GaBi 2022.2 in openLCA

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openLCA

Contents

1 Caution

It odd to be noted that for this version of the GaBi databases only the impact method 'Environmental Footprint' is available. This is because of unmatching universal unique identifiers in the methods that were provided to us, rendering us unable to integrate all potentially available impact methods.

Furthermore, redundant units and unit groups were removed from the database. Also, in openLCA reference output flows cannot be waste flows and reference input flows cannot be product flows. For processes where this occurred, the reference flow was substituted with a flow of the correct flow type

2 GaBi databases

This document aims to guide the use of GaBi 2022.2 databases in openLCA. These databases have been released/developed by Sphera in 2022[1], and they were adapted to openLCA software. Therefore, all the modifications made in these databases in order to be compatible with openLCA are also explained. The list of GaBi 2022.2 databases available in Nexus website[2] to be used in openLCA (as zolca file) is available hereunder:

- Professional database 2022.2
- Lean database 2022.2
- Indian database 2022.2
- Extension database XXII_ carbon composites 2022.2
- Extension database XXI_ India 2022.2
- Extension database XX_ food & feed 2022.2
- Extension database XVIII_ NREL USLCI integrated 2022.2
- Extension database XVII_ full US 2022.2
- Extension database XVI_ seat covers 2022.2
- Extension database XV_ textile finishing 2022.2
- Extension database XIX_ bioplastics 2022.2
- Extension database XIV_ construction materials 2022.2
- Extension database XII_ renewable materials 2022.2
- Extension database XI_ electronics 2022.2
- Extension database X_ machining processes 2022.1
- Extension database VIII_ coating 2022.2
- Extension database VII_ plastics 2022.2
- Extension database VI_ precious metals 2022.2
- Extension database V_ nonferrous metals 2022.2
- Extension Database IXb_ end of life parameterised models 2022.2

- Extension database IXa_ end of life 2022.2
- Extension database IV_ aluminium 2022.2
- Extension database III_ iron and steel 2022.2
- Extension database II_ energy 2022.2
- Extension database Ib_ inorganic intermediates 2022.2
- Extension database Ia_ organic intermediates 2022.2

3 GaBi databases in openLCA

GaBi databases are created with the LCA software GaBi [3]. Therefore, the structure of their datasets is, in some cases, highly influenced by the type of modelling carried out in that software. For instance, it includes:

- Graphical modelling: the user manually creates the connections in the supply chains in the model graph; automatic connections are not feasible. That is one reason why most of the GaBi databases datasets are either fully aggregated or partially aggregated processes (i.e. creating thousands of linkages manually as when using unit processes might require too much effort).
- The same flow can be generated by multiple processes within the database (e.g. “electricity”, by all electricity mixes).
- Default providers cannot be set within the software, neither are supported by ILCD, which is the format used by thinkstep to provide to GreenDelta the datasets.

Due to all the abovementioned conditions, it is strongly recommended to create the product systems only linking the default providers for GaBi databases in openLCA, or to uncheck the “auto-link processes” box. Therefore, when creating new product systems, please remember to select the “Only link default providers” option in the product system wizard (Figure 1) for provider listing. In the case of selecting the “prefer default providers” option in the product system wizard for provider listing, please check the model graphs to eliminate the unwanted providers to avoid miscalculations in the impact assessment. GaBi processes cannot be calculated through the “Direct Calculation” option in openLCA.

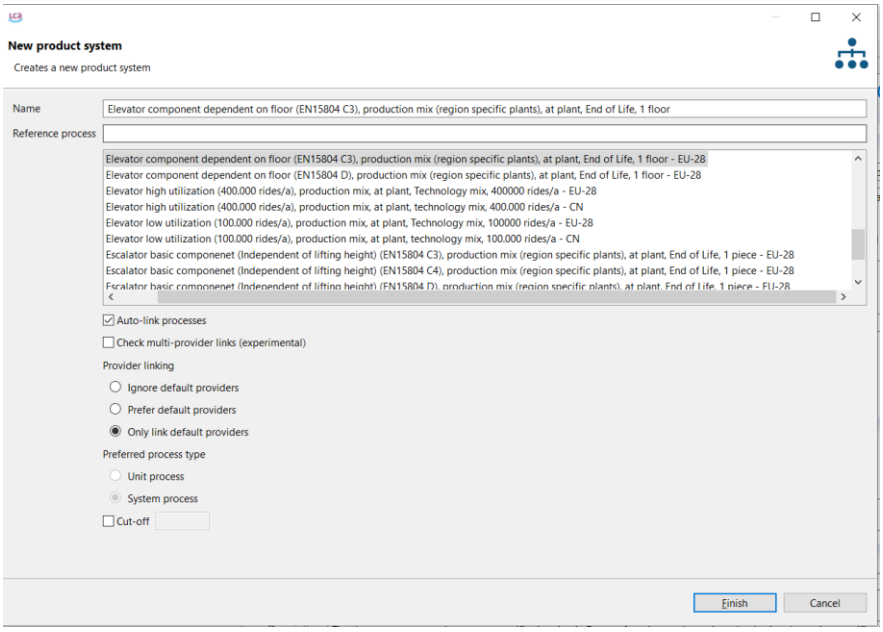


Figure 1: Wizard for creating a product system in openLCA.

For some processes, even selecting “Only link default providers”, openLCA will not finalise the product system creation, or the calculations will fail. These issues happen mainly for the following reasons:

(1) There are some processes in GaBi 2022.1 databases with no inputs/outputs, just parameters.
(2) For some processes, the reference flows are not defined according to openLCA requirements.

In openLCA, product flows on the input side are considered input materials, while on the output side, they are considered a product, by product, and/or avoided product. On the other hand, the waste flows on the output side are considered wastes, which should be connected to waste treatment processes. On the input side, waste flows are raw materials for treatment processes, and they cannot be linked to providers. Therefore, for openLCA calculations, reference flows can be either product flows on the output side or waste flows on the input side. If the reference flows do not respect these conditions, the process cannot be calculated by openLCA.

Appendix 1 summarises the number of processes (and the list of processes) that cannot be directly calculated due to the abovementioned reasons; one example for each case is given. For this reason, the user should modify the process, selecting the reference flow, in order to allow the calculations. For example, the process “Steam conversion (vlp) inv, production mix, at plant, technology mix” (Figure 2) would need to be modified regarding its reference flow.

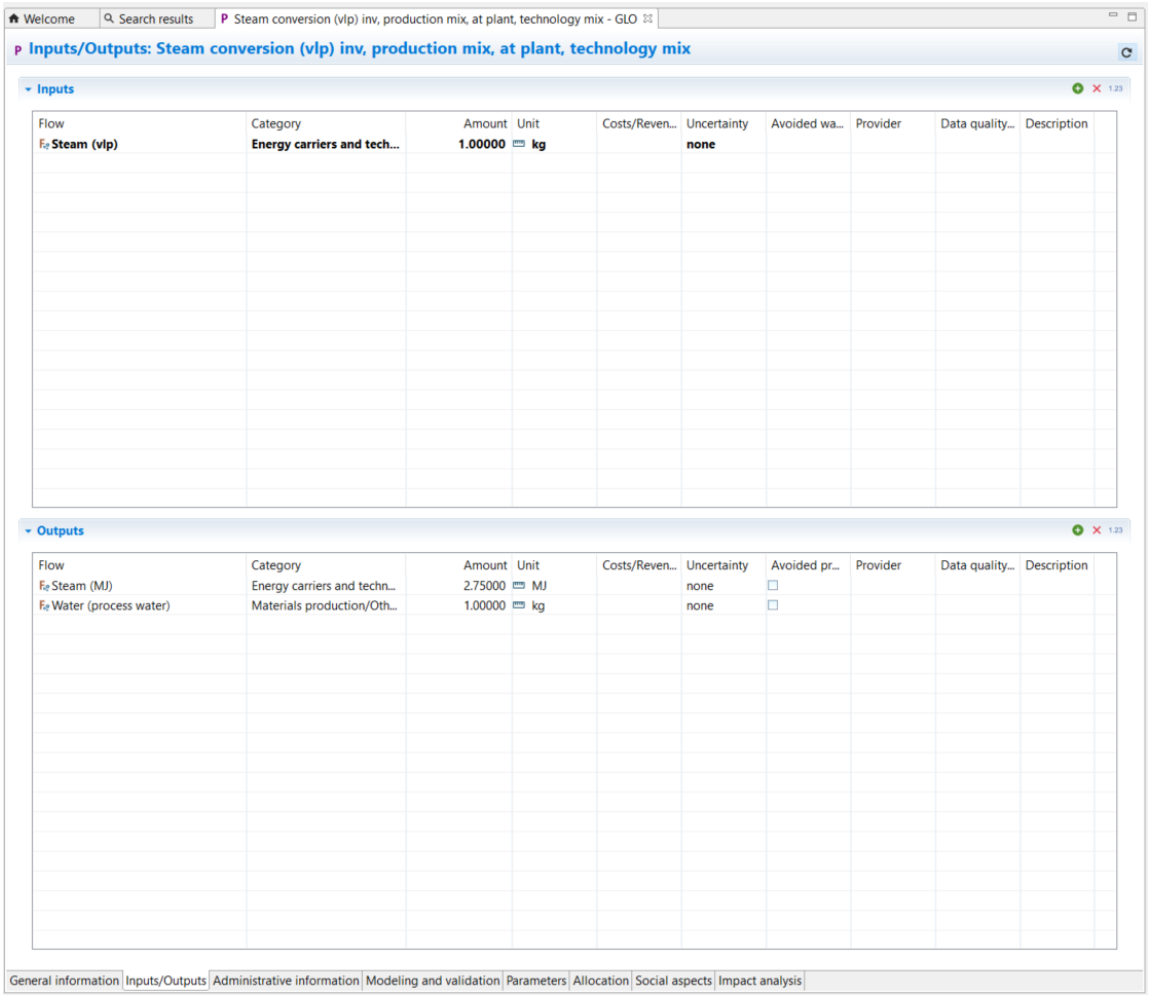
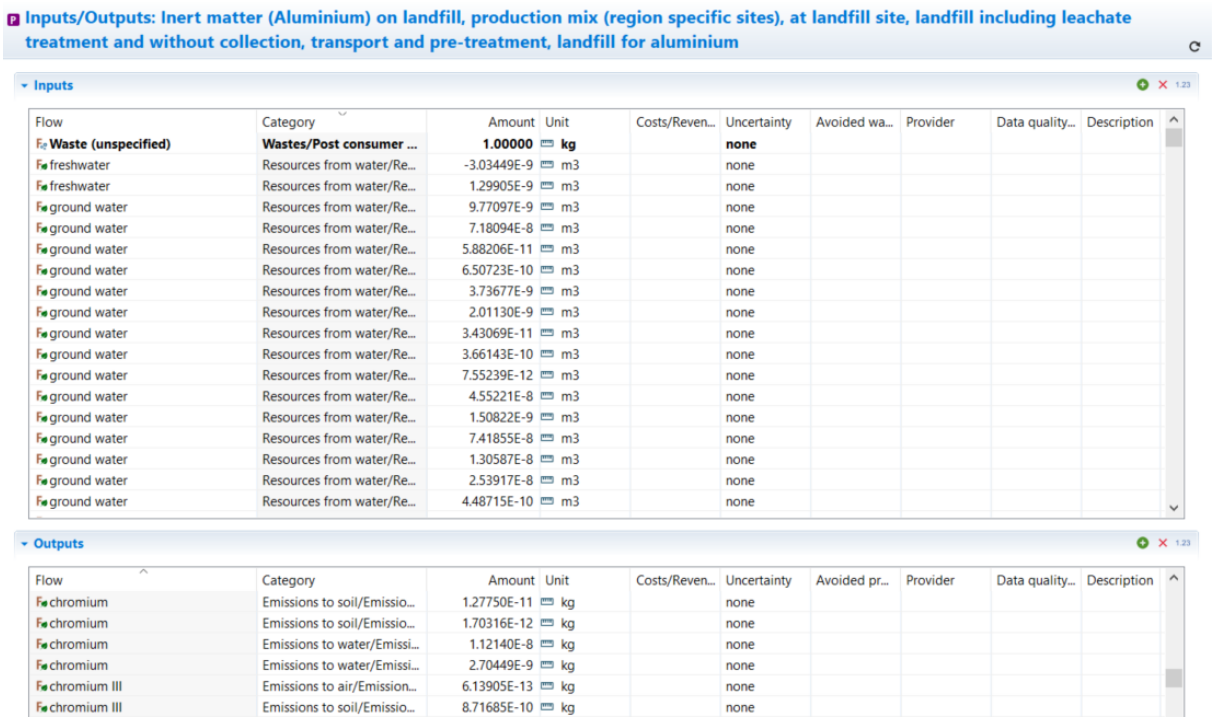


Figure 2: Example of a process that the reference flow (product flow, as an input) should be modified by the user.

Considering the example in Figure 3 (Process “Inert matter (Aluminium) on landfill, production mix (region specific sites), at landfill site, landfill including leachate treatment and without collection, transport and pre-treatment, landfill for aluminium”), the selected reference flow is a product flow on the input side. To solve this issue, as the flow name refers to waste, this product flow could be replaced by a waste flow, converting this process to a waste treatment process, or a new reference flow (product flow) should be added to the output side.



Inputs/Outputs: Inert matter (Aluminium) on landfill, production mix (region specific sites), at landfill site, landfill including leachate treatment and without collection, transport and pre-treatment, landfill for aluminium

Inputs

Flow	Category	Amount	Unit	Costs/Reven...	Uncertainty	Avoided wa...	Provider	Data quality...	Description
Waste (unspecified)	**Wastes/Post consumer ...**	**1.00000**	**kg**		**none**				
freshwater	Resources from water/Re...	-3.03449E-9	m3		none				
freshwater	Resources from water/Re...	1.29905E-9	m3		none				
ground water	Resources from water/Re...	9.77097E-9	m3		none				
ground water	Resources from water/Re...	7.18094E-8	m3		none				
ground water	Resources from water/Re...	5.88206E-11	m3		none				
ground water	Resources from water/Re...	6.50723E-10	m3		none				
ground water	Resources from water/Re...	3.73677E-9	m3		none				
ground water	Resources from water/Re...	2.01130E-9	m3		none				
ground water	Resources from water/Re...	3.43069E-11	m3		none				
ground water	Resources from water/Re...	3.66143E-10	m3		none				
ground water	Resources from water/Re...	7.55239E-12	m3		none				
ground water	Resources from water/Re...	4.55221E-8	m3		none				
ground water	Resources from water/Re...	1.50822E-9	m3		none				
ground water	Resources from water/Re...	7.41855E-8	m3		none				
ground water	Resources from water/Re...	1.30587E-8	m3		none				
ground water	Resources from water/Re...	2.53917E-8	m3		none				
ground water	Resources from water/Re...	4.48715E-10	m3		none				

Outputs

Flow	Category	Amount	Unit	Costs/Reven...	Uncertainty	Avoided pr...	Provider	Data quality...	Description
chromium	Emissions to soil/Emissio...	1.27750E-11	kg		none				
chromium	Emissions to soil/Emissio...	1.70316E-12	kg		none				
chromium	Emissions to water/Emissi...	1.12140E-8	kg		none				
chromium	Emissions to water/Emissi...	2.70449E-9	kg		none				
chromium III	Emissions to air/Emission...	6.13905E-13	kg		none				
chromium III	Emissions to soil/Emissio...	8.71685E-10	kg		none				

Figure 3: Example of a process that the reference flow (product flow, as an input) should be modified by the user.

In addition, the user is responsible for selecting the providers of the relevant exchanges, connecting one specific product flow (input) to the supply chain producing this flow, or connecting the waste flow (output) to a waste treatment process. Elementary flows represent emissions/resources going to/coming from nature, and they do not require providers. If no provider is available or if the available providers do not correspond to the modelling requirements, then the user should create its supply chain.

Besides the highlighted issues regarding the reference flows, which should be modified according to the user requirements, some modifications were needed to prepare GaBi databases to openLCA. GaBi databases contain some functions not available in openLCA, but that work in GaBi software (to see all GaBi functions, please check GaBi manual[4]). One of the most common cases is the use of the function "F_Q_Convert", which converts the amount of one specific flow from a starting size to a target size, as observed in Figure 4 for the calculation of the dependent parameter "crude_oil" (highlighted in green).

Parameters: Crude oil combustion, production mix, at plant, Electricity (AC) from crude oil, 230V

Global parameters

Input parameters

Name	Value	Uncertainty	Description
Acenaphtene	6.37E-5	none	[025] (g/GJ) Acenapht...
Acenaphthylene	7.63E-7	none	[026] (g/GJ) Acenapht...
Acrolein	0.0036	none	[028] (g/GJ) Acrolein ...
Anthracene	3.68E-6	none	[029] (g/GJ) Anthrace...
Benzene	6.46E-4	none	[030] (g/GJ) Benzene ...
Benzo_a_anthra	1.21E-5	none	[031] (g/GJ) Benzo(a)...
Benzo_a_pyr	1.28E-5	none	[032] (g/GJ) Benzo(a)...
Benzo_ghi	6.82E-6	none	[033] (g/GJ) Benzo(gh...
Benzofluoro	1.21E-5	none	[034] (g/GJ) Benzoflu...
CH4	3.02	none	[019] (g/GJ) CH4 emis...
Chrysene	7.18E-6	none	[035] (g/GJ) Chrysene ...
CO	15.1	none	[018] (g/GJ) CO emiss...

Dependent parameters

Name	Formula	Value	Description
CO2_biogenic	CO2 * Spec_CO2_bio	0.0	[017] (g/GJ) Biogenic ...
CO2_fossil	CO2 * Spec_CO2_fos	73300.0	[016] (g/GJ) Fossil CO...
crude_oil	f_q_convert('Crude oil';Mass;'Energy (net c...	0.0	[003] (MJ/kg) Low cal...
elec	eta / 100	0.36	[004] (MJ) Produced p...
LCV_ratio	1 / crude_oil	0.0	[006] (MJ) Low calorif...
Spec_CO2_bio	Share_CO2_bio	0.0	[008] (kgC/kg) kg bio...
Spec_CO2_fos	(1 - Share_CO2_bio)	1.0	[009] (kgC/kg) kg foss...
Spec_SO2_Em	20 * S_content_fuel / 1000 * LCV_ratio	0.0	[010] (kgSO2/kgdiese...
waste_heat	1 - elec	0.64	[005] (MJ) Waste heat

Figure 4: Example of a process originally containing functions not supported by OpenLCA

To solve this issue, for all the dependent parameters that the function “F_Q_Convert” was applied, the information contained in the Flow property section of openLCA for that specific flow (Figure 5) was applied to replace the use of the function (Figure 7).

Flow properties: Crude oil

Flow properties

Name	Conversion factor	Reference unit	Formula	Is reference
Gross calorific value	45.3	MJ	1.0 kg = 45.3 MJ	☐
Mass	**1.0**	**kg**	**1.0 kg = 1.0 kg**	☑
Net calorific value	42.33	MJ	1.0 kg = 42.33 MJ	☐
Volume	0.0011683	m3	1.0 kg = 0.0011683 m3	☐

Figure 5: Diesel Flow properties considered to replace the use of the “F_Q_Convert” function

Parameters: Crude oil combustion, production mix, at plant, Electricity (AC) from crude oil, 230V

Global parameters

Input parameters

Name	Value	Uncertainty	Description
Acenaphtene	6.37E-5	none	[025] (g/GJ) Acenaphtene em...
Acenaphthylene	7.63E-7	none	[026] (g/GJ) Acenaphthylene ...
Acrolein	0.0036	none	[028] (g/GJ) Acrolein emissions
Anthracene	3.68E-6	none	[029] (g/GJ) Anthracene emis...
Benzene	6.46E-4	none	[030] (g/GJ) Benzene emissions
Benzo_a_anthra	1.21E-5	none	[031] (g/GJ) Benzo(a)anthrac...
Benzo_a_pyr	1.28E-5	none	[032] (g/GJ) Benzo(a)pyrene ...
Benzo_ghi	6.82E-6	none	[033] (g/GJ) Benzo(ghi)peryle...
Benzofluoro	1.21E-5	none	[034] (g/GJ) Benzofluoranthe...
CH4	3.02	none	[019] (g/GJ) CH4 emissions
Chrysene	7.18E-6	none	[035] (g/GJ) Chrysene emissio...
CO	15.1	none	[018] (g/GJ) CO emissions
CO2	73300.0	none	[015] (g/GJ) CO2 emissions
Dibenz_a	5.04E-6	none	[036] (g/GJ) Dibenz(a)anthrac...
eta	36.0	none	[001] (%) efficiency of crude ...
Fluoranthene	1.46E-5	none	[037] (g/GJ) Fluoranthene emi...
Fluorene	1.35E-5	none	[038] (g/GJ) Fluorene emissio...
Formaldehyde	0.0996	none	[039] (g/GJ) Formaldehyde e...

Dependent parameters

Name	Formula	Value	Description
CO2_biogenic	CO2 * Spec_CO2_bio	0.0	[017] (g/GJ) Biogenic CO2 em...
CO2_fossil	CO2 * Spec_CO2_fos	73300.0	[016] (g/GJ) Fossil CO2 emissi...
crude_oil	(42.33/1)	42.33	[003] (MJ/kg) Low calorific va...
elec	eta / 100	0.36	[004] (MJ) Produced power
LCV_ratio	1 / crude_oil	0.023623907394283016	[006] (MJ) Low calorific value ...
Spec_CO2_bio	Share_CO2_bio	0.0	[008] (kgC/kg) kg biogenic C ...
Spec_CO2_fos	(1 - Share_CO2_bio)	1.0	[009] (kgC/kg) kg fossil C per ...
Spec_SO2_Em	20 * S_content_fuel / 1000 * LCV_ratio	5.669737774627924E-4	[010] (kgSO2/kgdiesel) Sulph...
waste_heat	1 - elec	0.64	[005] (MJ) Waste heat

Figure 6: Example of a process that the Function "F_Q_Convert" was replaced by numbers, according to the Flow Properties

In Appendix 2, the original inputs of the "F_Q_Convert" function are available. The selected numbers applied to replace this function for each parameter in each process (and its respective database) are also available. Other functions were not replaced, as it was not identified a problem in calculating the parameters when these other functions were applied.

However, some parameters in databases " Extension database X_ machining processes 2022.1" and "Extension database VIII_ coating 2022.1" contain the characters "ä","ö", and "ü" (Figure 8). In the current openLCA version (1.10.3), these letters can not be applied in formulas. Hence, they were replaced by "ae", "oe", and "ue", respectively. The list of processes modified for each database is also available in Appendix 2.

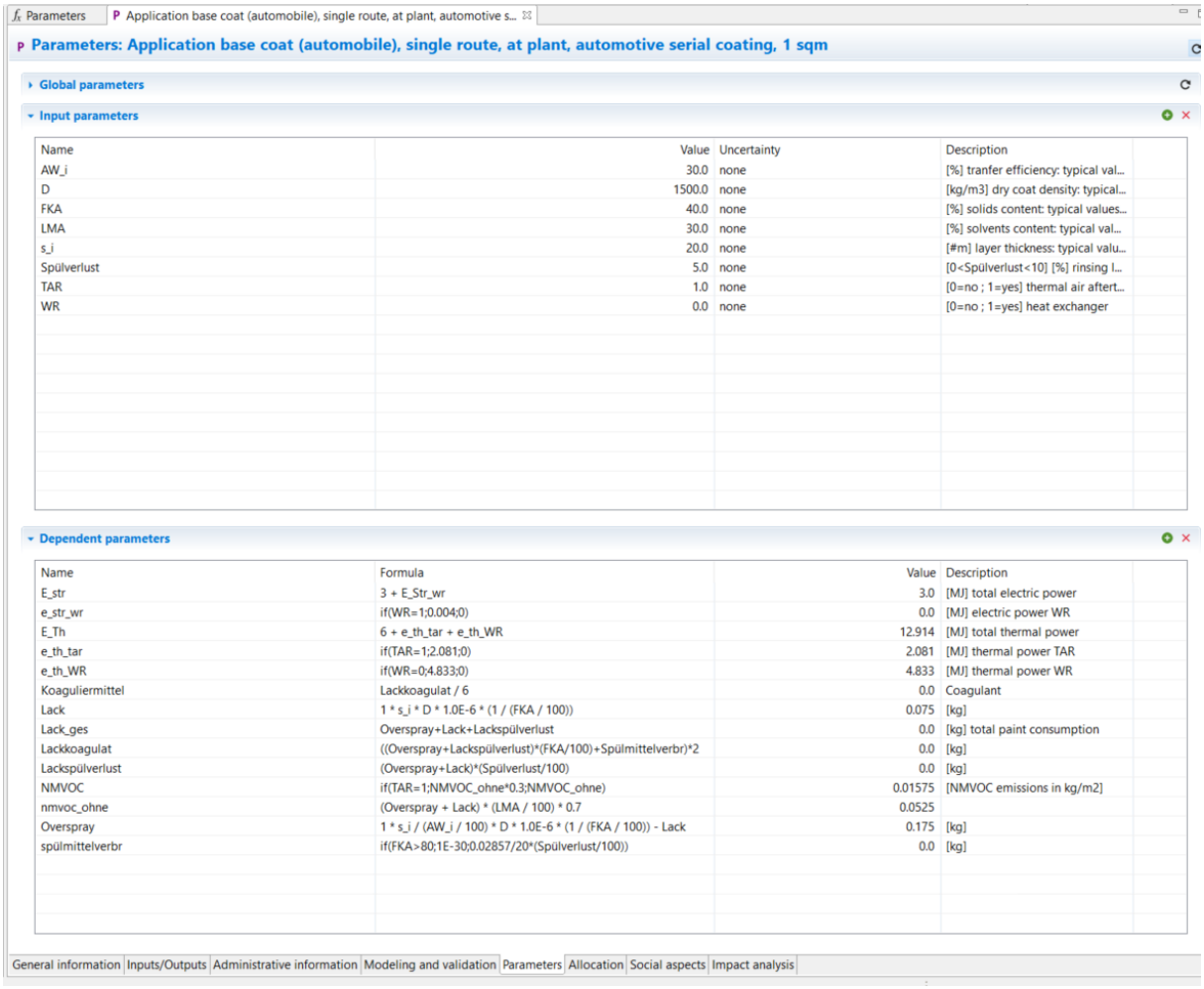


Figure 7: Example of parameters with “ä”,”ö”,”ü”.

4 Database combination

Inventory: Since the nomenclature of the elementary flows in GaBi databases is different from other LCI databases, it should not be combined with other databases from nexus.openLCA.org.

Impact Assessment: The method package for GaBi methods is available separately on nexus.openLCa.org, containing a set of LCIA methods that fit the elementary flows in the database.

Data quality systems: ILCD Data Quality System implemented.

5 References

(1) Sphera. GaBi LCA databases https://gabi.sphera.com/databases/gabi-databases/ (accessed Apr 19, 2022).

(2) GreenDelta GmbH. openLCA Nexus https://nexus.openlca.org/databases (accessed Aug 26, 2021).

(3) Sphera. GaBi Solutions https://gabi.sphera.com/deutsch/index/ (accessed Apr 19, 2022).

(4) Sphera. GaBi Manual https://gabi.sphera.com/fileadmin/GaBi_Manual/GaBi_6_manual.pdf (accessed Apr 19, 2022).

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