Assessment of the eLCAr guidelines
1	Manageable number of pages	The eLCAr guideline has around 130 pages and can be easily printed out and used as a reference and handbook during the conduction of an LCA.
2	Good structured content	The structure of the eLCAr guideline is adapted from the ILCD Handbook allowing an easy cross reference to the ILCD and reducing the adjustment for practitioners using the ILCD. Moreover, the structure is established and tested within the ILCD and supports the usability of the eLCAr guidelines. The eLCAr guideline contains at the end of the project a table of content, a table containing the provisions, a list of key definition and a

		bibliography providing further reading material.
3	Accentuation trough color and structure	The provisions are accentuated in the guidelines by structure and color similar to the ILCD handbook. Each provision is described and within a green box. This highlighting eases the location of the provisions within the guideline. Important examples in the guidelines are provided within a blue box to support a quick search of the examples and to differentiate them from the explanations of the provisions. A professional layout supports the handling of the guidelines additionally.
4	Examples	The specific eLCAr examples in the guideline already mentioned in Table 3 supports the easy handling of the guidelines due to the exemplary application of important provisions.
5	Further reading material	Further reading material is summarized at the end of the guidelines within a bibliography. Moreover, to provide explanations and profound explanations footnotes are used within the guidelines to reduce the need for the practitioners to read additional guidelines or explanations.
6	Online trainings material	The possibility to use the online trainings material supports also the handling of the eLCAr guidelines. The practitioners can choose if they want to use the eLCAr guideline as a whole or if they want to concentrate on specific aspects or to get a web based introduction to the guidelines. The diversity of the possibilities to use the eLCAr guidelines depending on the preferences of the practitioners supports the handling of the guidelines additionally.

These aspects enable the practitioners to use the guidelines quite comfortable and support the easiness of the handling.

3.5 Conclusion

The concluding assessment of the eLCAr guidelines and the corresponding trainings materials cannot be finalized within the eLCAr project duration, because the different stakeholders including practitioners from the EGCI need time to use the guidelines and to apply them to their LCAs within their projects. Impressions and comments can always be given on the eLCAr homepage in the forum and support the development of revised guidelines.

4 Qualitative and legal implications of the eLCAr guideline

In general, the usage of the eLCAr guidelines is not mandatory for the different stakeholder such as the industry, OEMs or research institutes. Nevertheless, for the projects within the European Green Cars Initiative it will be recommended to use the eLCAr guidelines if they are conducting a LCA in their projects. Therefore, the guidelines shall support the user in conducting high quality LCA without restrictions in the possible application of the guidelines.

The qualitative implications of the guidelines have been presented in chapter 2 analyzing different aspects of conducted LCA studies regarding their quality and their possible results. If the eLCAr guidelines are followed strictly, the quality of a study can be enhanced, guaranteeing the consideration of all relevant aspects and impact factors. Moreover, the comparability of a LCA study with other conducted studies within the EU can be assured by the usage of certain comparable input factors - such as the UCTE electricity mix - and by the provision of all relevant decisions and assumptions described in the eLCAr provisions and additional explanations.

The practical application of the guidelines for LCA studies is supported by the high usability analyzed in chapter 3 of this report. Different activities such as the provision of the online training material on the web site support this usability additionally. Nevertheless, the practical application of the guidelines can only be tested during LCA studies using the eLCAr guidelines as their main guidance document. This additional analysis cannot be included into the project duration for the different types and possible research questions of LCA studies because of the complexity coming from different study focuses and approaches. However, to enable the practitioners to ask questions regarding the guidelines, to talk about problems which are not covered by the guidelines and to exchange solutions for handling these problems, the eLCAr forum is available after the project duration to enable this kind of exchange between the stakeholders.

The eLCAr guidelines are directly based on the ISO 14040 and 14044 norms and the ILCD handbook. The similar structure of the eLCAr guidelines and the ILCD handbook support the transfer of the knowledge and helps to simplify the usage of the ILCD handbook as analyzed in chapter 3.2. The eLCAr guidelines are not mandatory for the conduction of LCA studies for EV or their components. The usage is optional for the LCA practitioners and focusses on projects of European Green Car Initiative.

The guidelines are not aiming at the reduction of possibilities to assess different technical values such as the EV consumption by proposing a certain approach. All proposed approaches for the definition of technical values of EV and their components such as the Common Parameter Plattform (CPP) and the method for the determination of the real energy consumption of EV are only one possible option for the practitioners, if they are not able to use measured data, for example. Hence, the approaches only support the practitioners during the determination of the critical parameters such as the parameters further analyzed in 2.2. Due to the missing legal commitment of the guidelines, the presented approach and parameters are voluntary to use by the practitioners and they do not aim at being legally binding.

Lacking data quality and data availability are frequently encountered problems for a component LCA because the practitioners regularly have access to reliable and/ or coherent information only for the single component in focus. Due to the interdependencies between different components having reliable data is crucial to obtain accurate results. The CPP in the eLCAr guideline provides a framework which enables the practitioners to make realistic and conclusive assumptions regarding the missing values. The usage of these values is not mandatory for the practitioner. Moreover, the CPP does not provide LCI-datasets itself but it supports the identification of existing LCI-datasets from available databases. The aim of the CPP is to support the practitioner to dimension the components. The technical parameters for EV presented in the CPP should only be used if the practitioners do not have better available data. However, the presented data in the CPP is static and will not be updated. Therefore, it could be used as a starting point of a LCA modeling but the development in the EV technologies should be taken into account.

The approach for the determination of the real vehicle consumption in the use phase is one possible method and equal in the eLCAr guidelines to existing standardized methods such as driving cycles as the NEDC. The approach presented in the guidelines aims not at replacing existing and acknowledged methods for the determination of the energy consumption for an electric vehicle such as the ECE R101 methodology. It only contains additionally information for the determination of realistic energy consumption in the use phase and it is not legally binding for OEMs or other stakeholders. Nevertheless, an adaption of the existing consumption determination methodology as the ECE R101 including more auxiliary consumer, driving behavior, environmental characteristics could enhance the accurateness of LCA studies and support the comparability significantly.

The holistic approach of LCA studies to analyze and assess all emissions of the entire life cycle of electric vehicle might have an impact on the EU regulation (EC) No 715/2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information. In accordance with this regulation, EVs do not have emissions during the driving process because only the tank-to-wheel emissions are considered. This aspect could be change in the future but have to be discussed in expert groups assessing the possibilities to include the energy supply chain for EV into this assessment and to ensure comparability between conventional vehicles with internal combustion engines and electric vehicles.

The eLCAr guideline are a helpful guidance document for the LCA practitioners conducting a study about EV or/and their components without being legally binding. If all quality requirements for the conduction of a LCA study according the ISO norm 14040 are achieved, different methods and values for the determination of relevant values such as the vehicle consumption can be used. The data provided in the CPP and interdependency matrix contains only typical vehicle values but do not present LCI-datasets.

5 Summary

This report analyzed the quality of LCA studies, the impact of the eLCAr guidelines on the possible LCA results, the usability of the guidelines and the legal implications.

The quality of results of LCA studies can be enhanced by using a checklist based on the eLCAr guidelines. The checklist gives a quick overview for the user to check if all relevant points are considered and described in the study. Missing points and assumption within the study can be identified and added. This leads to an increased quality of conducted and published LCA studies. Studies using the eLCAr guidelines will cover the most important LCA aspects which have to be mentioned in publications.

Moreover, the effect of deviating assumptions in different studies has been analyzed for the two applications of Deliverable D3.1. Regarding vehicle related parameters a 10% error in parameter assumptions can result in a variation of the results of up to +-8%. Regarding battery related parameters a 10% error can end up in variations of the results of +-2%. In a combined consideration of all possible parameter value variation combinations (low, reference and high) it was figured out, that a 10% error range of the input parameters can result in up to 20% variation of the final results. The biggest effect comes from the choice of an electricity mix. The results change up to 100% compared to the reference case with UCTE-electricity mix if national electricity mixes are used. Therefore, it is essential to use the same generation mix in studies to keep them comparable. The demand within the eLCAr guidelines to use the UCTE mix allows a better comparison of results reducing the possible spread of results to around 20% for parameter variations of 10%.

Due to the chapter “Introduction to LCA” and the explanations in the eLCAr guidelines supported by the different trainings materials the duration of the trainings period for practitioners is reduced to a minimum. The practitioners do not need much previous LCA knowledge before they start to use the guidelines and the guidelines can be read and applied by the user concurrently to conducting the study. This is supported by the low number of pages of the final guidelines document and the possibility to use the guidelines nearly without additional documents as the ISO 14040 norms or the ILCD handbook. The eLCAr provisions are quite accurate, compared to the ILCD handbook (ILCD 2010), and possess a reduced complexity because specific approaches are presented focusing the guidelines on EV and their components. Moreover, the structure of the guidelines as well as the additional material for further reading enables each practitioner to use the guidelines without any trouble ensuring a high comprehensibility. The high usability of the eLCAr guidelines qualifies the practitioners to use the guidelines quite comfortable and support the easiness of handling.

The eLCAr guidelines are not legally binding and are therefore a helpful guidance document for the LCA practitioners conducting a study about EV or/and their components. The methods, parameters and approaches presented and described in the guidelines are only one possibility for the practitioners to determine the values they need for their studies. If all quality requirements for the conduction of a LCA study according the ISO norm 14040 are achieved, different methods and values for the determination of relevant parameters such as the vehicle consumption can be used. This also secures the usability of the guidelines in the future and for unknown processes and approaches that are yet not even developed.

6 Abbreviation

BEV	Battery electric vehicle
CPP	Common Parameter Platform
EGCI	European Green Cars Initiative
eLCAr	E-Mobility Life Cycle Assessment Recommendations
EOL	End-of-Life
EV	Electric vehicle
GWP	Global Warming Potential
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
RES	Renewable Energy Sources
SOC	State of charge