SUSTAINABILITY ASSESSMENT OF HARMONISED HYDROGEN ENERGY SYSTEMS



Grant No. 101007163

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D4.3 Extended life-cycle tools

WP4 Harmonised extension to Life

Cycle Costing and Social Life Cycle

Assessment

User Manual

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DUE DATE	XX/XX/XX (MXX)



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EXECUTIVE SUMMARY

Designed to support LCA practitioners, the FCH-LCA tool is a powerful solution that enables precise calculations of environmental LCA, social LCA, and Life Cycle Costing, all in accordance with the comprehensively developed SH2E guidelines. The objective is to facilitate the application of these meticulously developed guidelines, ensuring the production of consistent and reliable results that can be readily interpreted and compared across various hydrogen systems. The FCH-LCA tool offers pre-set templates to streamline the initiation of projects, while also providing flexibility for modelers to create their own intrinsic models tailored to their specific case studies. With the FCH-LCA tool, LCA practitioners can confidently analyze the sustainability impact of hydrogen projects, saving time and effort by leveraging industry best practices and established benchmarks. The FCH-LCA tool is an add-on to openLCA software. This document provides installation guidance and acts as a manual to the FCH-LCA tool. Users are strongly recommended to also check the openLCA manual for understanding openLCA software.





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Installing the FCH-LCA

The tool can be installed by unzipping the file and then running the execution file as seen in Figure 1 from this link: <u>https://share.greendelta.com/index.php/s/R3uc0nuziZt6cGV/download</u>.

Name	Date modified	Туре	Size
📁 bin	5/20/2024 6:09 AM	File folder	
configuration	5/28/2024 4:09 PM	File folder	
📜 jre	5/20/2024 6:09 AM	File folder	
olca-mkl-x64_v1	5/20/2024 6:09 AM	File folder	
plugins	5/20/2024 6:11 AM	File folder	
.eclipseproduct	5/20/2024 6:09 AM	ECLIPSEPRODUCT	1 KB
C about.html	5/20/2024 6:09 AM	Microsoft Edge HT	436 KB
derby.log	6/14/2024 3:35 PM	Text Document	2 KB
LCa FCH-LCA.exe	5/20/2024 6:09 AM	Application	521 KB
FCH-LCA.ini	5/28/2024 4:08 PM	Configuration setti	1 KB
workbench.xmi	5/28/2024 4:14 PM	XMI File	74 KB

Figure 1 Tool installing

Users will then be guided to the following welcome page - Figure 2.



Figure 2 Welcome page FCH-LCA tool

Completing the wizard

To access the wizard and the templates, users must have an active database as seen in Figure 3. It is important to understand the database elements and structure – to do so, it is recommended to refer back to the openLCA manual.





FCH-LCA 2.0.5. SNAPSHOT - sh2e elca model 4tool File Database Tools Help Click here to start wizard E Navigation 🚳 🕴 🗖 🏚 Welcome > Archives Basic Training EN15804 EPD Verification FreshOnes v 🖿 SH2E ecoinvent_v3_10_Cutoff_Unit_Processes_SpringSchool FCH-LCA testing psilca_professional_work_hours_cutoff_1_0e_7_20230324 (1)
 psilca_professional_work_hours_cutoff_1_0e_7_SH2E sh2e_elca_model_4tool Projects Product systems Processes Flows EPDs Results A Indicators and parameters > iii Background data sh2e_elca_model_old SOCA Social Hotspots DB templates making agribalyse_v31_23012023_2_0_for_circularity_20230615 agribalyse_v_311_LCIAmethods233_final16Jan24 ecoinvent v3 10 en15804gd unit processes 2024 05-31 ef_3_1_from_nexus EPD Training EN15804+A2-forStudents (1) Icacommons_final_5dec23 master_ef_3_1_finished openica4students_11 pef sme tool db sh2e_elca_model_final SH2E_Templates soda4lca Welcome C:\Users\silve\openLCA-data-1.4\databases\sh2e_elca_model_4tool

SUSTAINABILITY ASSESSMENT OF HARMONISED HYDROGEN ENERGY SYSTEMS

Welcome to the FCH-LCA tool

Designed to support LCA practitioners, the FCH-LCA tool is a p that enables precise calculations of environmental LCA, social L Cycle Costing, all in accordance with the comprehensively deve guidelines. Our objective is to facilitate the application of these developed guidelines, ensuring the production of consistent ar that can be readily interpreted and compared across various hy The FCH-LCA tool offers pre-set templates to streamline the ini projects, while also providing flexibility for modelers to create a intrinsic models tailored to their specific case studies. With the LCA practitioners can confidently analyze the sustainability imp projects, saving time and effort by leveraging industry best pra established benchmarks.

Product system templates

The FCH-LCA tool provides a range pf pre-set templates tailore hydrogen production and use, catering to various scenarios an

Figure 3 Starting the wizard

Once the user starts the wizard, a pop-up window shall appear (Figure 4) where users shall go through it by selecting the appropriate decision. It is recommended that users should refer to the FCH-LCA guidelines as they go through the wizard to better understand the questions posed.

Tools Help					
100					
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Figure 4 Wizard pop-up window





14 FCH-LCA tool	×	IG FCH-LCA tool	- 0 ×	19 FCH-LCA tool
Technology readiness level	e	Boundaries of hydrogen production	()	Hydrogen Production Parameters
Technology readiness level Press tasts the Technology Readiness Level (TRL) of the involved technology. (TRL 1 - bits chronicles observed) (TRL 2 - technology readiness Level (TRL) of the involved technology. (TRL 3 - technology readinated in the technology. (TRL 4 - technology validated in the technology addited in technology validated in technology vali		Boundaries of hydrogen production Pease state the system boundary of the hydrogen production: C Galdie-to-syste 2 dydrogen production(C Galdie-to-syste 2 dydrogen purification) C Galdie-to-syste 3 dydrogen transportation() C Galdie-to-syste 5 dydrogen transportation() C Galdie-to-syste 5 dydrogen transportation) C Galdie-to-syste 5 dydrogen distribution)		Hydrogen production parameters Hydrogen retrained (MMkg) Hydrogen pressure (bar) Hydrogen pressure (bar) Hydrogen temperature (*C) Operating production capacity (kg Hu/year) Carbon capture and storage Has carbon capture and storage technology been installed in the hydrogen production plant? Histor CS
< Back Not > Friend	Cancel	< Back Next - 1	Finish Cancel	Functional unit Pesses select the Functional unit: Q tog of H ₂ M (3) H(2) of H ₂

Figure 5 Wizard questions

Based on the selection made by the users, the users shall be guided to a certain template option as seen in Figure 6.

E FCH-LCA tool		- 0	×
Select a template			P
Please select a matchi	ng template and a top-category under which the template	should be stored	
Category			
Select a template:			
Cradle-to-gate 1 (hyd	rogen production) (kg of H ₂)		
	< Back Next > Fini	sh Cancel	

Once the template is selected and users click on 'Finish', a product system will be created based on the selected template. The user responses through the wizard can be seen under 'FCH-LCA Properties' in the 'General Information' tab as seen in Figure 7. Moving to the 'modal graph' the users will be able to see the overview of structure of the product system template.



 FCH-LCA Properties 	
Intended application	Micro-level decision support
Modelling principles	Consequential
Prospectivity	Prospective study
End-of-life	Recycling approach
Capital goods	Included
Risk assessment	Simple LCA, without risk assessment
System boundaries	Hydrogen production and use
Technology readiness level	TRL 6 - technology demonstrated in relevant environment
LCI based on operating scale	Yes
Learning Curve Method	**
Hydrogen net calorific value (MJ/kg)	100.0
Hydrogen purity (%)	99.0
Hydrogen temperature (°C)	9.0
Hydrogen pressure (bar)	15.0
Operating production capacity (kg H ₂ /year)	**
Functional unit	km travelled
Carbon capture and storage	with CSS
Boundaries of hydrogen production	Cradle-to-gate 1 (hydrogen production)
Comparative LCA	Absolute study
Use purpose	Transportation
Vehicle lifetime (years)	15.0
Vehicle consumption (kg H ₂ /100km)	0.75
General information Parameters Model graph	Statistics





Figure 8 Product system of hydrogen production and use for vehicle

Template structure

In general, the pre-set templates are split into three main categories:

- 1. Case 1: Hydrogen Production
- 2. Case 2: Hydrogen Use
- 3. Case 3: Hydrogen Production and Use

For Case 1: Hydrogen Production, there are up to 6 main stages, as seen in Figure 9:



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- 1. Hydrogen Production
- 2. Hydrogen Purification
- 3. Hydrogen Compression
- 4. Hydrogen Transportation
- 5. Hydrogen Storage
- 6. Hydrogen Distribution



Figure 9 Foreground phases for studies assessing FCH systems

Accordingly, 6 main child categories are created, with each containing the following processes (1) Capital Goods, (2) Energy Consumption, (3) Raw Materials, and (4) Transportation. This can be seen in Figure 10. The point behind the classification is to later facilitate the interpretation of results and covering all LCA data requirements.



Figure 10 Breakdown of processes

For Case 1: Hydrogen Production stages

As for case 2: Hydrogen use, there are 3 main uses identified in the manual (1) transportation (2) fuels and chemicals production and (3) electricity and/or heat generation. Accordingly, similar approach has been taken to divide the templates as seen Figure 11.





ddrogen use purpose Use purpose Please select the purpose of the hydrogen use: Transportation Fue/Chemical production Electricity production Cogeneration					-
Use purpose Please select the purpose of the hydrogen use:	/drogen use purpose				2
Please select the purpose of the hydrogen use: Transportation Fuel/Chemical production Electricity production Cogeneration	Use purpose				
Transportation Fuel/Chemical production Electricity production Cogeneration	Please select the purpose	of the hydrogen use:			
Fuel/Chemical production Electricity production Cogeneration	O Transportation				
○ Electricity production ○ Cogeneration	O Fuel/Chemical producti	ion			
○ Cogeneration	O Electricity production				
	Cogeneration				

Figure 11 Hydrogen use cases

In the transportation use case, the template is split into the following main processes:

- 1. Vehicle Use/Maintenance
 - a. The hydrogen production from cradle-to-gate 6 is included
- 2. Vehicle Production
- 3. Vehicle End-of-Life

In the Fuel/chemical production use case, the template is split into the following main processes:

- 1. Upstream process including raw materials, energy consumed by raw materials extraction (if any), transport to gate, capital goods
- 2. Core process including auxiliary material, energy consumption, storage
- 3. Downstream process including distribution of the fuel/chemical produced and use

In the electricity generation/cogeneration use case, the template is split into the following main processes:

- 1. Manufacturing stage
- 2. Operation stage
- 3. End of life stage

In all production and use cases, users are free to adjust the processes they would prefer to see their overall results breakdown.

Completing the pre-set template

Users then should complete the processes by inserting the required input/output flows. Adding/removing flows can be added directly through the model graph by right-clicking on the graph, click on "Settings" and then check "Enable process editing".

🥴 Settings	X	
Theme	Light ~	
Connections	Curve ~	
	Show elementary flows	
	Enable process editing	
		_
	OK Cancel	

Figure 12 Activated settings in the model graph.



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♠ Welcome	# Hydrogen Production & Use for	or transportation $ imes$		- 0
Welcome	Hydrogen Production & Use for	○ Sl Carbon capture and stor ○ >> input flows ○ ○ CCS: Capital Goods 1.00 Item(s) ○ CCS: Renry Cons 1.00 Item(s) ○ CCS: Renry Cons 1.00 Item(s) ○ CCS: Transportation 1.00 Item(s)	Image: Create a new flow O Product O Waste Elementary flow	
	E) CCS: Transportation C) E) Stage 4: Capital Goods D) Stage 4: Capital Goods D) Stage 4: Energy Consumpt D) S) Stage 4: Raw Materials D) S) Stage 4: Transportation D) S) Stage 4: Transportation D) S)	edd flow output flows >> edd flow edd flow edd flow edd flow edd flow edd flow flows flows	Or select an existing > Im Elementary flows © Assembled Vehicle © Cashon capture and storage @ CCS: Capital Goods @ CCS: Energy Consumption © CCS: Transportation © Distance travelled © Hydrogen Dorduced © Hydrogen Production © Hydrogen Production © Hydrogen Production © Hydrogen Production © Hydrogen Production	ranspc
		Hydrogen Compressi 1.00 kg add flow	Create new Select existing Cancel Vistance travelled	5%

Then, by clicking on add flow, users can search the flows they wish to add in each process as well as the amount.

Figure 13 Adding of new flows in model graphs

However, after adding a new flow to a process, you need to add its provider. This can be done by right-clicking on the flow, then "Search providers".



Alternatively, users can go to the processes of the product system, which can be found under the 'processes' as seen in Figure 15.

After expanding the child category, users can open each process and insert the input/output flows directly by clicking on the green '+' sign on the top left corner. After inserting all the needed flows in each process, users must save their changes before moving on to the next process. Once adding a new flow, users must hover to the 'Provider' and select the convenient provider for the added flow.

Tip: users are recommended to close the 'product system' if they want to make changes on the process level – this so the changes in the product system can be also reflected over there.





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the Hydrogen Production & Use for transportation	* Inputs									•	Xu	
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Carbon capture and storage												
Stage 2: Hydrogen Production		19			×							
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Stage 2: Capital Goods		Flows			1							
6] Stage 2: Energy Consumption		Filter										
 Stage 2: Raw Materials 												
 Stage 2: Transportation 												
Stage 3: Hydrogen Purification		- Content										
Stage 4: Hydrogen Compression												
Stage 5: Transportation		Elementary flows										
Stage 6: Hydrogen Storage		> In Economic > In Emission to air > In Emission to soil										
Stage 7: Hydrogen Distribution												
 Hydrogen Production (Cradle-to-gate 6) wit 												
> Case 2: Hydrogen Use (Cradle-to-grave) for trar		> Emission to water										
> Elows	* Outputs	Immaterial emission								• •		
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sh2e_elca_model_4tool		CCS: Kaw Materials										
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5 of 3.1 from navis												
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Figure 15 Adding of new flows in the process

Calculating Results

After adding the new flows into the processes, if users did not do this in the product stage level, they must go back to the product stage, under 'general information' tab and click on calculate as seen Figure 16:

✿ Welcome	# Hydrogen Production and Electricity Generation X # Hydrogen Production & Use for Fuel/Chemical Production	- 1
🚠 General i	nformation - Hydrogen Production and Electricity Generation	(
- General inf	ormation	
Name	Hydrogen Production and Electricity Generation	
Category	- none -	
Description	First created: 2024-03-27T105400 Linking approach during creation: Prefer default providers; Preferred process type: System process	A
Tage	Version 0000002 🛞 🐨 Last change 2024-03-27 10:51:03 UOID due24ecc-0993-42.15-0b14-4dbebolce1c3	
1095	© Calculate	
 Reference 		
Process	Hydrogen Production and Electricity Generation	
Product	© Electricity Generation	Ŧ
Flow propert	y @Energy	*
Unit	EM	
Target amou	xt 1.0	

Figure 16 Calculating the results

Results will appear under the results tab seen in Figure 17. To understand the information conveyed in each tab, please refer to the openLCA manual:



 General information 		
Product system	🛱 LCA of FCEV	
Allocation method	As defined in processes	
Target amount	1.0 Item(s) LCA FCEV	
Impact assessment met	nod 🔮 ecoinvent - EF v3.1	
	Export to Excel R. Save result as	
5.0E1 -		 12544 mol H+-Eq: platinum group metal, mine and concentration operations platinum group metal concentrate AP 1304E2 mol H+-Eq: Other
Top 5 contributions to Flow Ølorobenzene	• flow results - overview - Emission to water/surface water *	

Special feature: parameter analysis

Part of the LCC of FCH is to evaluate equations that are time dependent. With this special feature of 'parameter analysis' this can be done. As an example to evaluate the discounting equations, users would follow the following steps:

3	- 🗆 X
lew flow	۵ 🗉
Creates a new fl	
Name	Present Value
Description	
	· · · · · · · · · · · · · · · · · · ·
Flow type	Ø Elementary flow ▼
Reference flow r	
step 2:	Create a new impact category
Step 2:	roperty
itep 2:	roperty
Step 2:	Property @ Market value, bulk prices Finish Cancel Create a new impact category - · · · · · · · · · · · · · · · · · ·
Gtep 2:	Create a new impact category nental indicator
Step 2:	Property 49 Market value, bulk prices Finish Cancel Create a new impact category nental indicator Discounting
Gitep 2:	Property 49 Market value, bulk prices Finish Cancel Create a new impact category nental indicator Discounting
Gitep 2:	Property 49 Market value, bulk prices Finish Cancel Create a new impact category nental indicator Discounting
Gtep 2: Bew environm Name Description	Property 49 Market value, bulk prices Finish Cancel Create a new impact category nental indicator Discounting

Step 3: Add the newly created flow into the new impact category:





Ob a se at a simultion i	la atomo a como amio a concern		
Characterization	ractors: economic assessr	ient	
Characterization facto	rs	(Lease)	× • • • •
Flow Ø price	Category	Flows	
		Filter	
		price	
		- Content	
		Ø price	

Step 4 Create a new method/add the created category in an existing method or in a new method.

e Database Iools Help							
84.8							
Navigation	8 - 0 63 SH2E Power	Train Manufacturing 💠 economic as	isessment 🧟 ecoinvent - EF v3.1 ×				
Impact assessment methods	e General	information: ecoinvent - EF	v3.1				
econvent 3.9.1 Methods							
ecoinvent - CML v4.8 2016	 General in 	formation					
econvent - CML v4.8 2016 no LI							
econvent - Crustal Scarcity Indicator 2020	Name	ecoinvent - EF v3.1					
econvent - Cumulative Energy Demand (CED)	Category	econvent 3.9.1 Methods					
econvent - Cumulative Exergy Demand (CEXD)			ICA		×		
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ecoinvent - IMPACT 2002+ (Endpoint) (legacy)	 Impact ca 	tegories					0
ecoinvent - IMPACT 2002+ (Midpoint) (legacy)							
ecoinvent - IPCC 2013 (superseded)	Name					Reference unit	
no LT (superseded)	13 acidific	ation - accumulated exceedance (AE)				mol H+-Eq	
ecoinvent - IPCC 2021	≣ climate	change - global warming potential (GW	1			kg CO2-Eq	
🛃 ecoinvent - IPCC 2021 no LT	E climate	change: biogenic - global warming pot	f			kg CO2-Eq	
😍 ecoinvent - ReCiPe 2016 v1.03, endpoint (E)	10 climate	change: fossil - global warming potenti	4			kg CO2-Eq	
🕐 ecoinvent - ReCiPe 2016 v1.03, endpoint (E) no LT	10 climate	change: land use and land use change -				kg CO2-Eq	
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😍 ecoinvent - ReCiPe 2016 v1.03, midpoint (H) no LT	[≘ human	toxicity: carcinogenic - comparative toxi	c unit for human (CTUh)	comparative toxic unit	for human (CTUh)	CTUh	
🔮 ecoinvent - ReCiPe 2016 v1.03, midpoint (I)	10 human	toxicity: carcinogenic, inorganics - comp	arative toxic unit for human (CTUh)	comparative toxic unit	for human (CTUh)	CTUh	
🔮 ecoinvent - ReCiPe 2016 v1.03, midpoint (I) no LT							
econvent - selected ICI results (lenary)							

Step 5 Create a new global parameter

Users then select the input parameter option and insert the value of 1 to represent the start year.

New parameter		£
Creates a new parameter		JZ
Name	year	
Description		4
Туре	• Input parameter O Dependent parameter	
Amount	1	

Step 6 Set up the equation in the selected process or new process





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Inputs								0) >
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🕸 electricity, low voltage	351:Electric power gener	9.00000E7	🚥 kWh		none		🔊 electricit		
🕸 graphite	089:Mining and quarryin	2.10000	🚥 kg		none		🔊 market f	(1; 2; 3; 4; 1)	
Nafion (Perfluorosulfon		5.80000	🚥 kg		none		🔊 Nafion ((1; 2; 3; 2; 2)	
🕸 platinum group metal	072:Mining of non-ferrou	0.23000	🚥 kg		none		🔊 market f	(1; 3; 3; 4; 1)	
reinforcing steel	241:Manufacture of basic	1600.00000	🚥 kg		none		🔊 market f	(1; 2; 3; 4; 1)	
silicone product	201:Manufacture of basic	1.30000	🚥 kg		none		🔊 market f	(1; 2; 3; 4; 1)	
🕸 steel, low-alloyed	241:Manufacture of basic	3.60000E4	🚥 kg		none		🔊 market f	(1; 2; 3; 3; 1)	
🕸 tap water	360:Water collection, tre	1.10000	🚥 kg		none		🔊 market	(1; 2; 3; 2; 3)	
🕸 tap water	360:Water collection, tre	3.42000E7	🚥 kg		- 4 -		a] market f	(1; 2; 3; 2; 1)	
🕸 titanium	242:Manufacture of basic	0.76000	🚥 kg	F	$= P(1 \cdot$	$(+ r)^{n}$	🔊 market f	(1; 2; 3; 3; 1)	
Ø price		9.0E7*0.017*(1+rate)^year	📼 EUR 2000			-			

Step 6 Got to -> tools -> parameter analysis

ICH-LCA 2.0.5.SNAPSHOT - ecoinvent_391_apos_upr_n3_29june2023

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	~	Pro		Parameter analysis					
		>	Δ	Bulk-replace	Deres				
		> 🖿 I	B	Flow mapping (experimental)	Param	eter ana			
		> 🖿 (c	Library export (experimental)					
		> 🖿 (C alla	Get EPDs from EC3		kg)			
		~ 🖿 (c			ortatio			
		>		Formula interpreter					
		>	Veri	cie Froudetion					
			Vahi	cla Lica Staga					

Step 7 Add the parameter and adjust end value (eg. 10 iterations = 10 years)

Product system	Hydrogen Production & U	se for transportation	n		_
Impact assessment method	ecoinvent - EF v3.1				
Allocation method	As defined in processes				
Number of iterations	0				
Parameter	Context		Start value	End value	
fk year	global		1.0	10.0	
		0	Create new		
		×	Remove selected		

Results can then be seen in tabular and graphical form. The results can be exported via excel.







A full tutorial can be found on youtube on the openLCA channel¹

Direct approach SLCA on openLCA

🗉 Manufacture of food products and beverages; Manufacture of tobacco products - RU

In SLCA, results are usually viewed in the form of medium risk hours which is based on the social impact assessment method. The direct approach method² was previously implemented as a Python script to perform direct calculation of social indicators. Instead, you can now view this type of calculation directly under the "Social Assessment" tab after calculating your results. To activate this new feature, go to "File" -> "Preferences" -> "Experimental Features" -> check "New Social Impact Assessment." Then, restart your software for the changes to take effect. Results can also be exported by simply right-clicking anywhere in the page seen below and clicking on "export to excel".

	Activity value	Raw value	но	MO	LO	NOP	NOR	VLR	LR	MR	HR	VHR	ND	NA
Local Community			0%	0%	0%	0%	5%	13%	20%	29%	12%	11%	9%	0%
Access to material resources			0%	0%	0%	0%	0%	56%	15%	14%	2%	12%	2%	0%
> 🚢 Certified environmental managemen	0.08630 work hours [h]	17.79860 [# of CEMS per 10000 em	0%	0%	0%	0%	0%	54%	17%	4%	9%	1%	15%	0%
> 🚢 Extraction of biomass (related to area	0.08630 work hours [h]	67.03139 [annual t/km2]	0%	0%	0%	0%	0%	95%	2%	1%	1%	1%	0%	0%
> 🚢 Extraction of biomass (related to pop	0.08630 work hours [h]	4.48392 [annual t/cap]	0%	0%	0%	0%	0%	2%	95%	3%	1%	0%	0%	0%
> 🚢 Extraction of fossil fuels	0.08630 work hours [h]	8.77402 [annual t/cap]	0%	0%	0%	0%	0%	99%	1%	0%	0%	0%	0%	0%
> 🚢 Extraction of industrial and construct	0.08630 work hours [h]	5.67899 [annual t/cap]	0%	0%	0%	0%	0%	2%	2%	95%	0%	1%	0%	0%
> 🚜 Extraction of ores	0.08630 work hours [h]	1.75079 [annual t/cap]	0%	0%	0%	0%	0%	98%	0%	1%	0%	0%	0%	0%
> 🚜 Level of industrial water use (related t	0.08630 work hours [h]	1.17842 [% of total actual renewabl	0%	0%	0%	0%	0%	95%	0%	3%	1%	0%	0%	0%
> 🚢 Level of industrial water use (related t	0.08630 work hours [h]	47.68259 [% of total water withdra	0%	0%	0%	0%	0%	3%	1%	2%	0%	94%	0%	0%
> Environmental Footprints			0%	0%	0%	0%	31%	2%	32%	26%	8%	1%	0%	0%
> GHG Footprints			0%	0%	0%	0%	2%	0%	0%	56%	42%	0%	0%	0%
> Local employment			0%	0%	0%	0%	0%	0%	93%	0%	0%	0%	6%	0%
> 📙 Migration			0%	0%	0%	0%	0%	33%	1%	16%	0%	0%	50%	0%
> Respect of indigenous rights			0%	0%	0%	0%	2%	0%	1%	95%	1%	0%	2%	0%
> E Safe and healthy living conditions			0%	0%	0%	0%	0%	1%	1%	0%	32%	65%	0%	0%
Society			0%	4%	1%	0%	0%	42%	10%	20%	14%	8%	0%	0%
Value Chain Actors			0%	0%	0%	0%	0%	6%	23%	11%	5%	23%	32%	0%
Workers			0%	0%	0%	0%	9%	27%	8%	21%	16%	8%	11%	0%
> 📒 Child labour			0%	0%	0%	0%	3%	78%	17%	1%	0%	0%	0%	0%
> Discrimination			0%	0%	0%	0%	0%	65%	1%	1%	1%	0%	32%	0%
🗸 🚞 Fair Salary			0%	0%	0%	0%	0%	2%	2%	63%	1%	33%	0%	0%
> 🚢 Living wage, per month (AV)	0.08630 work hours [h]	359.59740 [USD]	0%	0%	0%	0%	0%	1%	2%	95%	1%	1%	0%	0%
> 🚢 Minimum wage, per month	0.08630 work hours [h]	178.13004 [USD]	0%	0%	0%	0%	0%	0%	1%	2%	0%	97%	0%	0%
> 🚢 Sector average wage, per month	0.08630 work hours [h]	701.60971 [USD]	0%	0%	0%	0%	0%	4%	3%	91%	2%	0%	0%	0%
✓ Forced Labour			0%	0%	0%	0%	0%	1%	36%	2%	5%	31%	25%	0%
> 🚢 Frequency of forced labour	0.08630 work hours [h]	5.41101 [Cases per 1.000 inhabitants]	0%	0%	0%	0%	0%	3%	97%	0%	0%	0%	0%	0%
> 🚢 Goods produced by forced labour	0.08630 work hours [h]	0.26023 [#]	0%	0%	0%	0%	0%	1%	8%	3%	15%	0%	74%	0%
> 🚢 Trafficking in persons	0.08630 work hours [h]	2.91291 [Tier]	0%	0%	0%	0%	0%	0%	2%	4%	1%	93%	0%	0%

General information Inventory results Impact analysis Social assessment Process results Contribution tree Grouping Locations Sankey diagram LCIA Checks

Figure 18 Direct approach method SLCA

End of document

² Ciroth A, Di Noi C, Srocka M (2019) Revisiting the activity variable in social LCA, beyond worker hours. Presentation LCA XIX, Tucson. <u>https://www.greendelta.com/wp-content/uploads/2019/11/2019 LCA XIX Revisiting-the-activity-variable-in-SLCA.pdf</u>



¹ <u>https://www.youtube.com/watch?v=ocmWcnEGUxo&t=383s&ab_channel=openLCA</u>