



SH₂E



openLCA in SH₂E: A dedicated tool for Life Cycle Sustainability Assessment of Hydrogen Systems

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openLCA conference, April 15, 2024



Co-funded by
the European Union



This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 101007163. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research.

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TOOL DEMONSTRATION

1. The FCH-LCA tool
2. LCA modeling and assessment with the FCA-LCA tool
3. Specific features of the FCA-LCA tool
 1. Wizard templates
 2. Social LCA calculation
 3. Time for support of discounting and prospective modeling
4. Conclusions



SH₂E



About the FCH-LCA tool



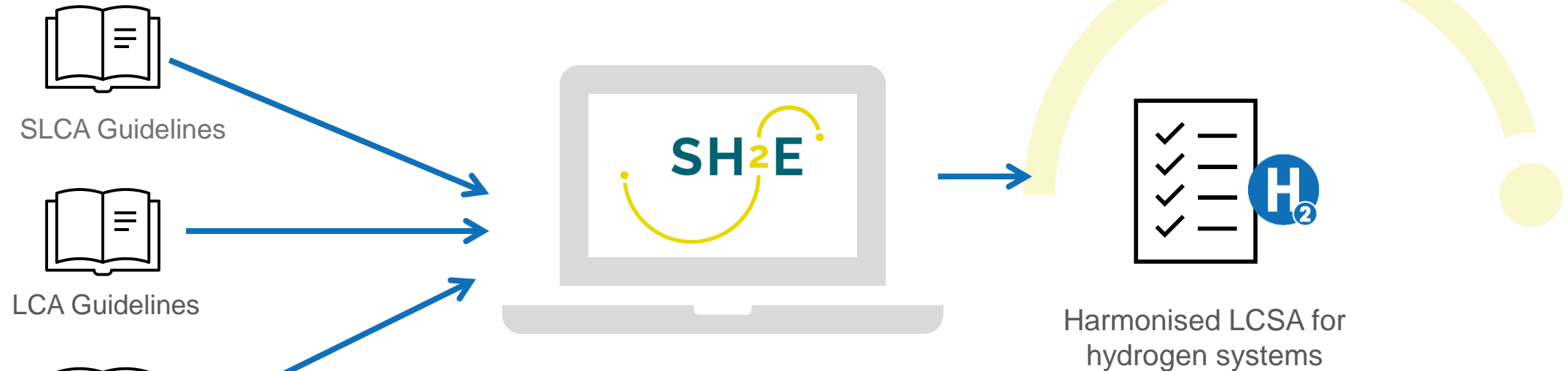
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Welcome to the FCH-LCA tool

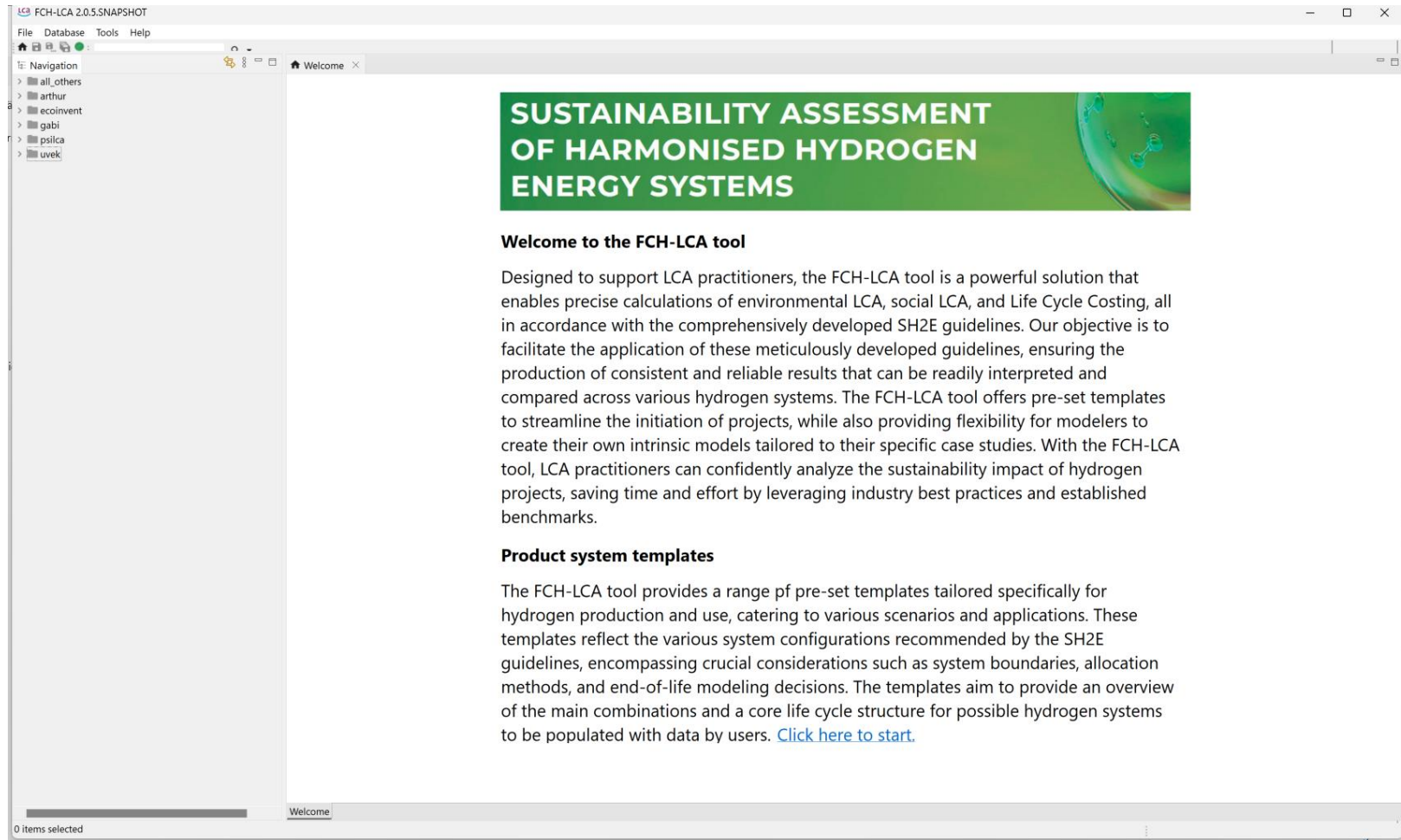


Free, open source software

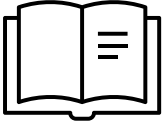
Harmonised LCSA for hydrogen systems

Objectives:

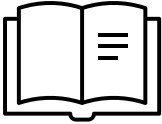
- Facilitate the application of the developed LCSA guidelines
- Ensuring the production of consistent and reliable results



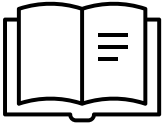
Welcome to the FCH-LCA tool



SLCA Guidelines



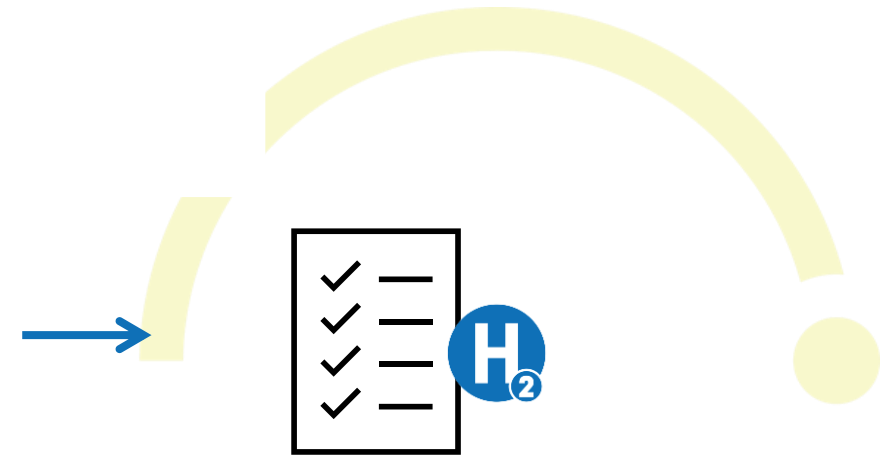
LCA Guidelines



LCC Guidelines



Free, open source software,
Based on openLCA



Harmonised LCSA for
hydrogen systems

Objectives:

- Facilitate the application of the developed LCSA guidelines
- Ensuring the production of consistent and reliable results

About the openLCA software

- A free and (yet) professional approach to Life Cycle Assessment: powerful, feature-rich, (comparatively) easy to use, technically up-to-date, in active development; last version 2.1 released in January 2024
- 100,000 users worldwide
- Broad support for LCA databases and methods, in openLCA Nexus: > 300,000 datasets available
- Developed by GreenDelta since 2006
- Completely Open Source (Mozilla Public License)





SH₂E



Specific features of the FCA-LCA tool



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Templates to guide through methodological choices

SH2E guidelines foresee quite some methodological choices that are difficult to follow by practitioners

Creating “templates” that adhere to the guidelines supports users in following the guidelines (and in the end creates more consistent, comparable models)

Tool Wizard: Guideline recommendations

Guidelines come with many recommendations and requirements

Box 1

The intended application must be considered for LCAs. The intended application is characterised by the intended reliability and the safeguard level. The application situation must be coherent with it, by stating if the LCA study would be employed for decision support (yes/no) and the scale of the induced changes in the considered system (micro, meso or macro).

Box 2

An LCA that has only the purpose to describe a situation and is not meant for decision support must be modelled following the attributional LCI modelling approach.

An LCA that is meant for decision support needs to follow a change-oriented LCA modelling principle when the anticipated system change induced by the decision at stake is not minor compared to the existing system.

Box 7

If the LCA study is aimed at a macro-level decision (e.g., policy-making), a consequential approach has to be followed.

Box 4

To be prospective within the context of these guidelines, an LCA study must meet the following requisites:

1. The system must be modelled at a future time. ●●●●●
2. The foreground data for the technical/operating parameters and capital goods of the analysed product system must be prospective. ●●●●●

When performing a comparative study, it must be ensured that the FCH technologies under comparison are modelled at the same future time of implementation.

Box 5

1. The use of relevant prospective background data for processes directly linked to the foreground system (e.g., electricity production) is strongly recommended. ●●●●○
2. The use of prospective background data from dedicated databases (e.g., *premise*) is recommended. ●●●○
3. It is recommended to state the Technology Readiness Level (TRL) and/or the Manufacturing Readiness Level (MRL) of the involved technology to facilitate comparability decisions.

To ensure users are applying the requirements/recommendations a tool wizard was created

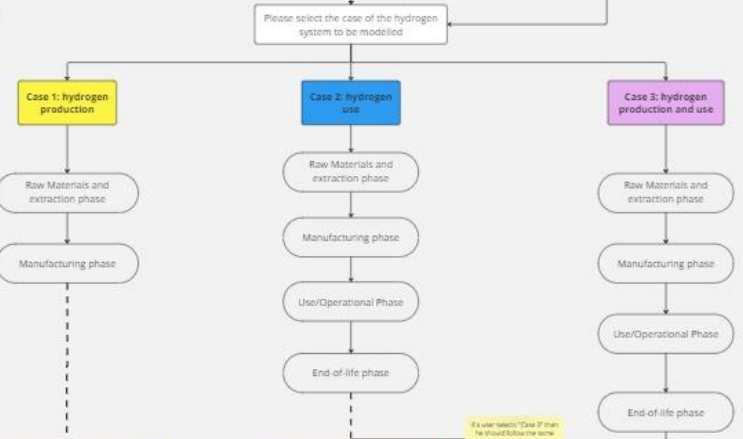
Tool Development: Wizards & templates

- Starting with the main 3 cases of hydrogen:
 1. Hydrogen production
 2. Hydrogen use
 3. Hydrogen production and use

then breaking them down based on possible functional units.

- Overall, 46 templates created

System Boundaries



Please select the system boundary of the hydrogen production:

- Cradle-to-gate 1 (hydrogen production)
- Cradle-to-gate 2 (hydrogen purification)
- Cradle-to-gate 3 (hydrogen compression) - recommended
- Cradle-to-gate 4 (hydrogen transportation)
- Cradle-to-gate 5 (hydrogen storage)
- Cradle-to-gate 6 (hydrogen distribution)

Case 3 flow starts here

Please fill the following based on the hydrogen produced:

- Net calorific value (MJ/kg)
- Purity (%)
- Temperature (°C)
- Pressure (bar)

Please state the state the assumed operating scale/production capacity of the hydrogen production system (kg of H2 per year):

Please select your functional unit

- kg of H2
- MJ (LHV) of H2

Has carbon capture and storage technology been installed in the Hydrogen production plant?

- Yes
- No

- Applicable templates in [pre-set template - Files - ownCloud \(greendelta.com\)](#):
- Case 1 Cradle-to-gate 1 (hydrogen production) kg
 - Case 1 Cradle-to-gate 2 (hydrogen purification) kg
 - Case 1 Cradle-to-gate 3 (hydrogen compression) kg
 - Case 1 Cradle-to-gate 4 (hydrogen transportation) kg
 - Case 1 Cradle-to-gate 5 (hydrogen storage) kg
 - Case 1 Cradle-to-gate 6 (hydrogen distribution) kg

Applicable templates in [pre-set template - Files - ownCloud \(greendelta.com\)](#):

- All case 1 templates "with CCS" but of course depending on the previous step filter whether its MJ or kg

Please select the purpose of hydrogen usage:

For transportation

If Selected

Please fill the following based on the vehicle used:

- Lifetime of the vehicle (years)
- Hydrogen consumption kg per 100 km

Please select your functional unit

- km travelled
- passenger load
- freight load

For fuels and Chemical Production

If Selected

Please fill the following according to the fuel/chemical production:

- Purity (%)
- Pressure (kPa)
- Temperature (°C)
- Net Calorific Value (MJ/kg) (if fuel)

Please select your functional unit

- kg of fuel/chemical
- MJ (LHV) of fuel

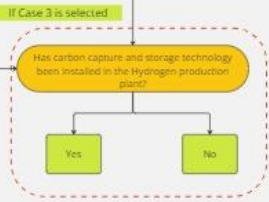
For electricity and/or heat generation

If Selected

Please select the basis of the functional unit

- Energy (MJ) (for electricity generation)
- Energy (MJ) (for cogeneration systems i.e., electricity and heat generation)

- Applicable templates in [pre-set template - Files - ownCloud \(greendelta.com\)](#):
- Case 2 Hydrogen use for electricity generation (MJ)
 - Case 3 Hydrogen production and use for electricity generation is selected and no CCS
 - Case 3 Hydrogen production and use for electricity generation is selected and no CCS



- Applicable templates in [pre-set template - Files - ownCloud \(greendelta.com\)](#):
- Case 1 Cradle-to-gate 1 (hydrogen production) MJ
 - Case 1 Cradle-to-gate 2 (hydrogen purification) MJ
 - Case 1 Cradle-to-gate 3 (hydrogen compression) MJ
 - Case 1 Cradle-to-gate 4 (hydrogen transportation) MJ
 - Case 1 Cradle-to-gate 5 (hydrogen storage) MJ
 - Case 1 Cradle-to-gate 6 (hydrogen distribution) MJ

Tool Wizard



Welcome to the SH2E tool
To get through this dialog, it is recommended that you refer to the SH2E guidelines for clarification.

Goal scope
Is the application of the LCA intended for decision support?
 Yes
 No

< Back Next > Finish Cancel

C:\Users\silve\openLCA-data-1.4\databases\sh2e_elca_model_final

Welcome

The FCH-LCA tool provides a range of pre-set templates tailored specifically for hydrogen production and use, catering to various scenarios and applications.

Tool Wizard

FCH-LCA tool

Technology readiness level

Technology readiness level

Please state the Technology Readiness Level (TRL) of the involved technology:

- TRL 1 - basic principles observed
- TRL 2 - technology concept formulated
- TRL 3 - experimental proof of concept
- TRL 4 - technology validated in lab
- TRL 5 - technology validated in relevant environment
- TRL 6 - technology demonstrated in relevant environment
- TRL 7 - system prototype demonstration in operational environment
- TRL 8 - system complete and qualified
- TRL 9 - actual system proven in operational environment

< Back Next > Finish Cancel

FCH-LCA tool

Boundaries of hydrogen production

Boundaries of hydrogen production

Please state the system boundary of the hydrogen production:

- Cradle-to-gate 1 (hydrogen production)
- Cradle-to-gate 2 (hydrogen purification)
- Cradle-to-gate 3 (hydrogen compression)
- Cradle-to-gate 4 (hydrogen transportation)
- Cradle-to-gate 5 (hydrogen storage)
- Cradle-to-gate 6 (hydrogen distribution)

< Back Next > Finish Cancel

FCH-LCA tool

Hydrogen Production Parameters

Hydrogen production parameters

Hydrogen net calorific value (MJ/kg)

Hydrogen purity (%)

Hydrogen pressure (bar)

Hydrogen temperature (°C)

Operating production capacity (kg H₂/year)

Carbon capture and storage

Has carbon capture and storage technology been installed in the hydrogen production plant?

- without CSS
- with CSS

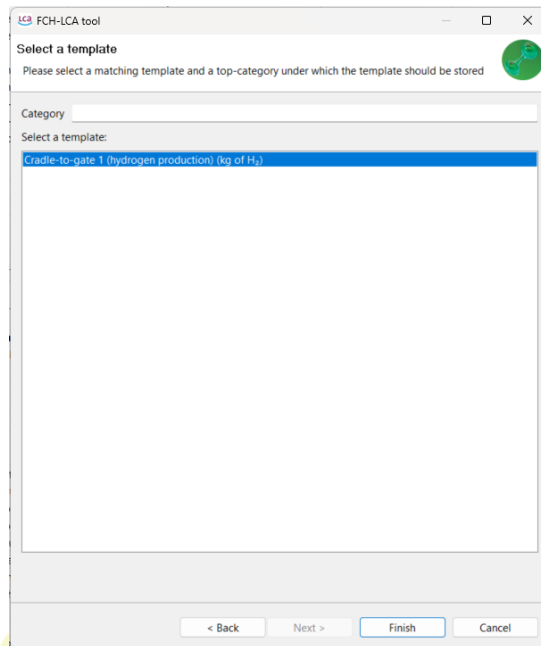
Functional unit

Please select the functional unit:

- kg of H₂
- MJ (LHV) of H₂

< Back Next > Finish Cancel

Tool Wizard filters the templates



General information: Hydrogen Production (Cradle-to-gate 1) (kg)

General information

Name: Hydrogen Production (Cradle-to-gate 1) (kg)

Category: - none -

Description: First created: 2023-09-27T12:26:02
Linking approach during creation: Prefer default providers; Preferred process type: System process

Version: 00.000001 | Last change: 2023-09-29 16:32:46 | UUID: 5160474c-2536-424a-a519-2c7d1164f256

Tags: Add a tag | Calculate

Reference

Process: Hydrogen Production (Cradle-to-gate 1) (kg)

Product: H2 Produced

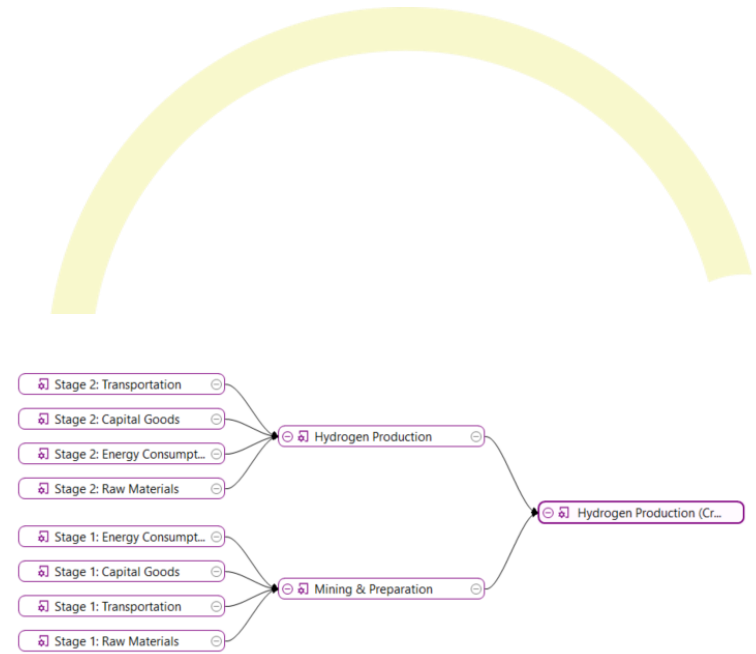
Flow property: Mass

Unit: kg

Target amount: 1.0

FCH-LCA Properties

Intended application	Meso/Macro-level decision support
Modelling principles	Attributional
Prospectivity	Prospective study
End-of-life	Cut-off approach
Capital goods	Included
Risk assessment	Simple LCA, without risk assessment
System boundaries	Hydrogen production
Technology readiness level	TRL 1 - basic principles observed
LCI based on operating scale	Yes
Learning Curve Method	--
Hydrogen net calorific value (MJ/kg)	2.0
Hydrogen purity (%)	3.0
Hydrogen temperature (°C)	6.0
Hydrogen pressure (bar)	5.0
Operating production capacity (kg H ₂ /year)	7.0
Functional unit	kg of H ₂
Carbon capture and storage	without CSS
Boundaries of hydrogen production	Cradle-to-gate 1 (hydrogen production)
Comparative LCA	Absolute study
Use purpose	None



Users simply add the inputs and outputs in the model graph

Using the toggle edit tool

Users can then add flow at any process stage in the product system

Create a new flow

Product Waste Elementary flow

Mass

Or select an existing

- A: Agriculture, forestry and fishing
- B: Mining and quarrying
- C: Manufacturing
- D: Electricity, gas, steam and air conditioning supply
- E: Water supply; sewerage, waste management and remediation activities
- Elementary flows
- F: Construction
- G: Wholesale and retail trade; repair of motor vehicles and motorcycles
- H: Transportation and storage
- I: Accommodation and food service activities
- J: Information and communication
- M: Professional, scientific and technical activities
- N: Administrative and support service activities
- S: Other service activities

Support for documenting goal and scope and modelling choices

General information: Hydrogen production

General information

Name:

Category: ■ SH2E case study/Operation&Maintenance

Description:

Version: 00.00.006 ↻ ⊕ ⊖ UUID: Last change: 2022-11-23 12:48:48

Tags:

Infrastructure process:

Time

Start date: 📅

End date: 📅

Description:

Geography

General information | **Inputs/Outputs** | Administrative information | Modeling and validation | Parameters | Allocation | Social aspects | Impact analysis

Modeling and validation: Hydrogen production

Modeling and validation

Process type:

LCI method:

Modeling constants:

Data completeness:

Data selection:

Data treatment:

Data source information

Sampling procedure:

Data collection period:

Process evaluation and validation

General information | Inputs/Outputs | Administrative information | **Modeling and validation** | Parameters | Allocation | Social aspects | Impact analysis

Users use parameters to set up changeable inputs or create equations

Parameters: Vehicle Production: Hydrogen Tank

Global parameters

Name	Value	Uncertainty	Description
discount_rate	0.05	none	discount rate per period of time
time2	1.0	none	number of discount periods

Input parameters

Name	Value	Uncertainty	Description
density_naturalgas	0.65	none	kg/m3

Inputs

Flow	Category	Amount	Unit	Costs/Revenues
tap water	3600:Water collection, treatment and supply/3600:Water co...	2.42000E7	m ³	kg
price		$10 / ((1 + \text{discount_rate})^{\text{time2}})$	USD 2002	$10 / ((1 + \text{discount_rate})^{\text{time2}})$ USD

Inputs/Outputs: Vehicle Production: Hydrogen Tank

Inputs

Flow	Category	Amount	Unit
Composite material - carbon fiber		70.50000	kg
compressed air, 1000 kPa gauge	201:Manufacture of basic chemicals, fertilizers and n...	0.13836	m ³
electricity, low voltage	351:Electric power generation, transmission and distr...	791.77800	MJ
electricity, low voltage	351:Electric power generation, transmission and distr...	1.60179	kWh
epoxy resin, liquid	201:Manufacture of basic chemicals, fertilizers and n...	24.20510	kg
injection moulding	222:Manufacture of plastics products/2220:Manufac...	7.00607	kg
metal working - average for metal product manufa...	25:Manufacture of fabricated metal products, except...	0.83571	kg
natural gas, high pressure	B:Mining and quarrying/06:Extraction of crude petro...	$0.696 / \text{density_naturalgas}$	m ³
polyethylene, high density, granulate	201:Manufacture of basic chemicals, fertilizers and n...	7.73179	kg
transport, freight, lorry 3.5-7.5 metric ton, EURO5	492:Other land transport/4923:Freight transport by r...	1.54793	t*km

Multifunctionality in the SH2E FCH-LCA tool

Inputs/Outputs: SH2E Hydrogen production Germany (System expansion)

Inputs

Flow	Category	Amount	Unit	Costs/Revenues	Uncertainty	Avoided waste	Provider	Data quality entry	Location	Description
aluminium, primary, ingot	242:Manufacture of basic precious and oth...	3500.00000	kg		none		market for alumi...	(1; 2; 3; 4; 1)		
concrete, normal strength	239:Manufacture of non-metallic mineral p...	1300000/concrete_d...	m3		none		concrete, all typ...	(1; 2; 3; 4; 1)		
electricity, medium voltage	D:Electricity, gas, steam and air conditionin...	1.12500E8	kWh		none		market for electr...	(1; 2; 3; 1; 1)		
metal working, average for copper produ...	25:Manufacture of fabricated metal produc...	300.00000	kg		none		market for metal...	(1; 2; 3; 4; 2)		copper
natural gas, high pressure	B:Mining and quarrying/06:Extraction of cr...	88875000000/NG_h...	m3		none		market for natur...	(1; 1; 3; 1; 1)		
nickel, class 1	242:Manufacture of basic precious and oth...	300.00000	kg		none		market for nickel...	(1; 2; 3; 4; 1)		
steel, chromium steel 18/8	241:Manufacture of basic iron and steel/24...	6.00000E4	kg		none		market for steel, ...	(1; 2; 3; 4; 3)		steel, high alloy
steel, low-alloyed	241:Manufacture of basic iron and steel/24...	1.00000E5	kg		none		market for steel, ...	(1; 2; 3; 4; 1)		
steel, unalloyed	241:Manufacture of basic iron and steel/24...	2.40000E5	kg		none		market for steel, ...	(1; 2; 3; 4; 1)		
tap water	360:Water collection, treatment and supply...	8.10000E9	kg		none		market for tap w...	(1; 2; 3; 2; 1)		
zinc	242:Manufacture of basic precious and oth...	300.00000	kg		none		market for zinc ...	(1; 2; 3; 4; 2)		

Outputs

Flow	Category	Amount	Unit	Costs/Revenues	Uncertainty	Avoided product	Provider	Data quality entry	Location	Description
SH2E Hydrogen (to conditioning and ...)		5.62500E8	kg	1.08000E9 EUR	none					
steam, in chemical industry	201:Manufacture of basic chemicals, fertiliz...	2.98125E9	kg	4.47000E7 EUR	none	<input checked="" type="checkbox"/>	market for steam...	(1; 2; 3; 3; 2)		
Carbon dioxide, fossil	Emission to air/unspecified	4.80938E9	kg		none			(1; 2; 5; 5; 1)		
Carbon monoxide, fossil	Emission to air/unspecified	6.18750E5	kg		none			(1; 2; 5; 5; 1)		
Methane, fossil	Emission to air/unspecified	1.02375E6	kg		none			(1; 2; 5; 5; 1)		
Nitrogen oxides	Emission to air/unspecified	1.29375E6	kg		none			(1; 2; 5; 5; 1)		
NMVOC, non-methane volatile organic c...	Emission to air/unspecified	1.91250E6	kg		none			(1; 2; 5; 5; 2)		NMHC Proxy
Particulate Matter, < 2.5 um	Emission to air/unspecified	1.23750E4	kg		none			(1; 2; 5; 5; 1)		
Sulfur oxides	Emission to air/unspecified	6.18750E4	kg		none			(1; 2; 5; 5; 1)		

When there is more than one product output

Users can do allocation based on physical, economic, energy

Users can also do system expansion

Multifunctionality in the SH2E FCH-LCA tool

Users can see the allocation factors in the allocation tab

Allocation: SH2E Hydrogen production Germany

Default method: Causal Calculate factors

Physical & economic allocation

Product	Physical	Economic
SH2E Hydrogen (to conditioning and dispensing) [562500000.00 kg]	0.15873015873015872	0.9602560682848761
steam, in chemical industry [2981250000.00 kg]	0.8412698412698413	0.0397493171512403
Σ	1.00000	1.00000

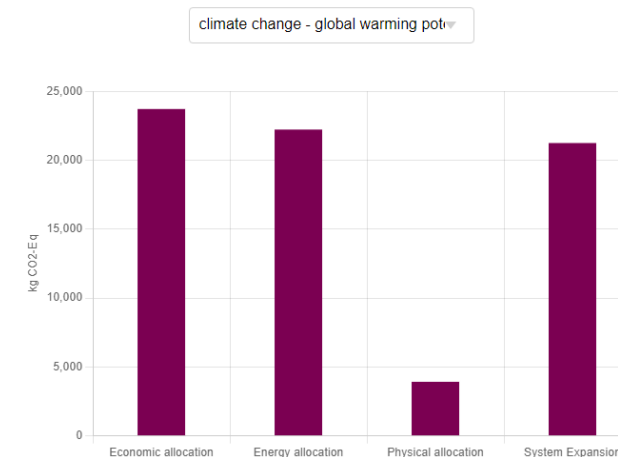
Causal allocation

Flow	Direction	Category	Amount	SH2E Hydr...	steam, in c...	I
natural gas, high pressure	Input	B:Mining and quarrying/06...	2.46875E9 m3	0.89987978...	0.10012021...	1.00000
steel, unalloyed	Input	241:Manufacture of basic ir...	2.40000E5 kg	0.89987978...	0.10012021...	1.00000
steel, low-alloyed	Input	241:Manufacture of basic ir...	1.00000E5 kg	0.89987978...	0.10012021...	1.00000
tap water	Input	360:Water collection, treat...	8.10000E9 kg	0.89987978...	0.10012021...	1.00000
electricity, medium voltage	Input	D:Electricity, gas, steam an...	1.12500E9 kWh	0.89987978...	0.10012021...	1.00000
concrete, normal strength	Input	239:Manufacture of non-m...	5.41667E5 m3	0.89987978...	0.10012021...	1.00000
metal working, average for copper product manufacturing	Input	25:Manufacture of fabricat...	300.00000 kg	0.89987978...	0.10012021...	1.00000
steel, chromium steel 18/8	Input	241:Manufacture of basic ir...	6.00000E4 kg	0.89987978...	0.10012021...	1.00000
zinc	Input	242:Manufacture of basic p...	300.00000 kg	0.89987978...	0.10012021...	1.00000
nickel, class 1	Input	242:Manufacture of basic p...	300.00000 kg	0.89987978...	0.10012021...	1.00000
aluminium, primary, ingot	Input	242:Manufacture of basic p...	3500.00000 kg	0.89987978...	0.10012021...	1.00000
Carbon dioxide, fossil	Output	Emission to air/unspecified	4.80938E9 kg	0.89987978...	0.10012021...	1.00000
NM VOC, non-methane volatile organic compounds	Output	Emission to air/unspecified	1.91250E6 kg	0.89987978...	0.10012021...	1.00000
Carbon monoxide, fossil	Output	Emission to air/unspecified	6.18750E5 kg	0.89987978...	0.10012021...	1.00000
Particulate Matter, < 2.5 um	Output	Emission to air/unspecified	1.23750E4 kg	0.89987978...	0.10012021...	1.00000
Methane, fossil	Output	Emission to air/unspecified	1.02375E6 kg	0.89987978...	0.10012021...	1.00000
Nitrogen oxides	Output	Emission to air/unspecified	1.29375E6 kg	0.89987978...	0.10012021...	1.00000
Sulfur oxides	Output	Emission to air/unspecified	6.18750E4 kg	0.89987978...	0.10012021...	1.00000

Compare the different allocations using Project-report feature

Variant comparison

The chart below compares the results of the different project variant for the selected indicator. You can change the selection and the chart is dynamically updated.



Data quality documentation and assessment

▼ Data quality

Process schema Ciroth Muller Weidema Lesage ✕

Data quality entry (1; 2; 3; 4; 2)

Flow schema Ciroth Muller Weidema Lesage ✕

Social schema - none - ✕

General information | Inputs/Outputs | Administrative information | Modeling and validation

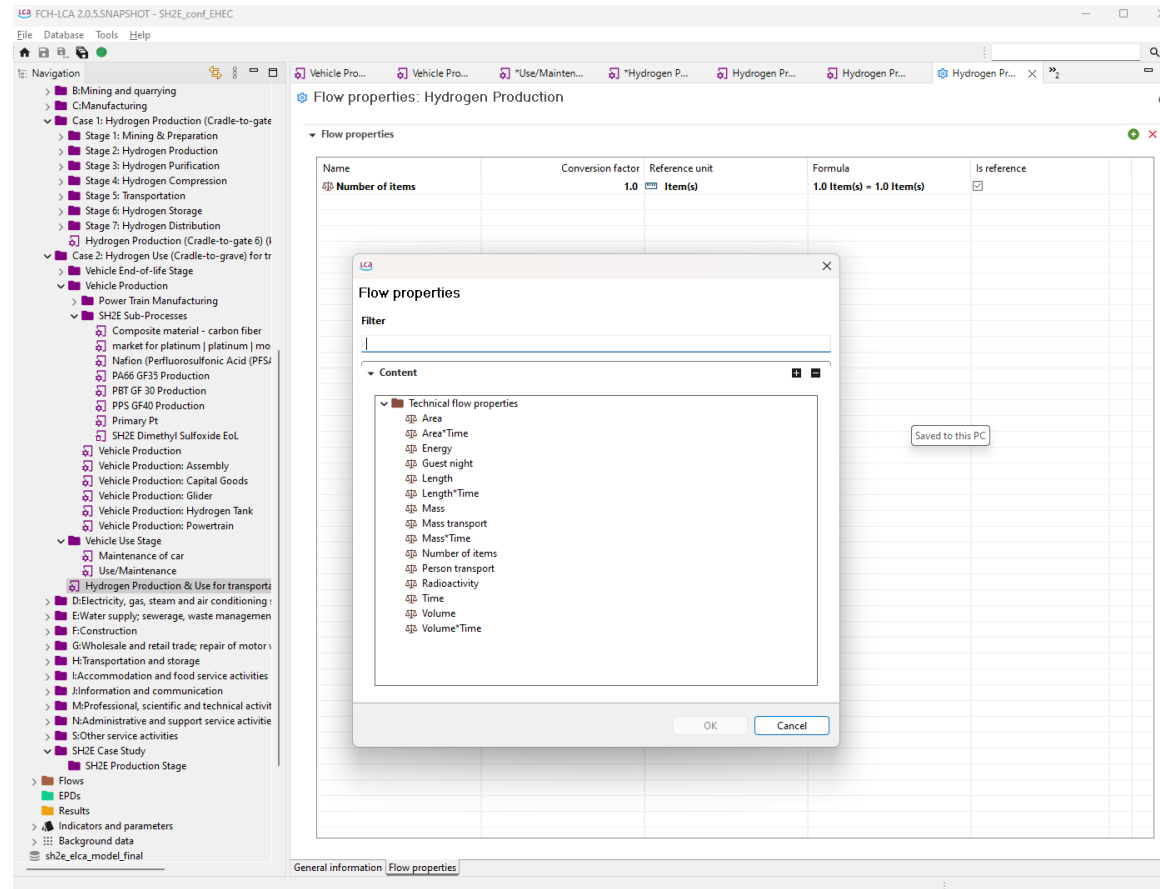
Pedigree matrix

Click on the matrix cells to select entries

	1	2	3	4	5
Reliability	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 estimate (e.g. by industrial expert)	Non-qualified estimates
Completeness	Representative data from all sites relevant for the market considered, over and adequate period to even out normal fluctuations	Representative data from > 50% of the sites relevant for the market considered, over an adequate period to even out normal fluctuations	Representative data from only some sites (<< 50% relevant for the market considered or > 50% of sites but from shorter periods)	Representative data from only one site relevant for the market considered or some sites but from shorter periods	Representativeness unknown or data from a small number of sites and from shorter periods
Temporal correlation	Less than 3 years of difference to the time period of the data set	Less than 6 years of difference to the time period of the data set	Less than 10 years of difference to the time period of the data set	Less than 15 years of difference to the time period of the data set	Age of data unknown or more than 15 years of difference to the time period of the data set
Geographical correlation	Data from area under study	Average data from larger 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	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 or materials	Data on related processes on laboratory scale or from different technology

OK Delete Cancel

Users can also alter the defined Flow properties of the processes



Name	Conversion factor	Reference unit	Formula	Is reference
Number of items	1.0	Item(s)	1.0 Item(s) = 1.0 Item(s)	<input checked="" type="checkbox"/>

Special features: Social Assessment

Risk Level Scale

Home | Manufacture of motor vehicles, trailers and semi-trailers - FR | Manufacture of motor vehicles, trailers and semi-trailers | Results of: Manufacture of motor vehicles, trailers and semi-trailers | Contribution of the sector to economic development

Manufacture of motor vehicles, trailers and semi-trailers

Indicator results

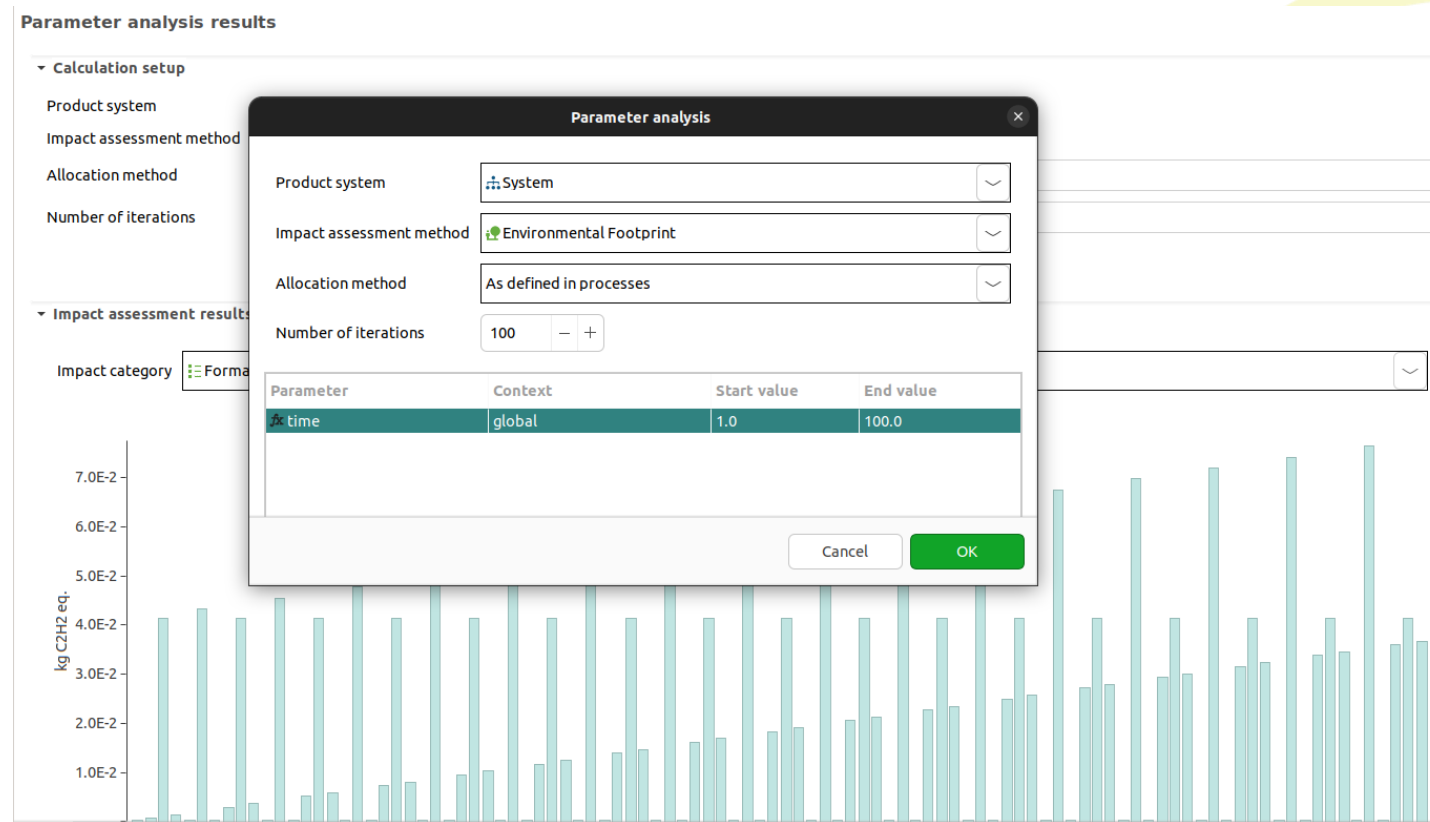
Activity value	Raw value	HO	MO	LO	NOP	NOR	VLR	LR	MR	HR	VHR	ND	NA
> Local Community		0%	0%	0%	0%	7%	12%	15%	54%	8%	2%	2%	0%
> Society		0%	6%	0%	0%	8%	58%	17%	6%	6%	0%	0%	0%
> Contribution to economic development		0%	11%	0%	0%	0%	67%	0%	11%	11%	0%	0%	0%
> Contribution of the sector to economic development	0.00248 work hours [h]	11.23000 [% of GDP]	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
> Embodied value added total	0.00248 work hours [h]	0.21000 [\$/]\$]	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
> Illiteracy rate, female	0.00248 work hours [h]	0.85000 [% of female population]	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
> Illiteracy rate, male	0.00248 work hours [h]	0.54000 [% of male population]	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
> Illiteracy rate, total	0.00248 work hours [h]	0.70000 [% of total population]	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
> Public expenditure on education	0.00248 work hours [h]	5.46000 [% of GDP]	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
> Youth illiteracy rate, female	0.00248 work hours [h]	0.23000 [% of female population, age 15-24]	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
> Youth illiteracy rate, male	0.00248 work hours [h]	0.26000 [% of male population, age 15-24]	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
> Youth illiteracy rate, total	0.00248 work hours [h]	0.25000 [% of total population, age 15-24]	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
> Health and Safety			0%	0%	0%	17%	50%	33%	0%	0%	0%	0%	0%
> Value Chain Actors			0%	0%	0%	0%	0%	33%	17%	0%	50%	0%	0%
> Workers			0%	0%	0%	9%	35%	10%	33%	0%	7%	4%	0%

HO – High opportunity
 MO – Medium opportunity
 LO – Low opportunity
 NOP - No Opportunity

NOR– No Risk
 VLR – Very Low Risk
 LR – Low risk
 MR - Medium Risk
 HR – High Risk

VHR– Very High Risk
 ND – No Data
 NA – Not applicable

Special features: Time variable





SH₂E



Conclusions



Co-funded by
the European Union



This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 101007163. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research.

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Conclusions

Based on openLCA, a powerful tool has been created, open source and free to use, with the aim to fully reflect the SH2E guidelines and to support users in applying them.

We hope this is useful for the community. Feedback welcome.

Some of the implemented features are already integrated in the latest openLCA release as well (social calculation), some will come (time), and some are probably interesting also beyond openLCA (templates), in the context of EPDs and Environmental Footprint.



**SUSTAINABILITY ASSESSMENT
OF HARMONISED HYDROGEN
ENERGY SYSTEMS**

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