SUSTAINABILITY ASSESSMENT
OF HARMONISED HYDROGEN
ENERGY SYSTEMS

SH2E

Grant No. 101007163

Project start date: 01.01.2021
Project duration: 42 months
Project Coordinator: IMDEA Energy

D4.3 Extended life-cycle tools

WP4 Harmonised extension to Life Cycle Costing and Social Life Cycle Assessment

User Manual

WP LEADER	GreenDelta GmbH
DELIVERABLE LEADER(S)	Andreas Ciroth Ashrakat Hamed Francois le Rall Michael Srocka
REVIEWER(S)	XX (REVIEWERS NAME, ORGANIZATION)

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STATUS	F
DISSEMINATION LEVEL	PU
DELIVERABLE TYPE	OTHER
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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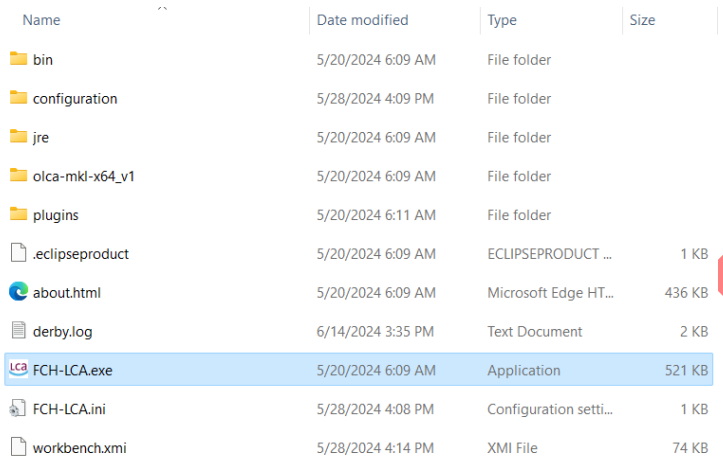
Installing the FCH-LCA

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



Name	Date modified	Type	Size
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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
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
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.

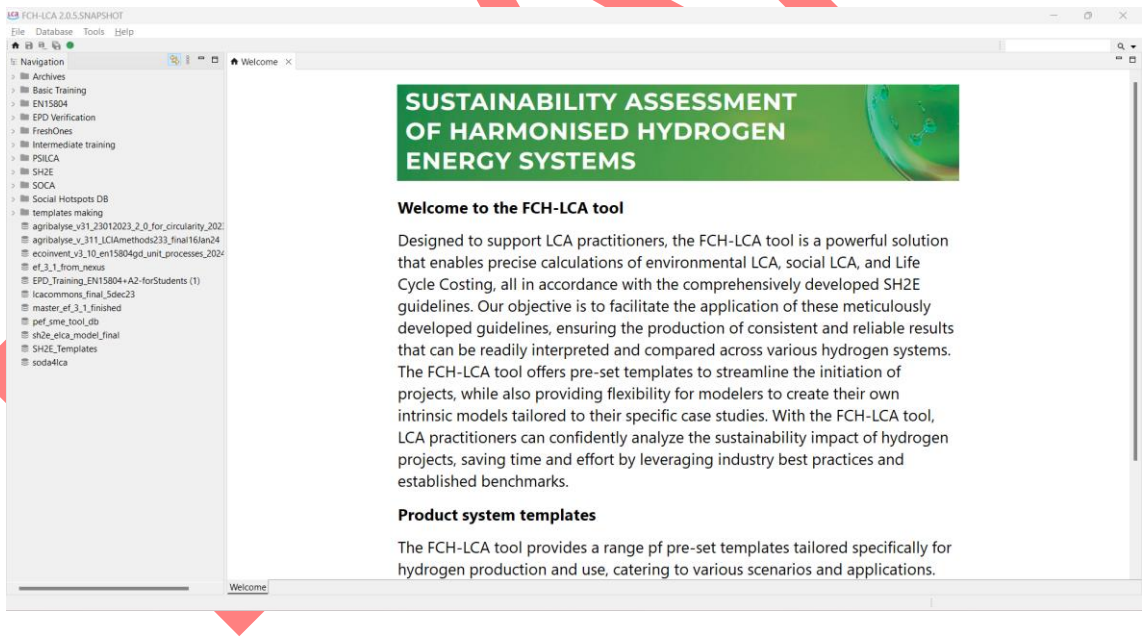

Figure 2 Welcome page FCH-LCA tool

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.

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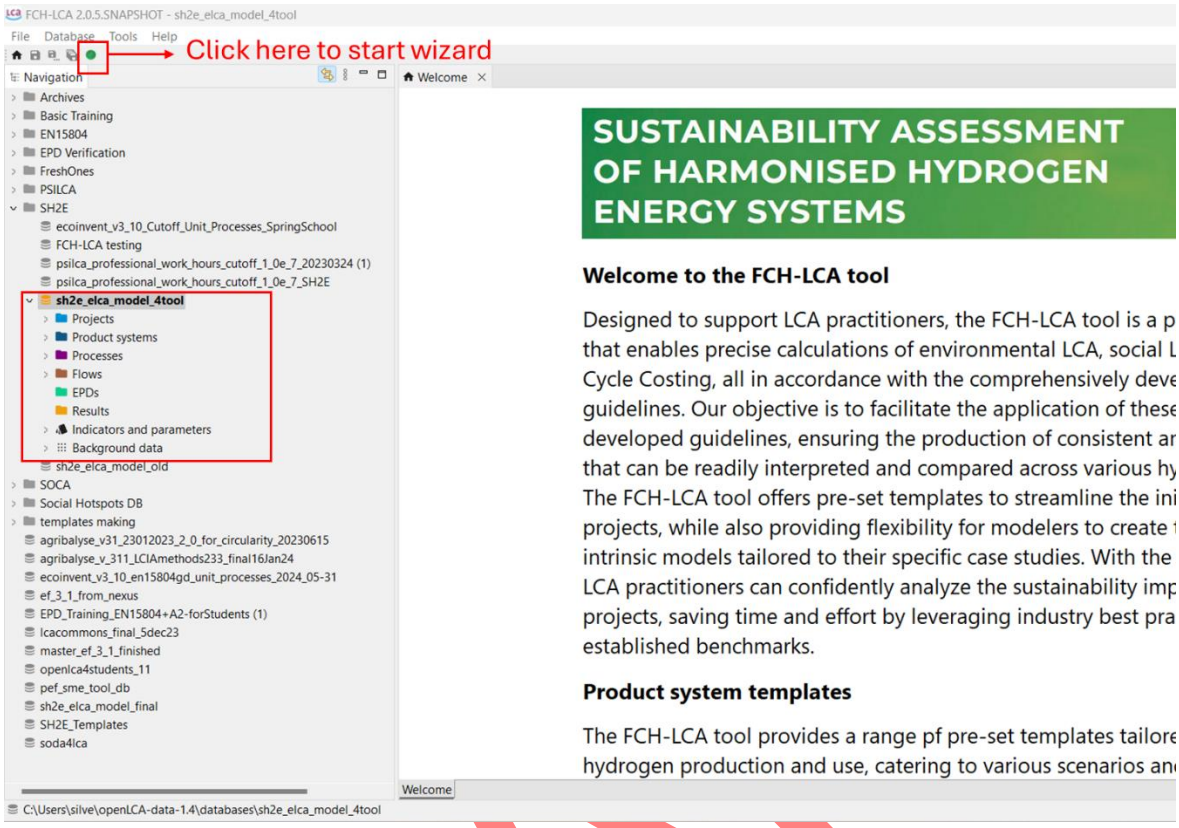

Figure 3 Starting the wizard

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.

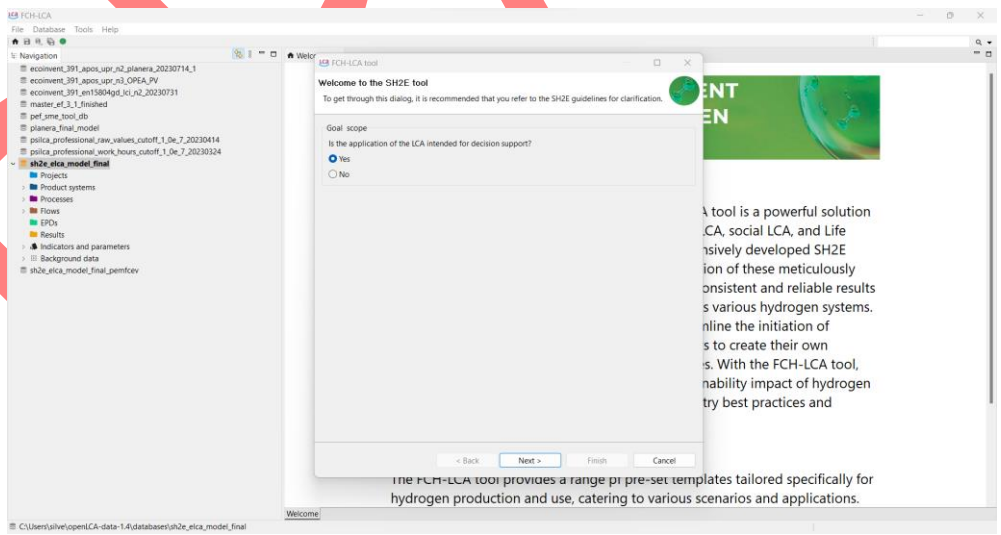

Figure 4 Wizard pop-up window

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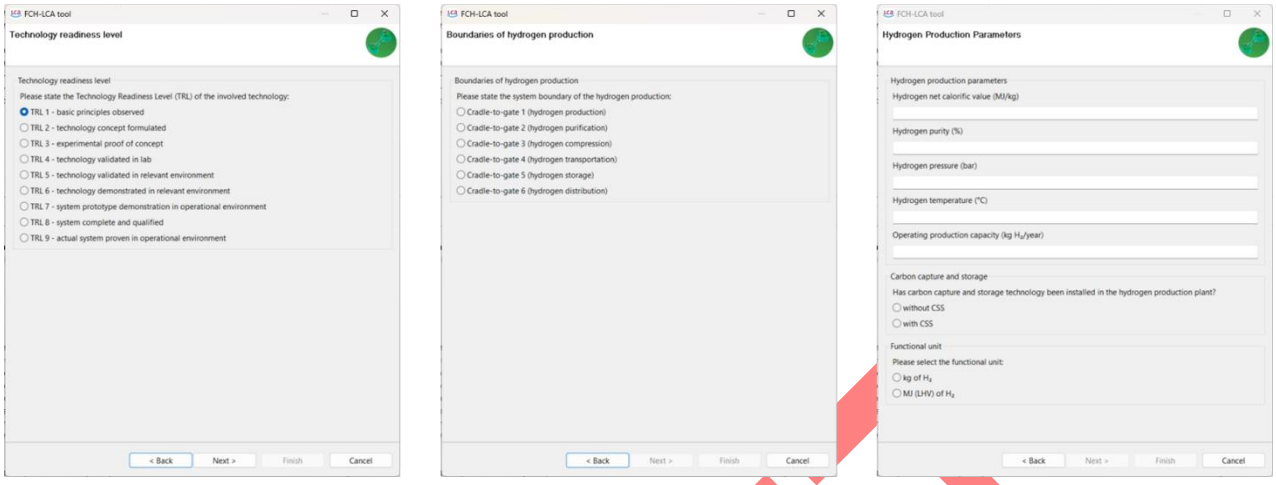

Figure 5 Wizard questions

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

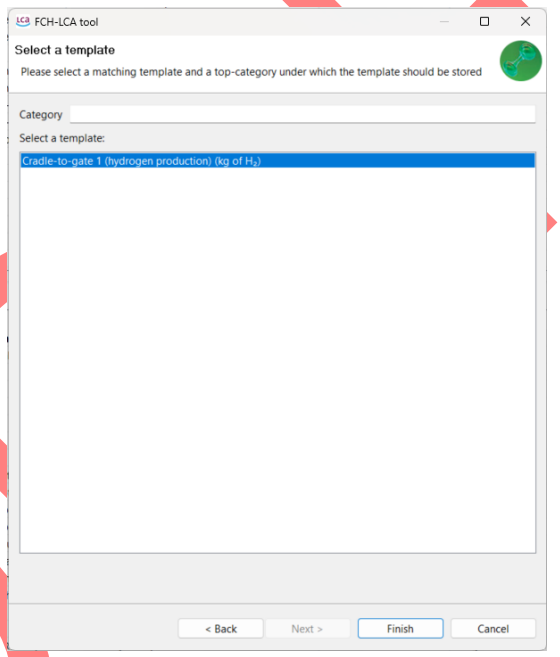

Figure 6 Template decision based on wizard selection

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.

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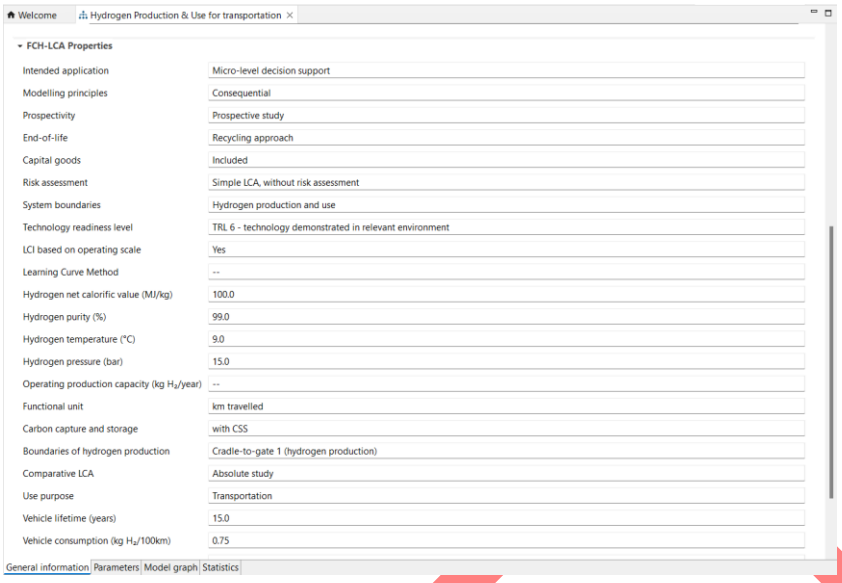

Figure 7 FCH-LCA Properties

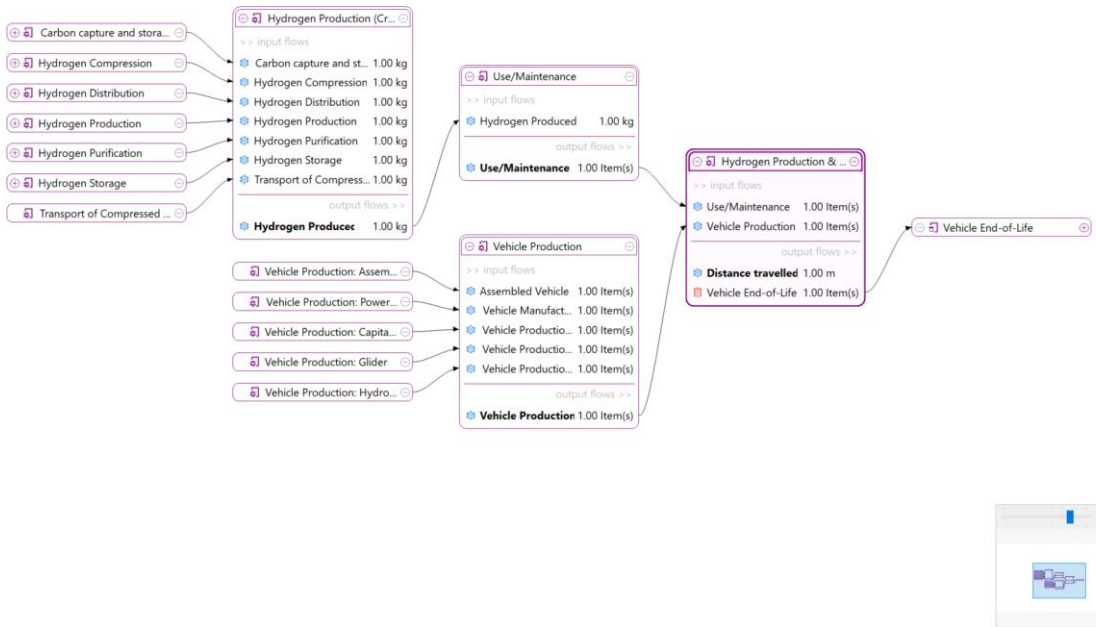

Figure 8 Product system of hydrogen production and use for vehicle

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

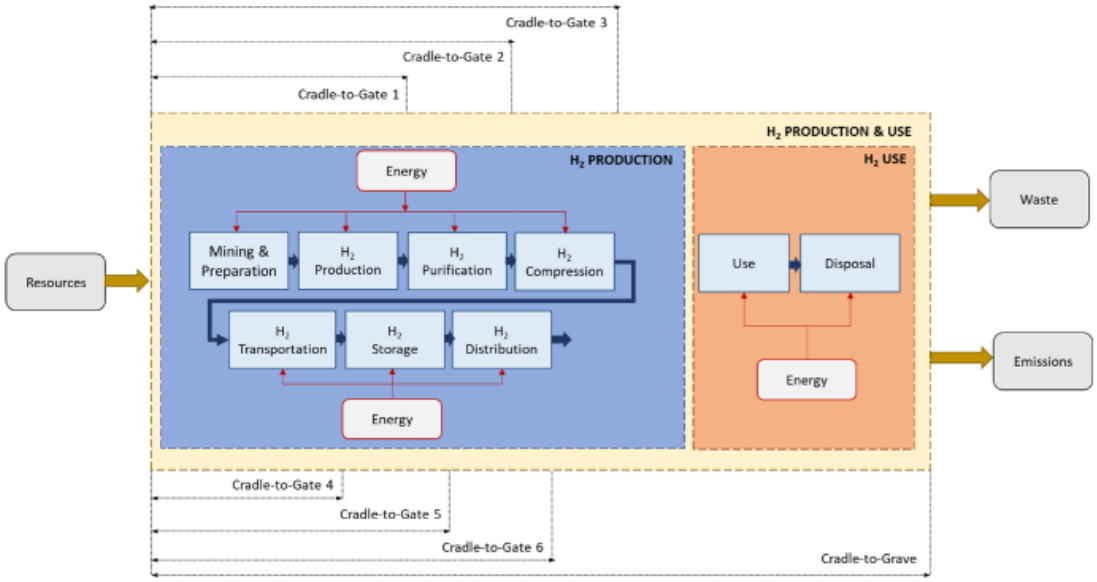

Figure 9 Foreground phases for studies assessing FCH systems

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.

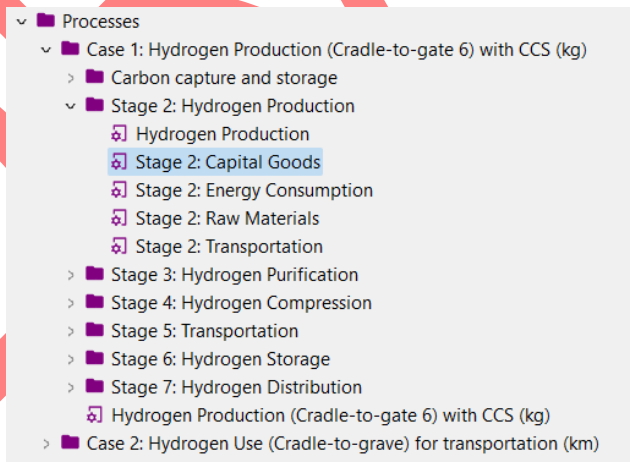

Figure 10 Breakdown of processes

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.

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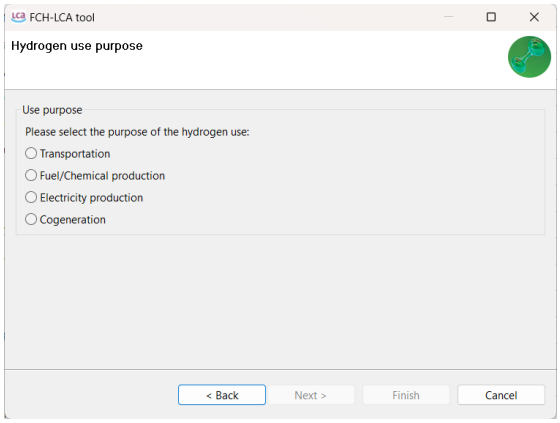

Figure 11 Hydrogen use cases

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".

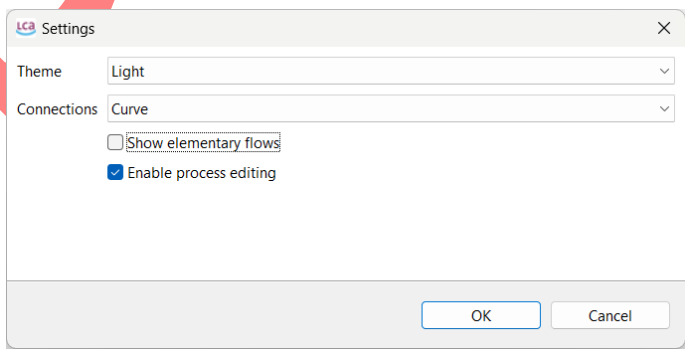

Figure 12 Activated settings in the model graph.

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

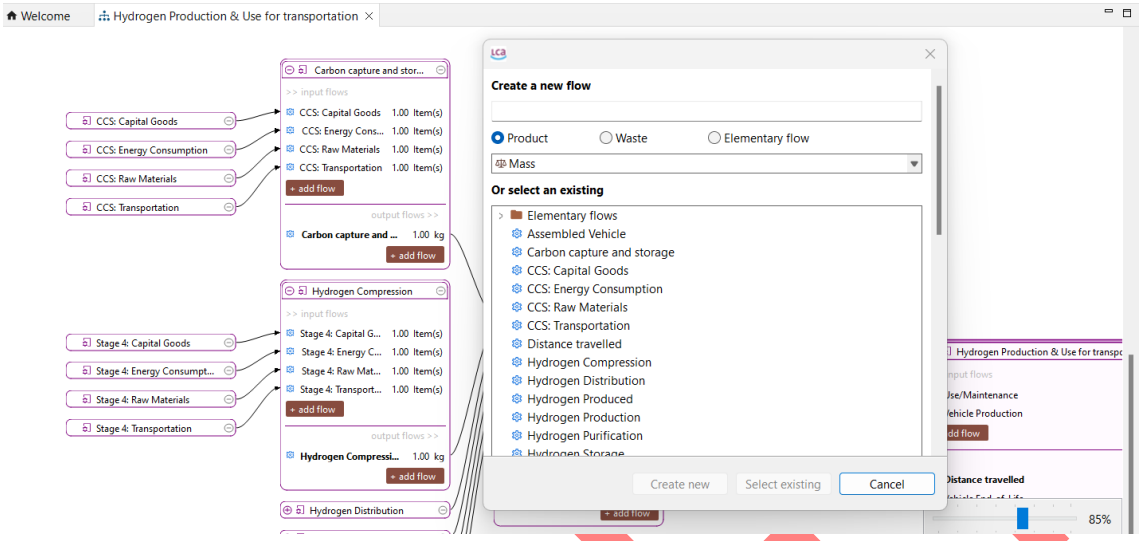

Figure 13 Adding of new flows in model graphs

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".

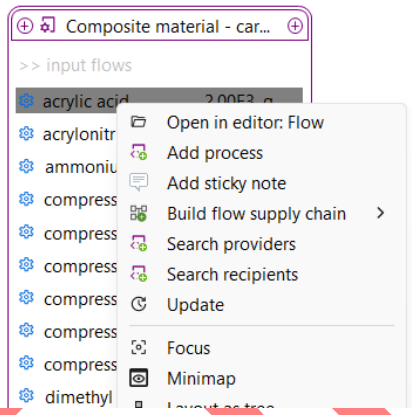

Figure 14 Searching for providers

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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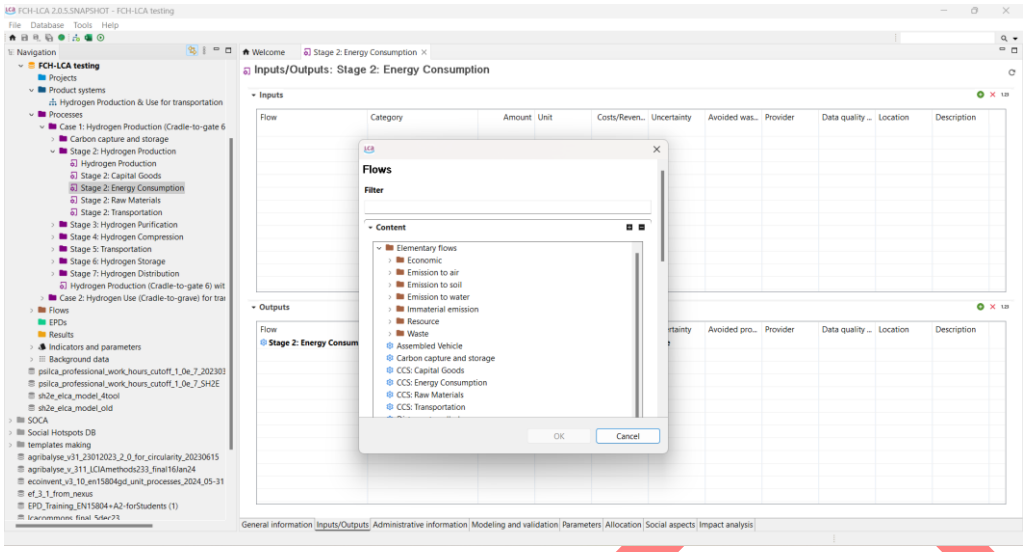

Figure 15 Adding of new flows in the process

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:

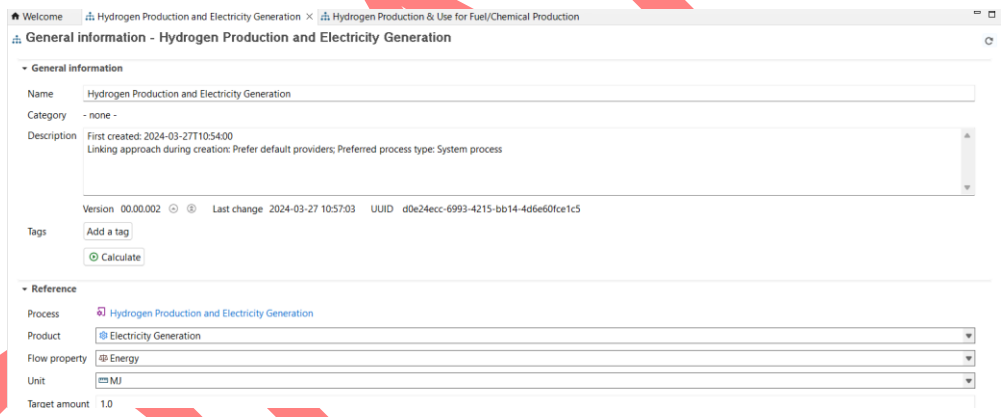

Figure 16 Calculating the results

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:

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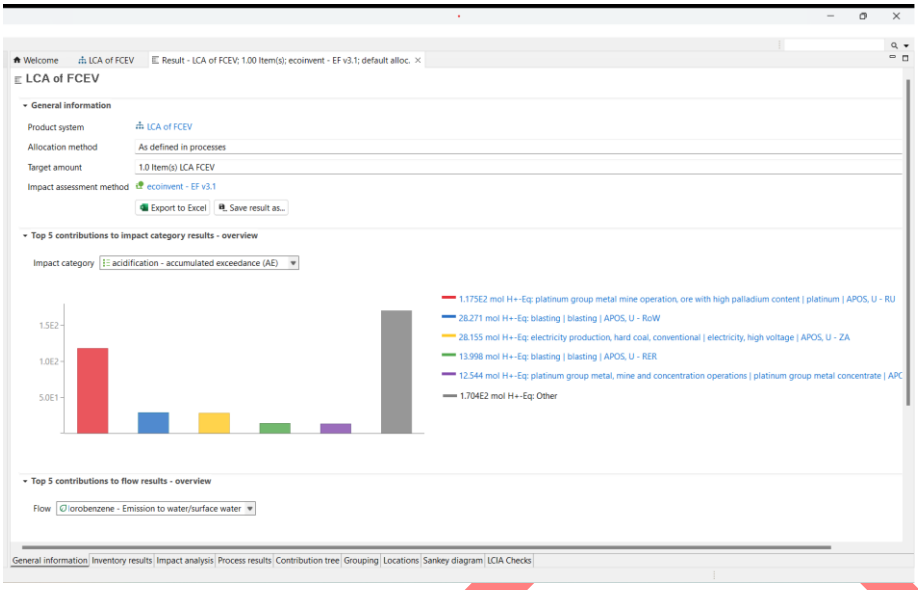
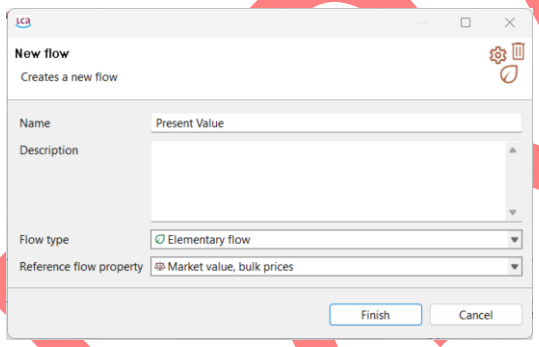


Figure 17 Results of a product system

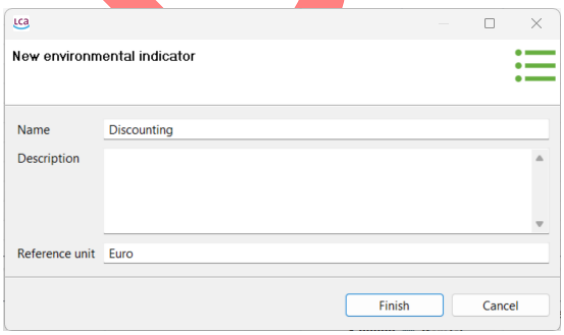
Special feature: parameter analysis

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:

Step 1: Create a new elementary flow



Step 2: Create a new impact category



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

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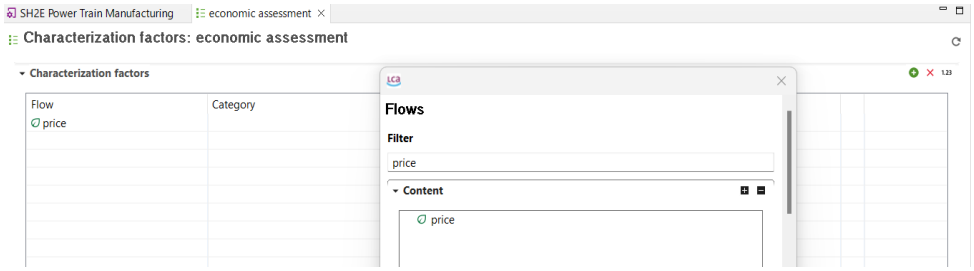
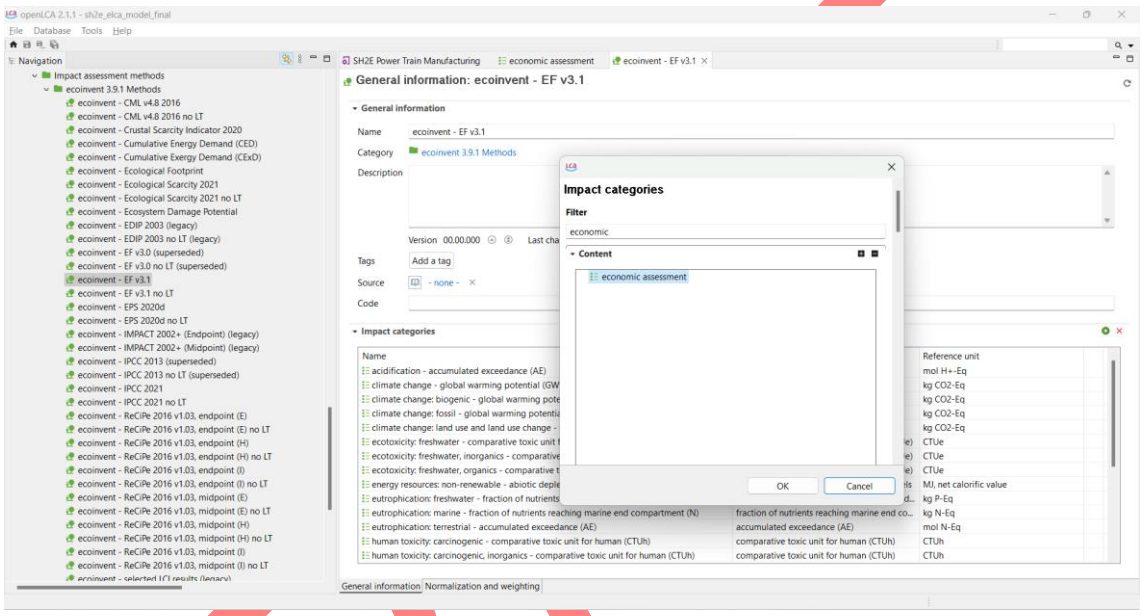
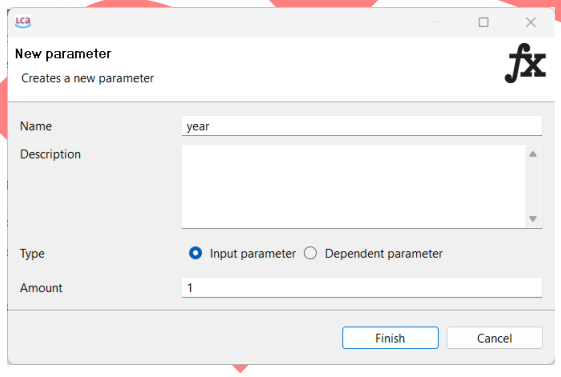


Step 4 Create a new method/add the created category in an existing method or in a new method.



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.



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

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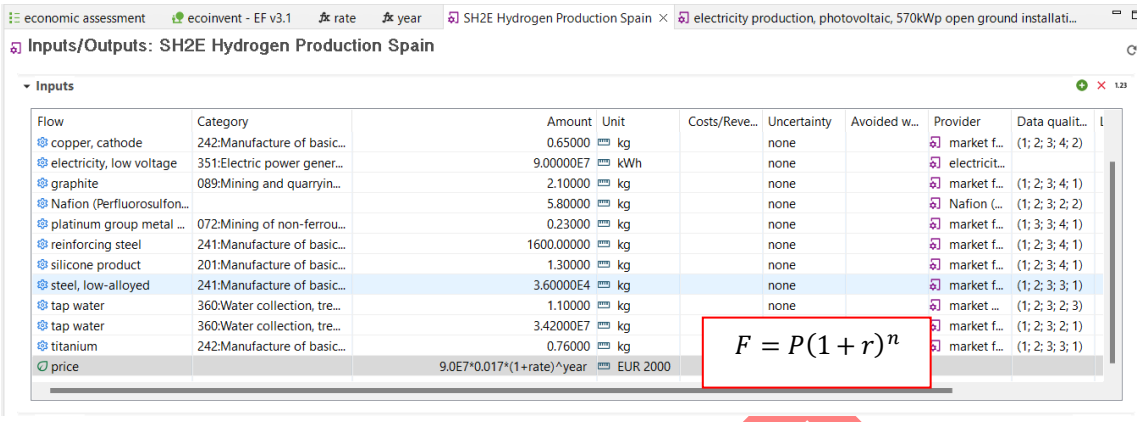
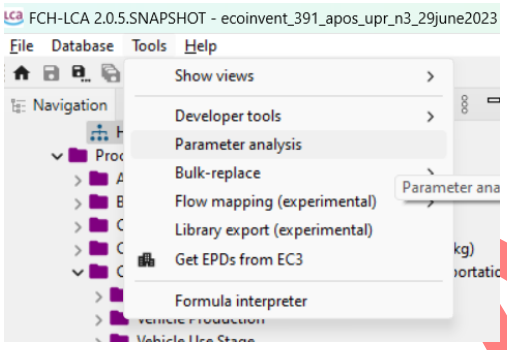
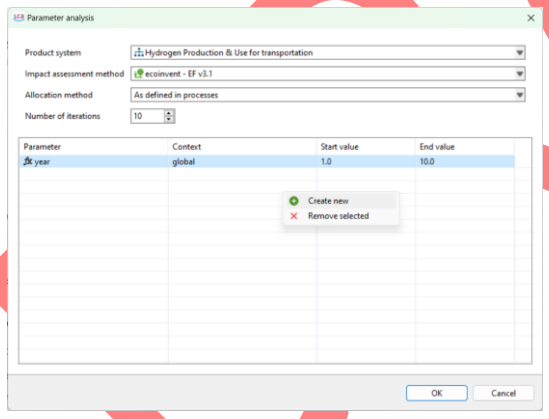


Step 6 Got to -> tools -> parameter analysis



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



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

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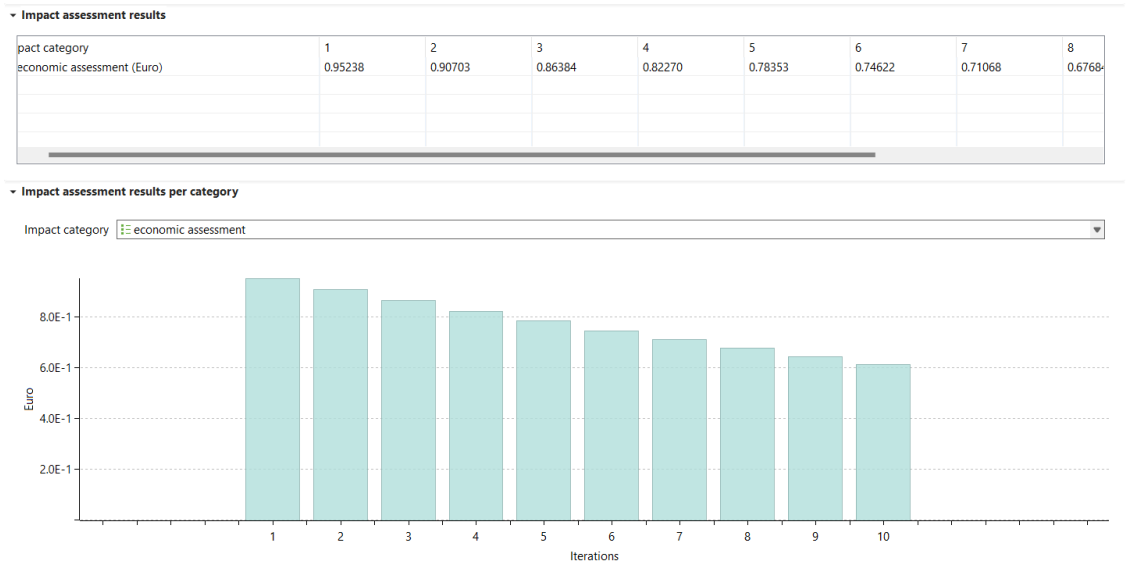

A full tutorial can be found on youtube on the openLCA channel[1]

Direct approach SLCA on openLCA

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 method[2] 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".

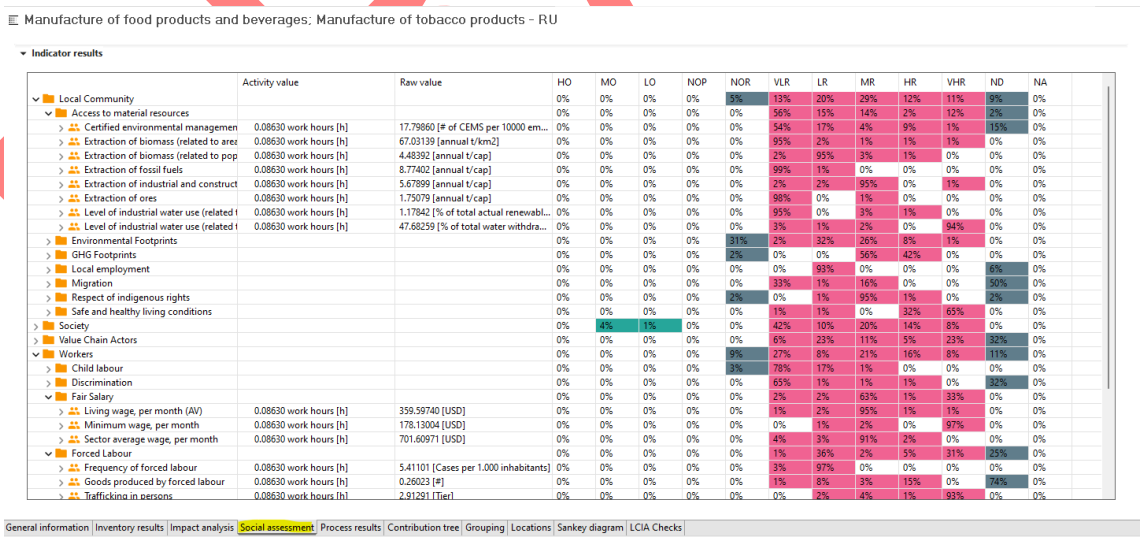

Figure 18 Direct approach method SLCA

End of document

[1] https://www.youtube.com/watch?v=ocmWcnEGUxo&t=383s&ab_channel=openLCA

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

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