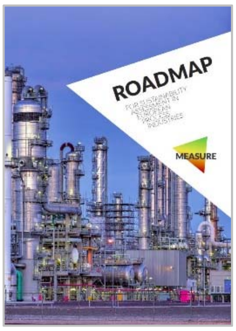
Background document

supplementing the

"Roadmap for

Sustainability Assessment in

European Process Industries"



Challenges of cross-sectorial sustainability assessment

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1 Introduction

This background document aims at giving an overview of the current practices observed in industrial collaborations along the value-chain or between sectors (at a B2B level only) and identifying advantages and disadvantages of the different approaches. Some recommendations will also be detailed in order to close the identified gaps.

The sharing of LCA data between companies exists but remains a difficult task because of the associated risks for the company providing data:

- LCA data can be related to costs (e.g. production cost)
- LCA data can deliver information about the process itself (yield, kind of substances emitted etc.) that are often highly confidential

Moreover, the collaboration requires much resource for both companies and the set-up of a joint-project is often required.

In order to facilitate the collaboration, a check-list is provided that summarizes the different steps that is recommended to be followed for a successful collaboration (Annex 1).

2 Sharing of primary data via “Black box model”

Using primary data from a specific supplier for a raw material is a good option when data available in database are not representative or when a very detailed study is performed, for which a specific raw material has a decisive impact. The company requesting data is often willing to have access to full LCA results and wishes to have a model that can be used in its own LCA software. The recipient is also interested to understand the origin of the results i.e. contribution of precursors, electricity etc. However, for the reasons mentioned above, those kinds of detailed information are seldom delivered and instead of it, LCA data are exchanged via “black box” models. Black box datasets represent an aggregated form of LCA results. Black box models are a good solution for sharing data without risking of sharing confidential data about processes.

A black box dataset means that only a Life Cycle Inventory (LCI) of the whole process is provided without giving detailed data about the different process steps. This is especially useful when there are several process steps so that no data will be delivered for a single process. Black box data are very interesting because they can be shared in several formats such as gbx, Ecospold or ILCD and directly used in a software by the data recipient. An advantage is also that all categories can be assessed and a certain level of information is available i.e. a LCI gives information about the kind of flows emitted this can be useful to understand and interpret results.

On the other side, exchanging black box datasets is not always possible, especially when there are few process steps or when some inventory flows can be directly linked to a process step or precursor.

Example: *Company A collaborated with company B and requires LCA data for a bio-based product P produced by mean of fermentation (Figure 1).*

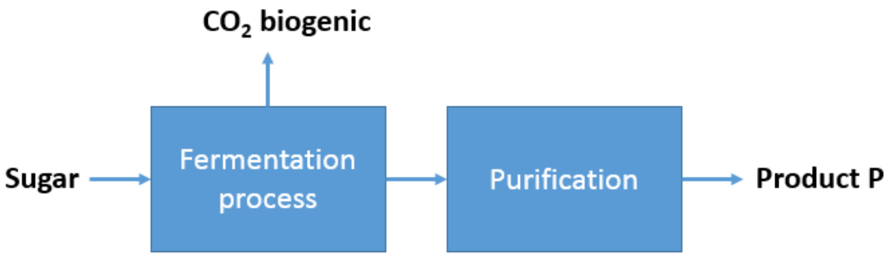
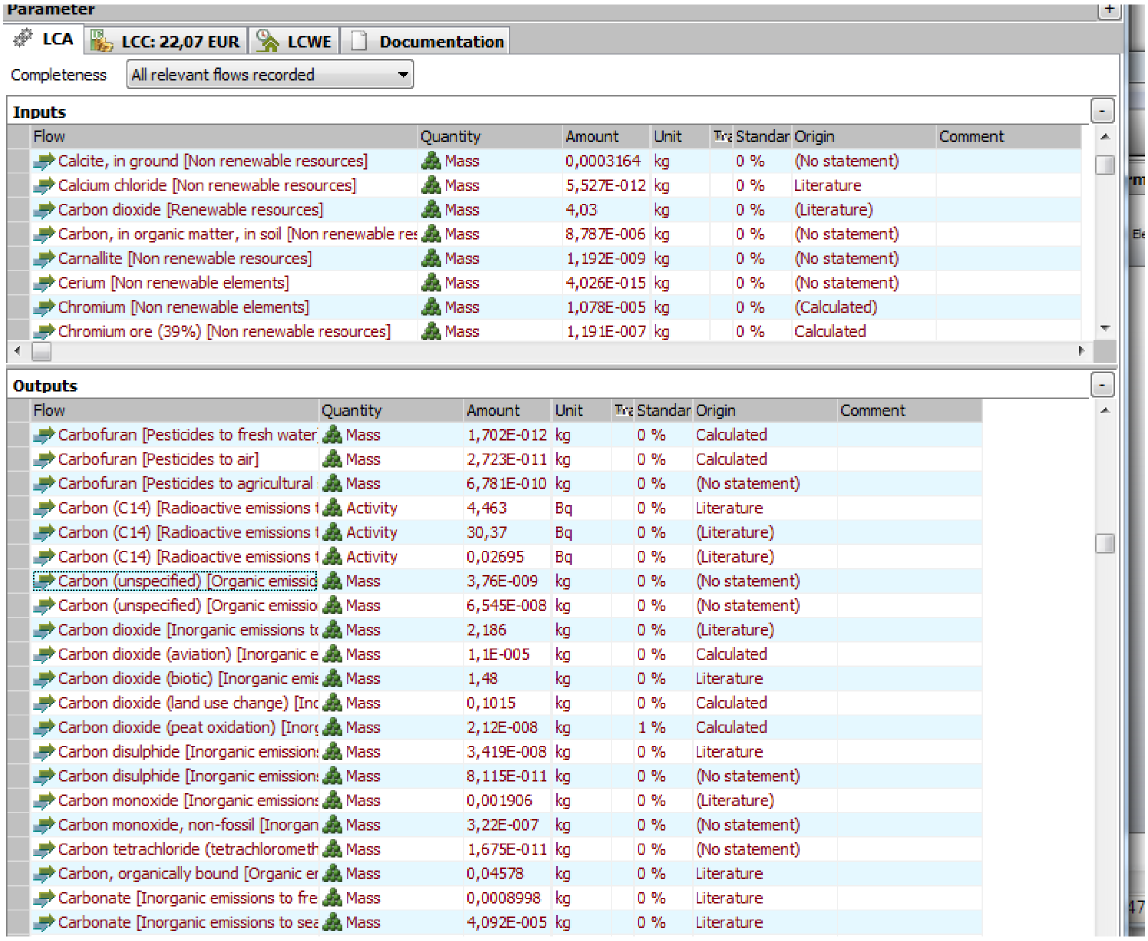


Figure 1: Simplified production process of product P

During the fermentation process, sugar is the main feedstock used for producing the product P. Emissions occur during the fermentation process i.e. biogenic carbon dioxide emissions. The quantity of sugar required for the fermentation process can be re-calculated based on LCI results (see Figure 2). Actually, in the LCI, the quantity of “CO_2e” taken up from the atmosphere by sugar is provided (input of carbon dioxide [Renewable resources]). Knowing the quantity of “CO_2” embedded in 1 kg of sugar (theoretical value), the quantity of sugar used for the process can easily be re-calculated. On the other side, *emissions occurring during the fermentation can also be read from the LCI of the whole production process because most of the emissions are occurring during the fermentation process step (output of carbon dioxide biotic [inorganic emissions to air]). Having this information, it is possible to re-calculate the yield of the process and relate the quantity of the main feedstock used to some cost information. In this case, sharing a black box dataset is not wished by the company owning data and only fully aggregated results will be provided i.e. GWP, AP, EP etc. instead of LCI results (see Table 1).*



Completeness: All relevant flows recorded

Inputs

Flow	Quantity	Amount	Unit	Tra	Standar	Origin	Comment
Calcite, in ground [Non renewable resources]	Mass	0,0003164	kg		0 %	(No statement)	
Calcium chloride [Non renewable resources]	Mass	5,527E-012	kg		0 %	Literature	
Carbon dioxide [Renewable resources]	Mass	4,03	kg		0 %	(Literature)	
Carbon, in organic matter, in soil [Non renewable res	Mass	8,787E-006	kg		0 %	(No statement)	
Carnallite [Non renewable resources]	Mass	1,192E-009	kg		0 %	(No statement)	
Cerium [Non renewable elements]	Mass	4,026E-015	kg		0 %	(No statement)	
Chromium [Non renewable elements]	Mass	1,078E-005	kg		0 %	(Calculated)	
Chromium ore (39%) [Non renewable resources]	Mass	1,191E-007	kg		0 %	Calculated	

Outputs

Flow	Quantity	Amount	Unit	Tra	Standar	Origin	Comment
Carbofuran [Pesticides to fresh water	Mass	1,702E-012	kg		0 %	Calculated	
Carbofuran [Pesticides to air]	Mass	2,723E-011	kg		0 %	Calculated	
Carbofuran [Pesticides to agricultural	Mass	6,781E-010	kg		0 %	(No statement)	
Carbon (C14) [Radioactive emissions t	Activity	4,463	Bq		0 %	Literature	
Carbon (C14) [Radioactive emissions t	Activity	30,37	Bq		0 %	(Literature)	
Carbon (C14) [Radioactive emissions t	Activity	0,02695	Bq		0 %	(Literature)	
Carbon (unspecified) [Organic emissic	Mass	3,76E-009	kg		0 %	(No statement)	
Carbon (unspecified) [Organic emissio	Mass	6,545E-008	kg		0 %	(No statement)	
Carbon dioxide [Inorganic emissions tc	Mass	2,186	kg		0 %	(Literature)	
Carbon dioxide (aviation) [Inorganic e	Mass	1,1E-005	kg		0 %	Calculated	
Carbon dioxide (biotic) [Inorganic emis	Mass	1,48	kg		0 %	Literature	
Carbon dioxide (land use change) [Inc	Mass	0,1015	kg		0 %	Calculated	
Carbon dioxide (peat oxidation) [Inorg	Mass	2,12E-008	kg		1 %	Calculated	
Carbon disulphide [Inorganic emission:	Mass	3,419E-008	kg		0 %	Literature	
Carbon disulphide [Inorganic emission:	Mass	8,115E-011	kg		0 %	(No statement)	
Carbon monoxide [Inorganic emissions	Mass	0,001906	kg		0 %	(Literature)	
Carbon monoxide, non-fossil [Inorgan	Mass	3,22E-007	kg		0 %	(No statement)	
Carbon tetrachloride (tetrachlorometh	Mass	1,675E-011	kg		0 %	(No statement)	
Carbon, organically bound [Organic er	Mass	0,04578	kg		0 %	Literature	
Carbonate [Inorganic emissions to fre	Mass	0,0008998	kg		0 %	Literature	
Carbonate [Inorganic emissions to sea	Mass	4,092E-005	kg		0 %	Literature	

Figure 2: Exemplary LCI results for the product P modelled in the GaBi software (think-step 2016)

By providing only results in some impact categories, the data recipient will have a limited usage of the data but confidentiality is ensured. However, it reduces a lot the transparency of the collaboration and the user has few possibilities to interpret results.

Table 1: Exemplary results of the product P in some selected impact categories

Impact category		**Unit**
GWP incl. biog C incl. LUC	0.4	kg CO_2e/kg
AP	0.016	kg SO_2e/kg
EP	0.008	kg PO_4e/kg
POCP	5E-4	kg Ethene-e/kg
PED	90	MJ/kg

3 Data exchange via industry averages/collaboration projects

The provision of industry average data sets is a commonly used solution in data management, in most cases coordinated directly by industry associations. The member companies have the common goal to collect sustainability data.

Several industrial organisations have been collecting and providing LCI data already for years. The format of the data collection and provision differs but the key characteristics of industrial average data sets are in general very similar.

Industry average data sets are a good and widely used solution to overcome confidentiality issues as the company specific data is only handled by the industry association as an independent third party.

3.1 Data collection

The data collection for industrial average LCA data is in most cases done on the inventory level. So that only input and output data for process steps at gate-to-gate level are collected.

Via implementing these data in LCA models and connecting them with upstream data sets, cradle-to-gate analyses are possible. In some cases also information about other life cycle stages such as the use or end-of-life phase are collected and included in the later on published data sets.

As information of several companies is collected detailed data checks are enabled. Via simple comparison among the data of the participating companies most reporting errors can be easily identified as they are most likely not in the same range with the data of other companies. Furthermore, based on the knowledge of process experts who are active in such a data collection project, industrial associations can also analyse the technological reasonableness of data which is a huge advantage (World Steel Association 2011).

This ensures high quality data which is relevant and representative for the products.

In the case where an agreed model and final impact assessment results are already available, it is also possible to collect data directly on impact assessment level. This is usually done only for very specific case studies and not for data provision purposes.

3.2 Representativity of industry averages

The use of industry averages has many advantages as the market mix reflects the current production technology of several producers. This way it remains valid for a longer time and for a broader field of application than single producer data. Instead of using company specific data the industry average is representative and helpful for many studies. It reflects the reality in which one material is often bought from several suppliers as otherwise a high dependency on one producer would be induced. The average LCA results allow staying representative with the real market conditions, instead of working only with one supplier in case of material and LCA supply which would require a change in the LCA every time a new supplier is used. The use of industrial averages for defined regions is seen as “the most open and consistent means of assessing improvements in “sustainability”” (FEVE 2016).

If high quality data is needed it is important to rely on process experts who know how the technology works in reality. This accurate and up-to-date knowledge is given at industrial organisations which collect data; therefore these data are technologically representative.

3.3 Industry averages: horizontal vs. vertical

In most cases industrial average data are aggregated to the product level so that no data for separate process steps are supplied. This is also called vertical aggregation (Figure 3). This approach is in general preferred because several companies with slightly different process step setups can collaborate and supply common data for a product that is made by all of them.

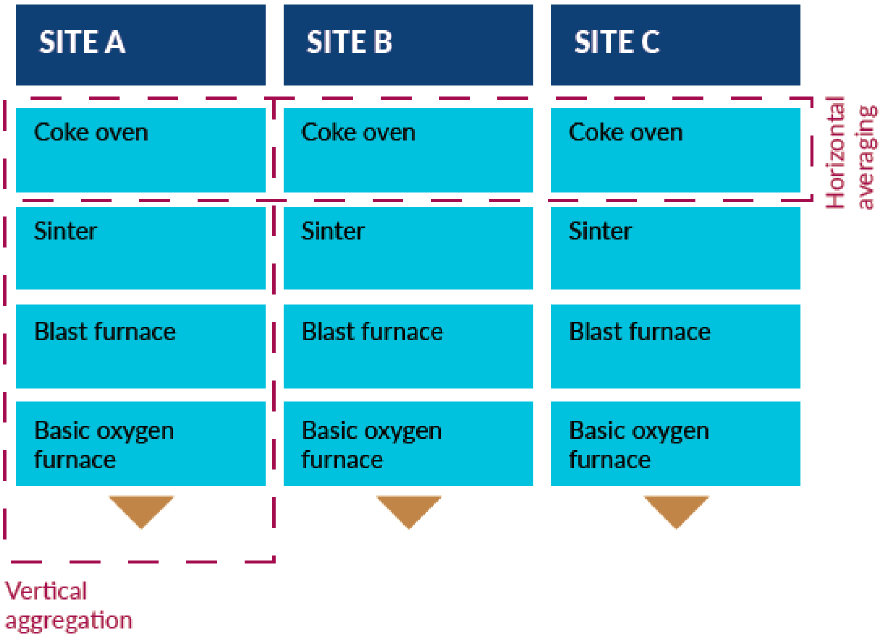


Figure 3: Vertical aggregation and horizontal averaging of LCI data for several companies (World Steel Association 2011).

However, horizontal averaging has advantages as well. It is helpful for benchmarking of process steps because the providing company can easily identify how its process performs in comparison to the industry average. With vertically aggregated data sets this is not easily done as only data for the whole process of the product is published, a process step which performs worse than the average cannot always be identified. Therefore the contribution of each process step and possibilities for improvement are more likely to be identified by horizontal comparisons (EAA 2013).

It is questionable if the need for more data aggregation to ensure confidentiality is fulfilled by horizontal averaging as the process know-how and cost-sensitive data could still be obvious in an industry average. For companies participating in the data provision the vertical aggregation ensures the highest confidentiality as all inputs and outputs are summed up for the whole system.

In case that the setups of one process step differ heavily between the participating companies the horizontal averaging is challenging might not be fully representative. For example if two process steps are connected at one production site but split at another, the vertical aggregation would allow to calculate an average for the product made via both production routes. The calculation of a horizontal average would require an allocation and a virtual split of the process steps.

That is why using the vertical aggregation approach a data set representative for the market mix of the production can be prepared.

From a data recipient’s perspective the complexity of the horizontal averaging approach has to be kept in mind.

Even if the first impression might be to receive more and detailed data with the horizontal averaging approach, the use of these data requires high expert knowledge. In the case where no strict process boundaries exist in reality, for example for integrated processes which use by-products of each other or have a shared energy production and consumption, complex modelling approaches are required. Although solutions for a virtual separation can be found, the problem that the process steps have to be reconnected in a technically realistic and logical way remains. This connection is in case of horizontal averaging the task of the data recipient who is seldom an expert for the production technology.

A vertically aggregated data set for the whole production of a product at one production site already incorporates these linkages and connections due to the wider system boundaries.

Furthermore a model which takes into account integrated process chains is seen as the most realistic and representative solution. In most industrial situations a system consisting of many process steps is optimised as a whole and not only with the focus on especially one process step. Such a limitation could lead to unintended burden shifting. Supplying data for separate process steps shifts the holistic production cycle perspective to a single focus point.

3.4 LCI models

In most cases the collected data are imported into a specific LCA model. By using only one model with agreed underlying modelling choices, the modelling uncertainty can be effectively reduced. An agreement for using the same assumptions (such as allocation approaches) and data sets for upstream data can be found. This way the best approach is discussed within industry and not decided differently by each company.

Even if the approach chosen cannot perfectly reflect reality, it is very helpful to agree on common modelling assumptions. In this case it is ensured that all players use the same model and the respective outcomes are based on the same decisions. Although the results do not get absolutely more accurate, they get more comparable and the modelling uncertainty is reduced.

Table 2: advantages and disadvantages of industry average based LCI models

	Advantages	**Disadvantages**
Data provider	Confidentiality can be ensured via industry averages	Data will be collected for most important processes. These might not be the most relevant processes for each individual producer.
	Intense data checks ensure higher data quality.	
	The environmental performance of a specific producer is hidden in the average. This can be advantageous or disadvantageous for a specific data provider.	
Data recipient	Intense data checks ensure higher data quality.	Data interpretation depends strongly on the quality of data documentation
	Data representative for the market mix, no dependence on one single producer.	No possibility to assess the individual environmental performance of specific producers.
	Data is very representative as it is based on production experts' knowledge.	No possibility to see or change modelling choices directly in the data set
	Process steps are in most cases linked correctly, data can be easily implemented.	No possibility to analyse the impact of changes in process modification
	Data is based on agreed methodology, so that the modelling uncertainty is reduced	

4 Data documentation in B2C collaboration

Having a well-documented dataset is of great support when data exchanged are intended to be used for decision-making. To publish LCA data via different platforms such as the Life Cycle Data Network from the Joint Research Center, datasets have to be compliant with quality requirements aimed at guaranteeing datasets quality and coherence in term of methodology, documentation and nomenclature. When data are exchanged between companies, no rules concerning the documentation exist and this point is often identified as a major bottleneck of the communication. Providing life cycle results without having a minimum extend of documentation presents some risks:

- Risk of misunderstanding of results and wrong communication over the value-chain
- Risk of inconsistency: when no information is provided about i.e. allocation approach or use of credits, a major risk of double counting exist.

Moreover, the recipient of the LCA data might face some major difficulties for interpreting its results and communicate further its own results along the value-chain when some major background information is missing.

In this section, a proposal is made for a pragmatic documentation of LCA data exchanged at the B2B level based on the experience of industrial LCA practitioners of the MEASURE project team.

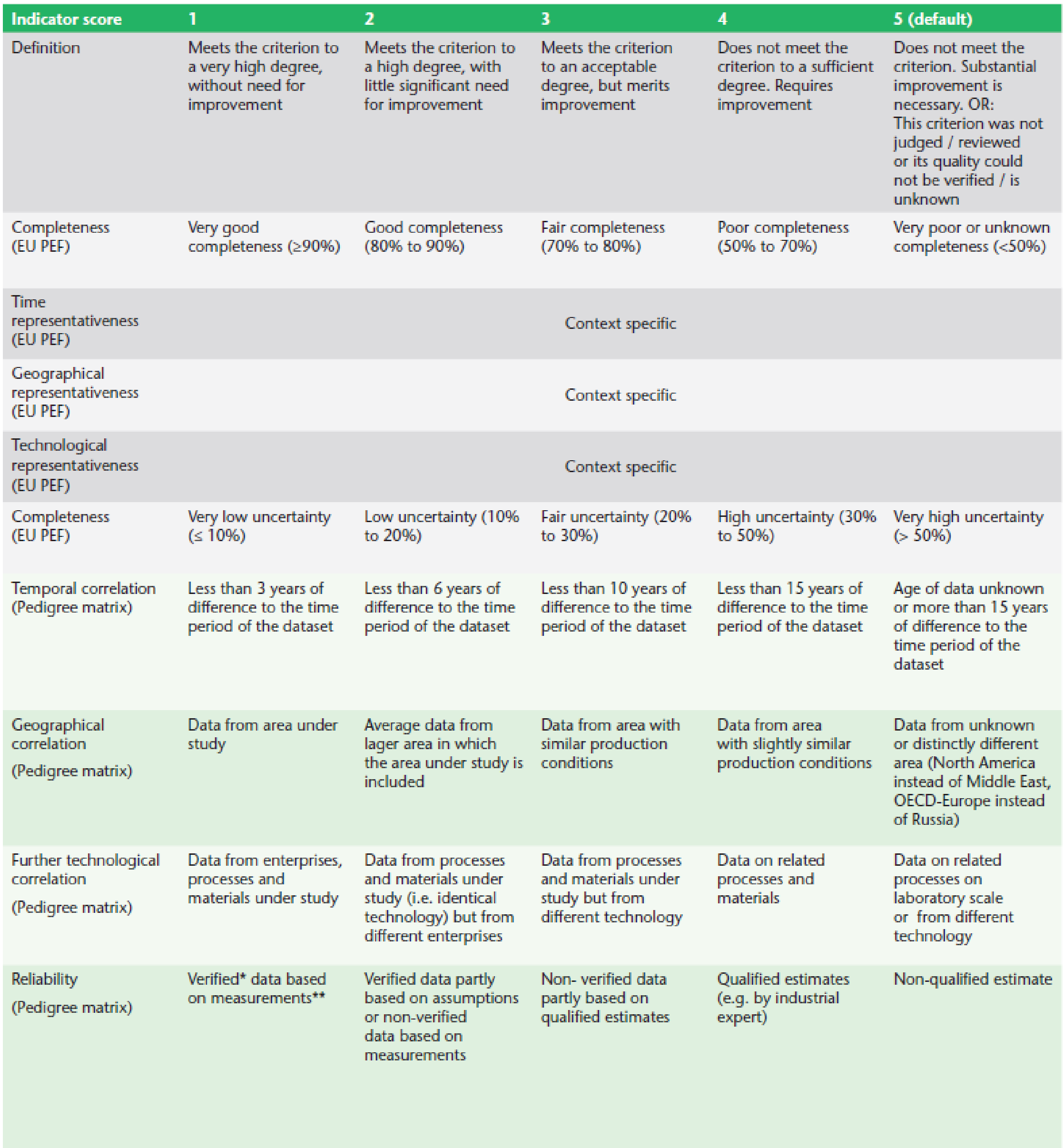
4.1 Data quality

In the WBCSD guidance for the Chemical sector (WBCSD 2014), indicators are recommended for assessing the quality of the data used for the modelling (Figure 4):

- Reliability or parameter uncertainty
- Completeness
- Time representativeness
- Geographical representativeness
- Technological representativeness.

For those indicators, the quality is assessed based on a scoring system according to data quality ratings from EU PEF and the Pedigree Matrix from the ecoinvent database version 3 (from 1 to 5, with 1 representing the highest score and 5 the lowest). It is recommended to perform the assessment for each process unit with a significant contribution (>10 %) to at least one environmental impact and to aggregate results at the life cycle stage level.

This approach for assessing data quality was discussed within the MEASURE consortium and judged very suitable for the documentation of LCA data exchanged at the B2B level and adapted to the different sectors of process industries (i.e. not specific to the chemical industry).



Indicator score	1	2	3	4	5 (default)
Definition	Meets the criterion to a very high degree, without need for improvement	Meets the criterion to a high degree, with little significant need for improvement	Meets the criterion to an acceptable degree, but merits improvement	Does not meet the criterion to a sufficient degree. Requires improvement	Does not meet the criterion. Substantial improvement is necessary. OR: This criterion was not judged / reviewed or its quality could not be verified / is unknown
Completeness (EU PEF)	Very good completeness (≥90%)	Good completeness (80% to 90%)	Fair completeness (70% to 80%)	Poor completeness (50% to 70%)	Very poor or unknown completeness (<50%)
Time representativeness (EU PEF)			Context specific		
Geographical representativeness (EU PEF)			Context specific		
Technological representativeness (EU PEF)			Context specific		
Completeness (EU PEF)	Very low uncertainty (≤ 10%)	Low uncertainty (10% to 20%)	Fair uncertainty (20% to 30%)	High uncertainty (30% to 50%)	Very high uncertainty (> 50%)
Temporal correlation (Pedigree matrix)	Less than 3 years of difference to the time period of the dataset	Less than 6 years of difference to the time period of the dataset	Less than 10 years of difference to the time period of the dataset	Less than 15 years of difference to the time period of the dataset	Age of data unknown or more than 15 years of difference to the time period of the dataset
Geographical correlation (Pedigree matrix)	Data from area under study	Average data from lager area in which the area under study is included	Data from area with similar production conditions	Data from area with slightly similar production conditions	Data from unknown or distinctly different area (North America instead of Middle East, OECD-Europe instead of Russia)
Further technological correlation (Pedigree matrix)	Data from enterprises, processes and materials under study	Data from processes and materials under study (i.e. identical technology) but from different enterprises	Data from processes and materials under study but from different technology	Data on related processes and materials	Data on related processes on laboratory scale or from different technology
Reliability (Pedigree matrix)	Verified* data based on measurements**	Verified data partly based on assumptions or non-verified data based on measurements	Non- verified data partly based on qualified estimates	Qualified estimates (e.g. by industrial expert)	Non-qualified estimate

Figure 4: Data quality rating (WBCSD, 2014)

On top of this quantitative rating, qualitative additional information concerning the quality of the impacts categories assessed might also be provided i.e. possible deviation of the data quality in the different impact categories.

Example: “The POCP impact category has a lower quality because VOC emissions could not be assessed based on primary data, literature data have been used.”

4.2 Methodological challenges and choices (qualitative information)

In the analysis of sectors A, B and C, several methodological issues have been identified that are specific to each of those sectors (section 3.2 of the MEASURE Roadmap and **background documents** “Sector report: chemistry and FMCG”, “Sector report: metal and automotive” and “Sector report: waste”). When data are exchanged over the supply chain, these methodological challenges require additional information about the way they have been handled. Consequently, the data that shall be provided are sector specific. The following Table 3 provide some examples of the issues that shall be described for at least the three sectors investigated within the MEASURE project:

Table 3: Qualitative information concerning the methodological issues

Methodological issues	**Qualitative information to provide**	**Sector concerned**
By-product	Are by-products obtained and how have they been handled (i.e. allocation, system expansion)?	All
Allocation	At which level was an allocation applied? Which method?	All
Credit	Was any credit applied?	All
Land Use Change	How were the emissions from Land Use Change estimated (i.e. method used for averaging, data sources for carbon stock, carbon pools considered, etc.)?	Sector A
Biogenic carbon	How was the biogenic carbon considered in the analysis? Was the carbon balance checked?	Sector A
End of Life	Which method was used for accounting for the recycling at the end of life (e.g. credit, recycling rate considered, recycled content)	Sector B, all sector generating wastes
End of Life	Modelling of long term emissions from the waste treatment: which approach has been used?	Sector C, all sectors generating wastes
End of Life	Modelling of materials or energy generated during the waste treatment: which replacement options have been used?	Sector C, all sectors generating wastes

Those critical issues are often a major source of uncertainty. For this reason, a qualitative uncertainty assessment shall be given by providing information about how the choice of the approach influences the overall results. Providing a range of results can in some situation be a good approach.

4.3 Quantitative (or semi quantitative) information about results

A major bottleneck for interpreting results provided by a supplier remains in the fact that data are often provided as a black box what makes the interpretation or the comparison of these primary data with some data from database or from industrial associations almost impossible. Nevertheless, providing quantitative data is possible at an aggregated level, without risking delivering confidential information.

First of all, the MEASURE project team recommends to provide allocation factors used when the choice of the allocation approach has a significant impact on the final results (e.g. >20%).

In order to interpret results obtained, the contribution of the different process parts for the most important impact categories shall be provided (the choice of the target categories shall be agreed between the two companies collaborating):

- Contribution of precursors (Upstream)
- Contribution of energy, utilities (electricity, steam, thermal energy, process water, compressed air etc.) and own process (process emissions) (gate-to-gate)
- Contribution of the waste treatment (solid and liquid wastes, waste water)

In order to respect the confidentiality of the underlying data, the contribution shall be expressed in the following way as a range in percentage (Table 4) and aggregated for upstream, gate-to-gate and downstream processes as described above.

Table 4: Rating of the contribution

Contribution	
Fundamental	> 80%
Major	50-80%
Significant	25-50%
Low	< 25%

Table 5 is an example of a summarized data documentation that shall be provided together with LCA results.

Table 5: Example of data documentation for the LCA of the product P

Data quality		
Indicator	**Score**	**Comment**
Reliability	*2*	
Completeness	*2*	
Time representativeness	*1*	*Production data from 2014 have been used for modelling*
Geographical representativeness	*1*	
Technological representativeness	*2*	
Methodological choices		
By-products and allocation	*No by-products obtained in any process steps. No allocation applied*	
Land Use Change (LUC)	*CO_2 emissions from LUC for Soybean oil have been estimated with the “Land use Change Assessment tool” from the PAS 2050-1, for the country Brazil. For more information about method and data source, please refer to PAS 2050-1 (BSI 2012)*	
Biogenic carbon	*Biogenic carbon has been considered in this analysis. The balance has been checked and the biogenic carbon content embedded in the product P corresponds to its stoichiometry (1,9 kg CO_2/kg)*	
Results (quantitative information) for GWP and Acidification Potential		
Process part	**Contribution**	**Comment**
Upstream	*Fundamental*	*Bio-based feedstock and emissions from LUC have a fundamental impact on the GWP*
Gate-to-Gate	*Low*	
Downstream	*Low*	

5 Difficulties currently not solved

The communication and interpretation of LCA results remains a major challenge in cross-sectorial collaboration. The results for different impact categories can have significantly different relevance and importance for each sector. In case of data sharing, an agreed approach between data provider and recipient regarding the most important impact categories should be sought to allow a correct and ideal data usage.

Apart from that, a harmonised way of communicating especially the uncertainty of results has not yet been found. During the MEASURE workshop in Mechelen, the communication of ranges of results was seen as a pragmatic solution for the near future.

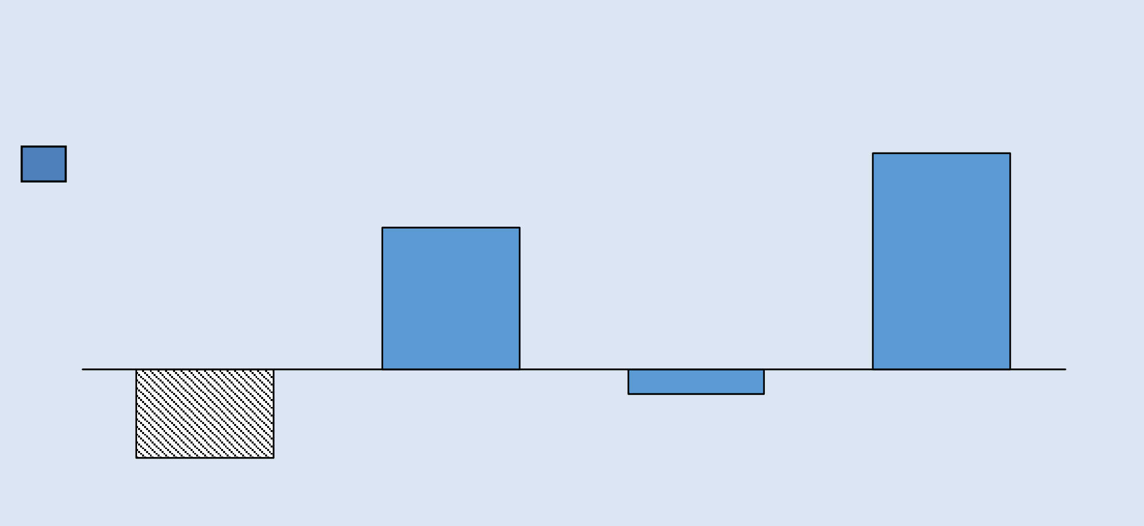


Figure 5: Different approaches for accounting of emissions from Land Use Change: exemplary display, left bar without consideration of Land Use Change

This could be either done visually as in Figure 5 or in a written way. For the example shown above this would mean that instead of communicating an average result (i.e. 2.1 kg CO_2e), the whole range (-1.3 to 3.2 kg CO_2e) would be provided.

However, such results cannot be understood and interpreted easily by data users. Difficulties occur especially when a decision shall be based on the results.

While communicating different scenarios and the corresponding range of results can help to understand the impact, relevance and reliability of the data, such a wide and open communication is especially complex to interpret for people who are not deeply involved in the topic.

Nevertheless, in the workshop discussion, it was expressed that already acknowledging the fact that uncertainty exists can be the first step to a more informed interpretation of LCA data.

One possibility to assess and visualise the impact of specific value choices is to analyse the sensitivity of results so that it is at least clear that the results should not be seen as concrete and definitive numbers.

Bearing in mind the uncertainty of data, product comparisons based on LCA data are especially problematic as there is currently no generally accepted definition which differences for impact results can be called significant. If the impact assessment results of 2 products differ for example by 20 %, it could be that the uncertainty is much higher than 20 %, so that such a difference cannot be considered relevant.

More guidance is needed how to assess uncertainty and how to deal with it in case of product comparisons. The only possibility which is readily available is to agree on assumptions in, but also between sectors to reduce the uncertainty in modelling and by this also the complexity of results.

6 WBCSD Guidance Document ‘Life Cycle Metrics for Chemical Products’ (2014): Analysis of Adoption and Transferability

A short analysis and survey was done to evaluate the degree of penetration and adoption of the *WBCSD Guidance Document ‘Life Cycle Metrics for Chemical Products’* (WBCSD 2014) amongst attendees of the MEASURE London WS and in our personal networks. There were around 10 expert respondents, distributed ~50/50 from the chemical sector versus other sectors. The results indicate that in the Chemical sector (A), the awareness of the report is reasonably good (> 50%) and that most of the guidance, examples and recommendations are deemed relevant and useful. Nevertheless, some discussion remains, mainly around choices of impacts and impact methodologies. More verbal comments came from the non-chemical sector, with some concerns around e.g. scope (cradle-to-gate vs cradle-to-grave), impact methods, allocation and end of life/recycling. Awareness in other sectors was low. It is therefore not recommended to promote the use of the WBCSD guideline outside sector A, other than ‘for information’.

Respondents who were aware of the Guideline emphasized that it should not be the intention to claim ‘compliance’ of LCA studies with this WBCSD guideline. As the name indicates, it is not a new methodology but provides guidance and recommendations. The aim was to establish a common understanding within the chemical industry on how to interpret and apply existing general LCA principles and rules. In that, the WBCSD guidance is more precise than e.g. the ISO 14040 series.

7 Abbreviations

AP	Acidification Potential
B2B	Business to Business
B2C	Business to Consumer
EP	Eutrophication Potential
GWP	Global Warming Potential
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LUC	Land Use Change
PED	Primary Energy Demand
PEF	Product Environment Footprint
POCP	Photochemical Ozone Creation Potential
VOC	Volatile Organic Compound
WBCSD	World Business Council for Sustainable Development

8 References

BSI (2012). PAS 2050-1:2012. Assessment of life cycle greenhouse gases emissions from horticultural products.

EAA (2013). Environmental Profile Report for the European Aluminium Industry. April 2013 - Data for the year 2010. Life Cycle Inventory data for aluminium production and transformation processes in Europe. 78 pp.

FEVE (2016). http://www.feve.org/index.php?option=com_content&view=article&id=62:lca-is-a-tool-to-evaluate-the-environmentfaqal-footprint-of-an-industry-or-a-product&catid=9&Itemid=29 (Accessed, March 2016).

Thinkstep (2016). GaBi software version 07.02 2016.

WBCSD (2014). Life Cycle Metrics for Chemical Products. A guideline by the chemical sector to assess and report on the environmental footprint of products, based on life cycle assessment. 120 pp.

World Steel Association (2011). *World Steel Association Life Cycle Inventory Study for Steel Products*. https://www.worldsteel.org/steel-by-topic/life-cycle-assessment/about-the-lci.html (Accessed, March 2016).

9 Annex 1

Checklist: Industrial Cooperation for sustainability assessments along the value-chain

1. **Preparation**
   - Identify how and where connections/ contact with the other companies in the supply chain can be established, i.e., can it be done via 1-1 meetings, via industry associations, via meetings with regulators, scientific events, etc.
   - Clearly define and articulate the mutual and long term category benefit, on top of interests of individual companies
   - Identify which (commercial) confidentiality and organizational conditions need to be met in order to proceed, taking into account competition law and other relevant regulations. Prepare confidentiality agreements if required.
2. **Planning/organisation of the work , technical aspects**
   - Define a timeline
   - Define which data are required by the recipient and which data the supplier is able to share
   - Define what the “target” categories of the study are (are other topic such as water footprint relevant?)
   - Agree on a format and the level of aggregation for data exchange:
     - Mass and energy balance
     - Life Cycle Inventory
     - Impact assessment results
     - Specific format such as gbx, Ecospold, excel.
   - Check if relevant standards and sectorial agreements are already available, based on these agree how methodological issues are intended to be handled: allocation, modelling of end of life, issues related to Land Use Change etc.
3. **Data review, summarization, communication, documentation**
   - Present results in a face to face meeting with both industry parties (if possible) to enable best understanding of the data and their usability:
     - Present the model and the underlying modelling choices
     - Present the major assumptions
     - Include information concerning data uncertainty
   - Exchange data in the agreed format
   - Prepare a suitable data documentation (see chapter 4)