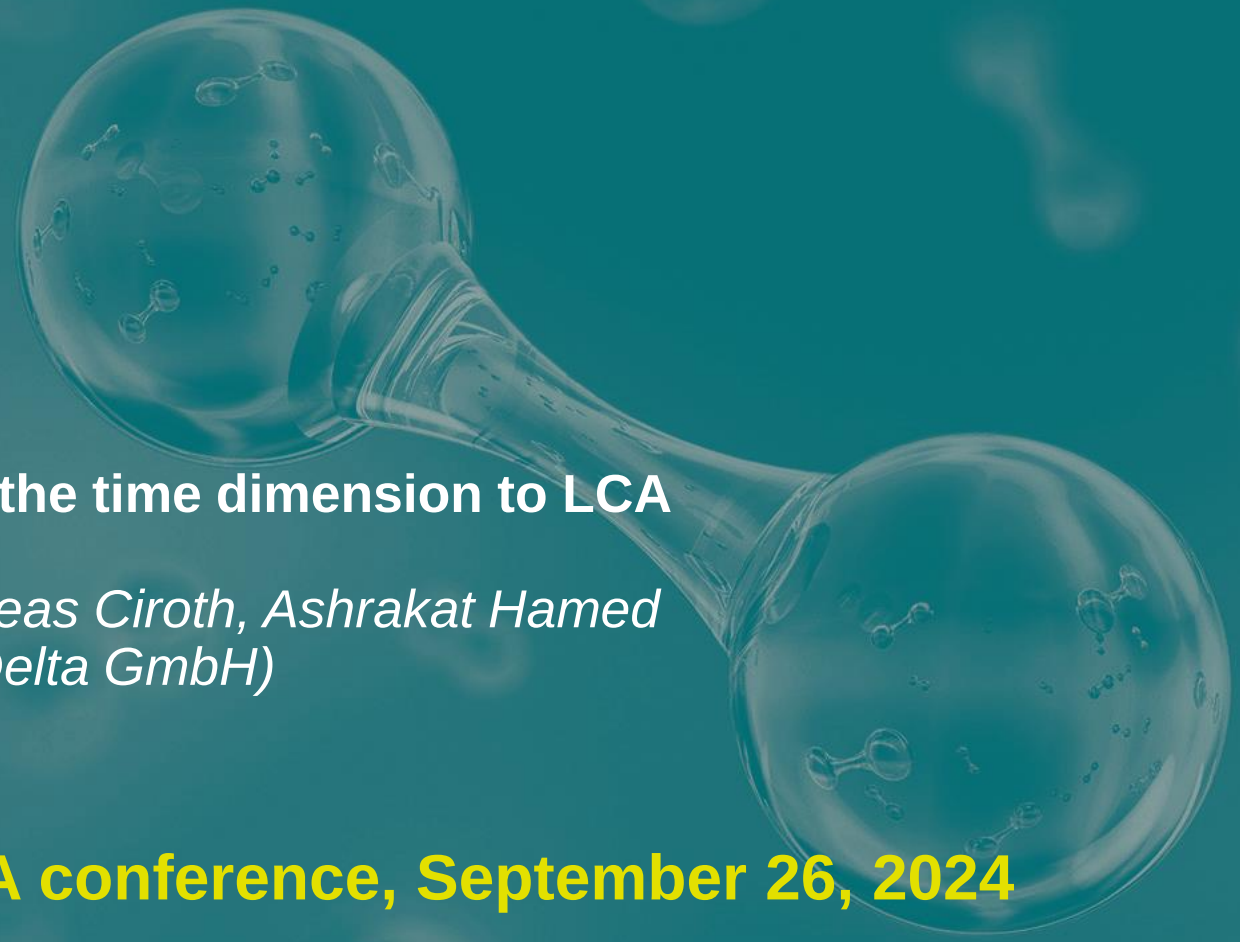
SH2E



Adding the time dimension to LCA

Dr. Andreas Ciroth, Ashrakat Hamed (GreenDelta GmbH)

ACLCA conference, September 26, 2024

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Clean Hydrogen Partnership

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Adding the time dimension to LCA

1. The SH2E Project in a nutshell
2. Modeling time in LCA, principle
3. Implementation
4. Application
5. Outlook

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SH2E

The SH2E project

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About the SH2E Project

- Call year: 2020
- Call topic: FCH-04-5-2020 — Guidelines for Life Cycle Sustainability Assessment (LCSA) of fuel cell and hydrogen systems
- Project dates: 1st Jan 2021 — 30th Jun 2024
- Total project budget: 2,142,778.75 €
- Clean Hydrogen Partnership max. contribution: 1,997,616.25 €
- Other financial contribution: 145,162.50 €

Partners

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Clean Hydrogen Partnership

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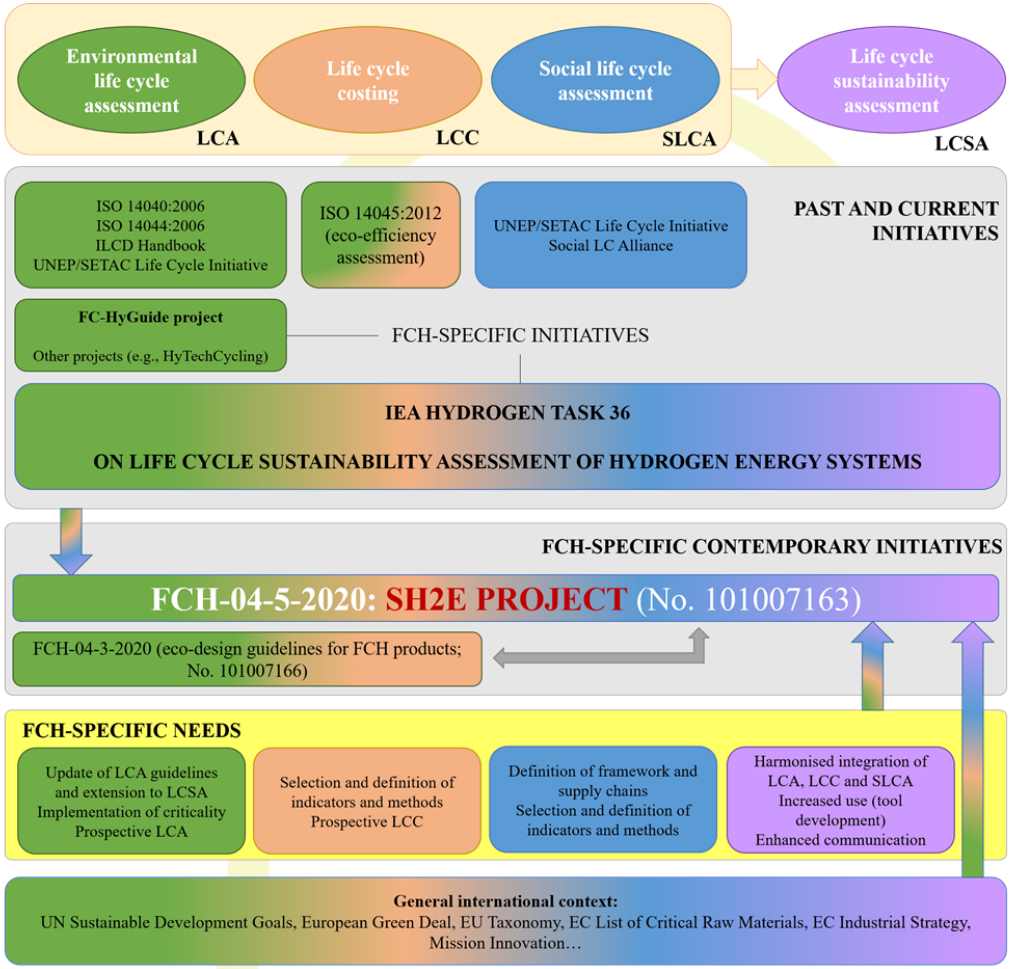
Objectives

- Provide a well-defined, validated and practical framework for LCSA of FCH systems.
- Facilitate robust decision-making processes in the field of FCH by adding sustainability criteria to the characterisation and benchmarking of FCH systems.
- Development and application of specific guidelines for the environmental, economic and social life cycle assessment of FCH systems, and their consistent integration into a sound LCSA framework.



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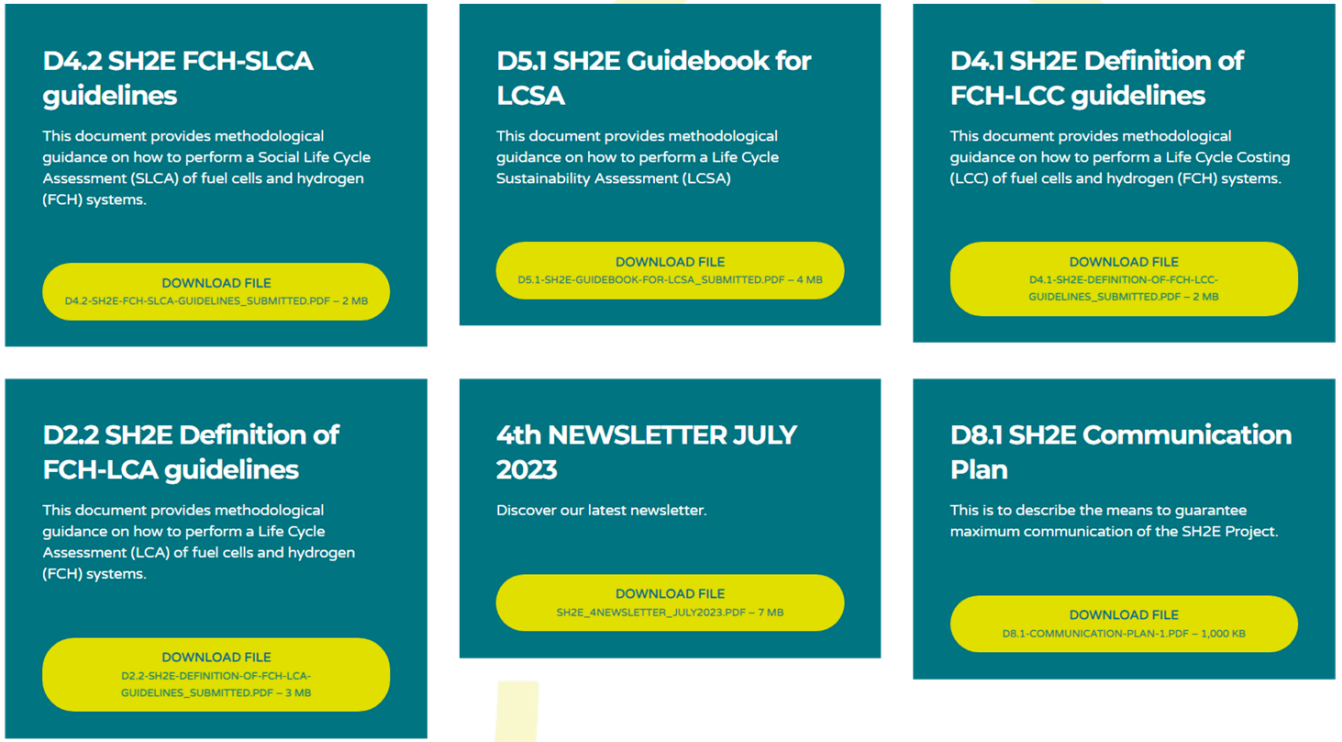
Project results

- 1 document of FCH-LCA guidelines
- 1 material criticality indicator
- 1 document of FCH-LCC guidelines
- 1 document of FCH-SLCA guidelines
- 1 document of FCH-LCSA guidelines
- **1 integrated FCH-LCA/LCC/SLCA/LCSA software tool**

You can download a draft of the guidelines. Go to: https://sh2e.eu/downloads/



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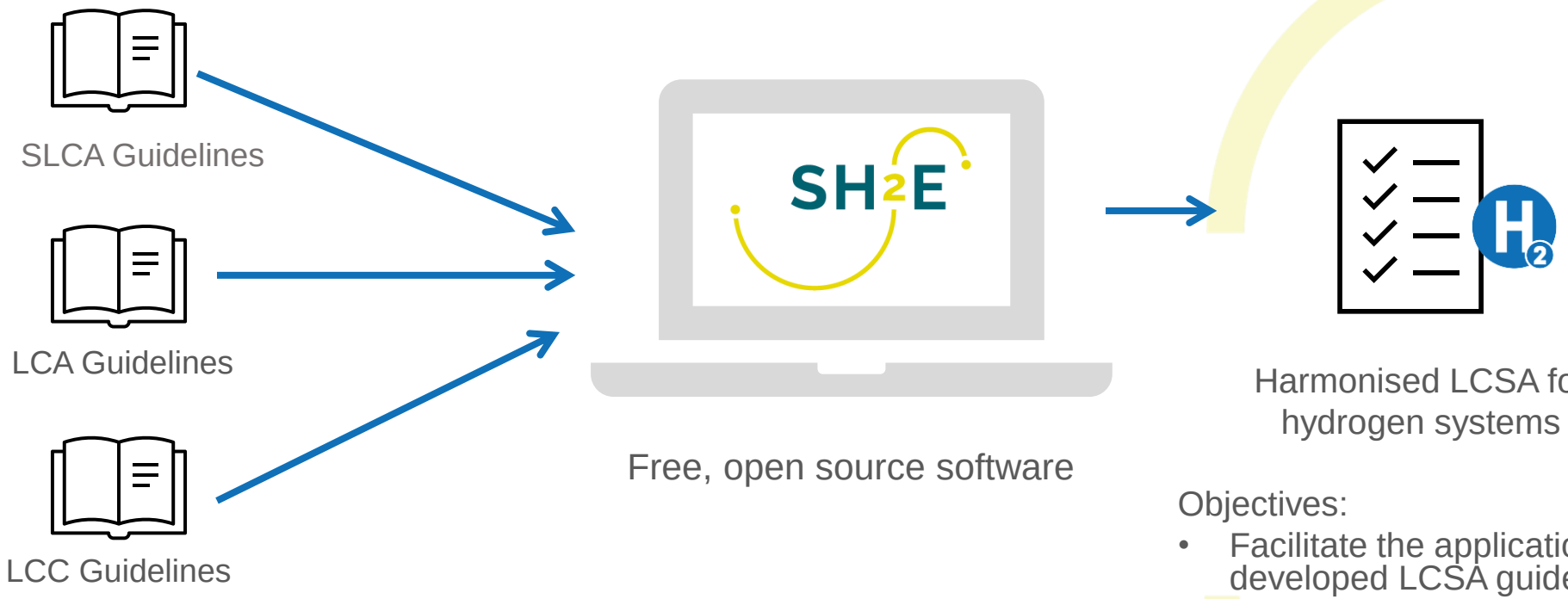
The FCH-LCA tool



Objectives:

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

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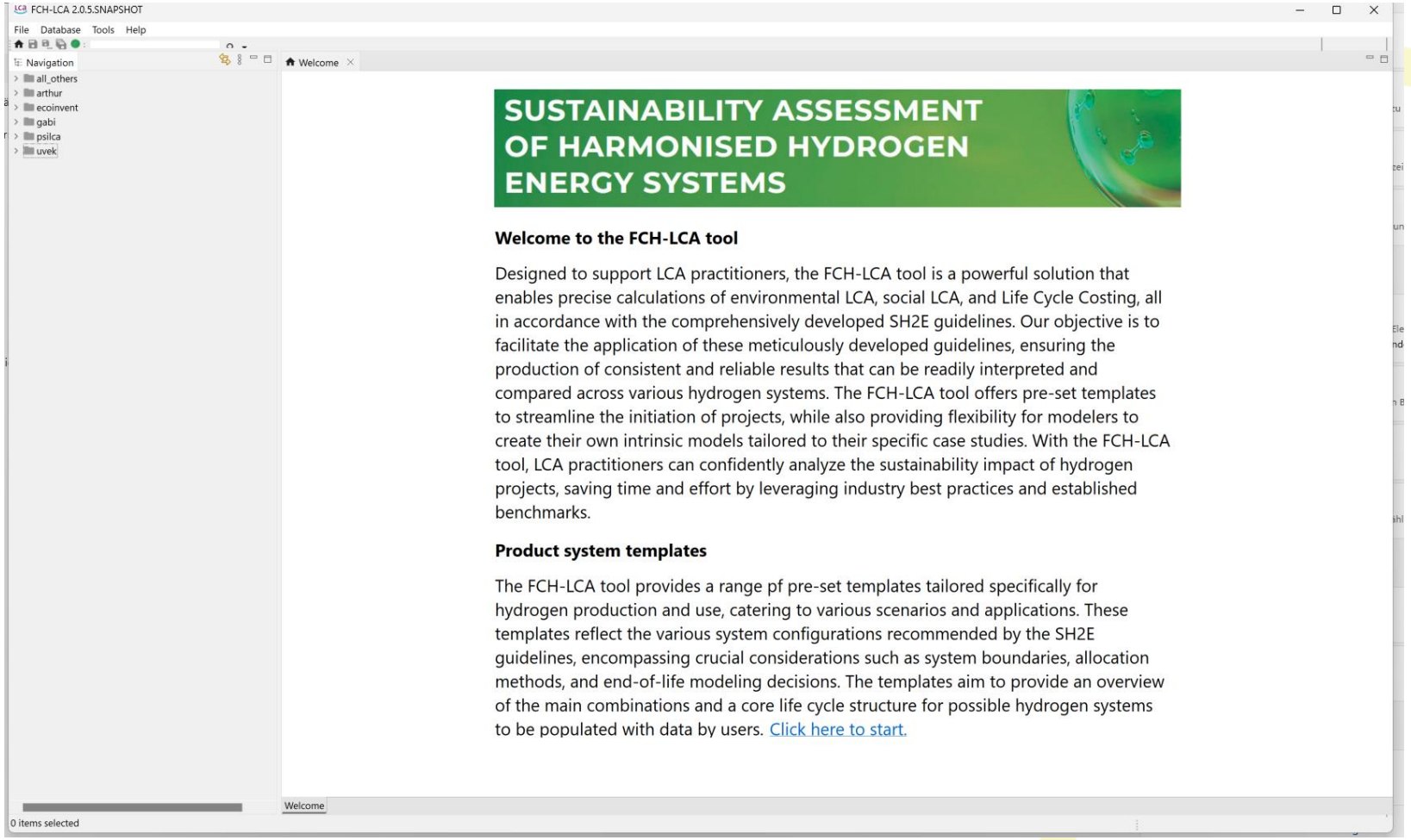
the FCH-LCA tool, screenshot



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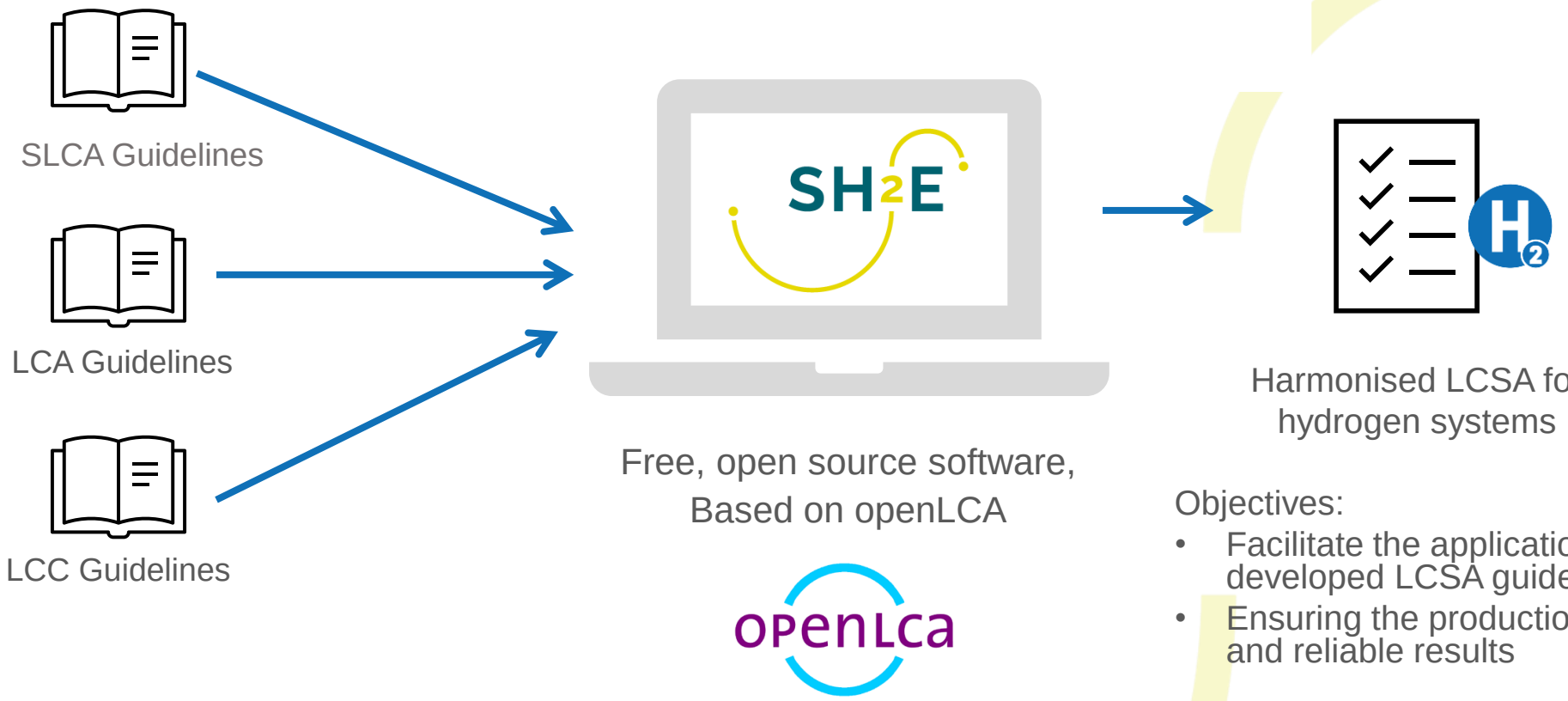
the FCH-LCA tool based on openLCA



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SH2E

Modeling time in LCA

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Time in Life Cycle Assessments

- LCA agnostic to time
- Real life systems obviously change over time
  - Technologies evolve
  - Wheather conditions etc. change (-> agriculture, impacts caused)
  - Background conditions change (electricity mixes 1990 and 2024..)
- Some life cycles stretch over a longer time period, e.g. investment goods with maintenance periods, refurbishment, ..
- Impacts and benefits probably are of different importance when happening now or in a far future e.g. (-> discounting)

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Time in Life Cycle Assessments

- So what would it take to bring time into LCA models?

Full fledged time implementation:

-> start time of processes

-> duration of processes

-> modifications of processes over time, learning curves, change of input product suppliers

-> different „reception“ of impacts (-> discounting, …)

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- Real life systems obviously change over time
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Time in Life Cycle Assessments

- So what would it take to bring time into LCA models?

-> know how and data

-> methodology

-> tool implementation

Full fledged time implementation:

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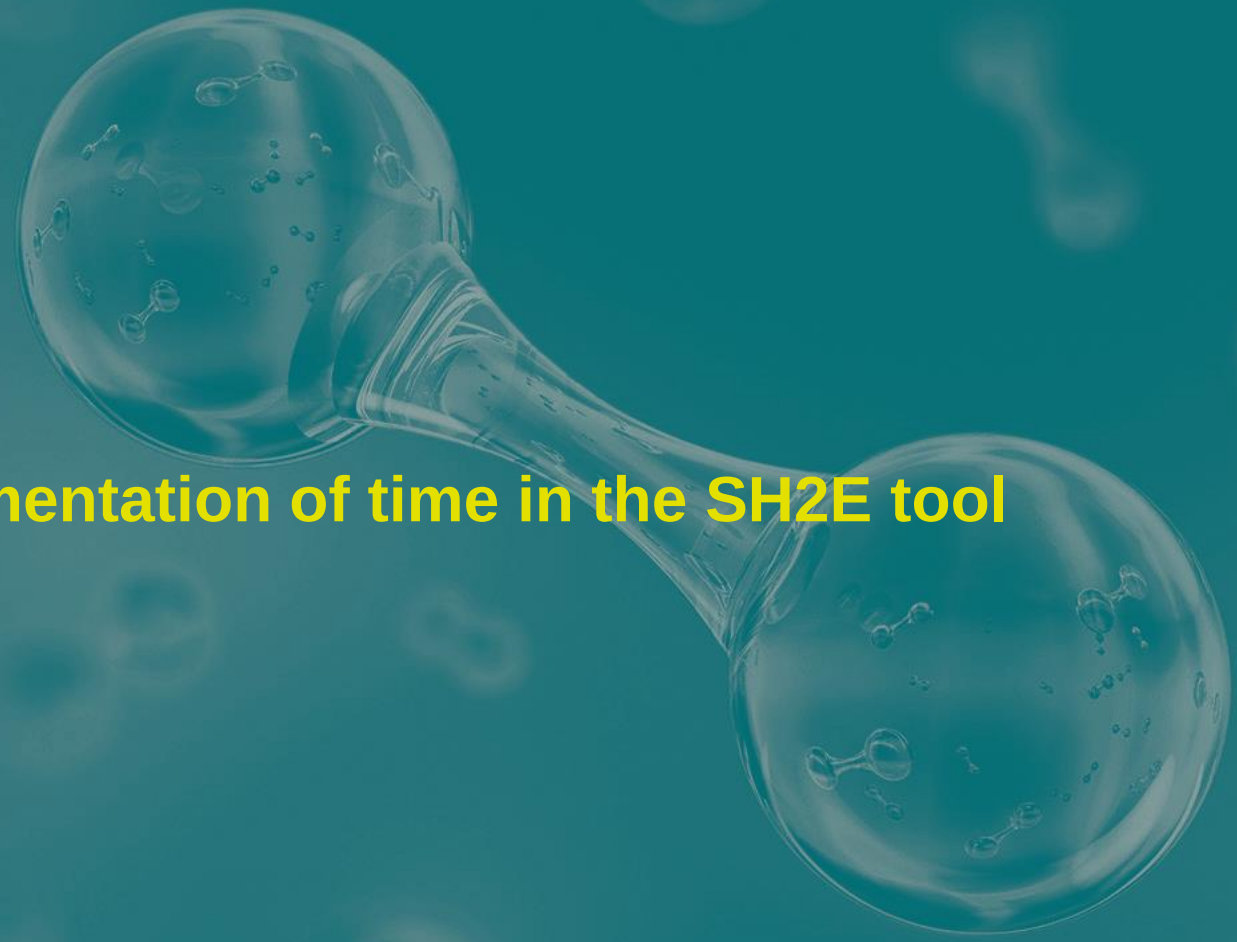
SH2E



Implementation of time in the SH2E tool

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Implementation of time in the SH2E tool

1. Parameters can be selected and a time, and calculation steps can be specified;
2. Parameters can be defined for

- Processes (inputs, outputs, providers)
- Product systems
- LCIA methods
- Global, across (potentially) everything

3. In the calculation, the parameters are then assessed for each calculation step.

Full fledged time implementation:

-> start time of processes

-> duration of processes

-> modifications of processes over time, learning curves, change of input product suppliers

-> different „reception“ of impacts (-> discounting, …)

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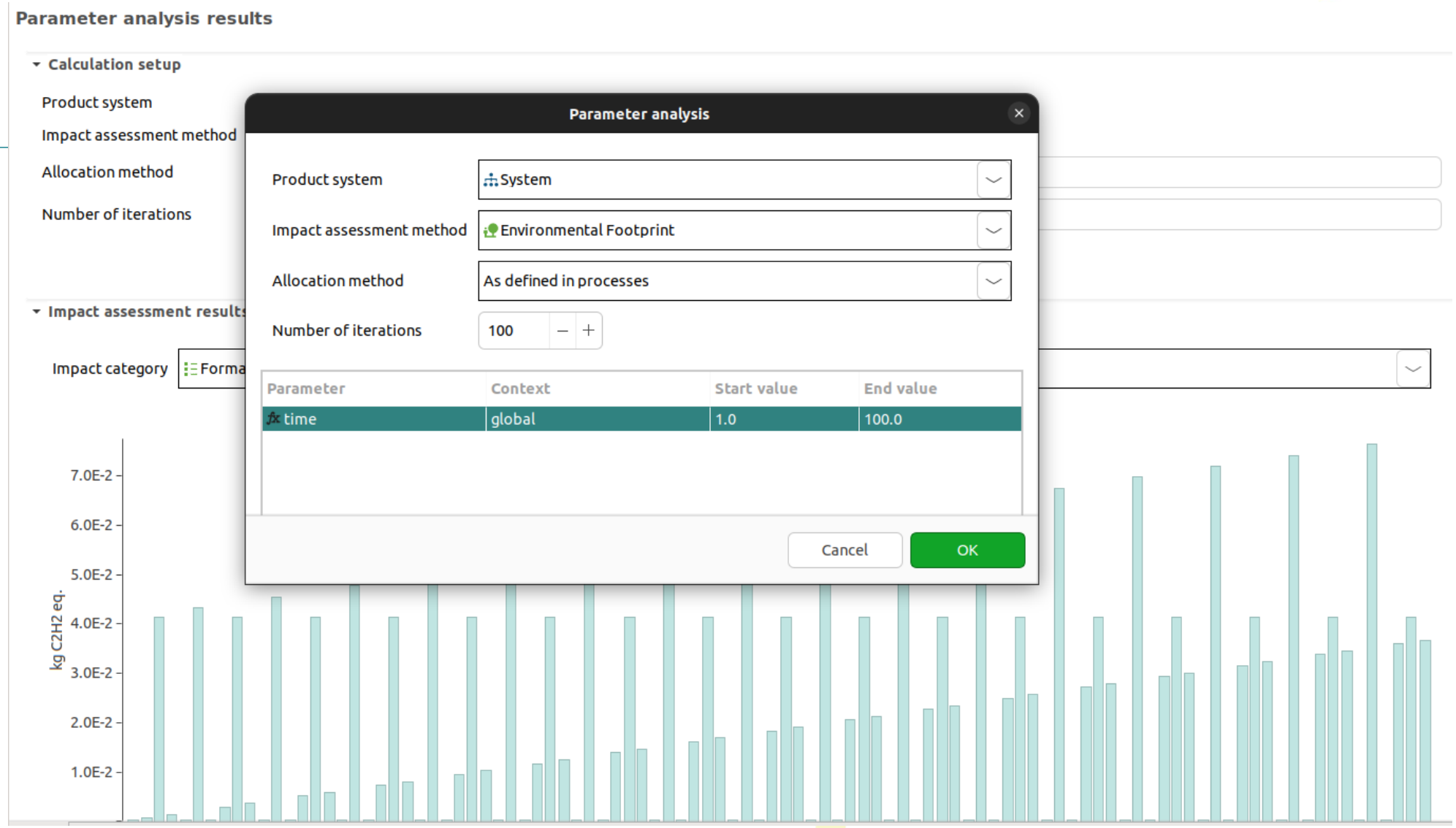
e.g., global parameter time in a product system,
100 iterations



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A more complete example: Evaluating time dependent equations, Discounting

Common in “conventional” LCC: discounting ~ depreciation of future money flows, because of a) inflation, b) missed opportunities for later-arriving money flows, risks and insecurities

Formula:

$$P = F\left[\frac{1}{(1+r)^n}\right]$$

P: present-day cost or value,

F: cost or value at a future date, n periods from the present; the sum is equivalent to P with compound interest at r (discount rate) over n periods,

r: value representing a specific change over time periods; discount rate per period of time, sum of inflation, risk, other aspects

n: number of discount periods, mostly expressed in years,

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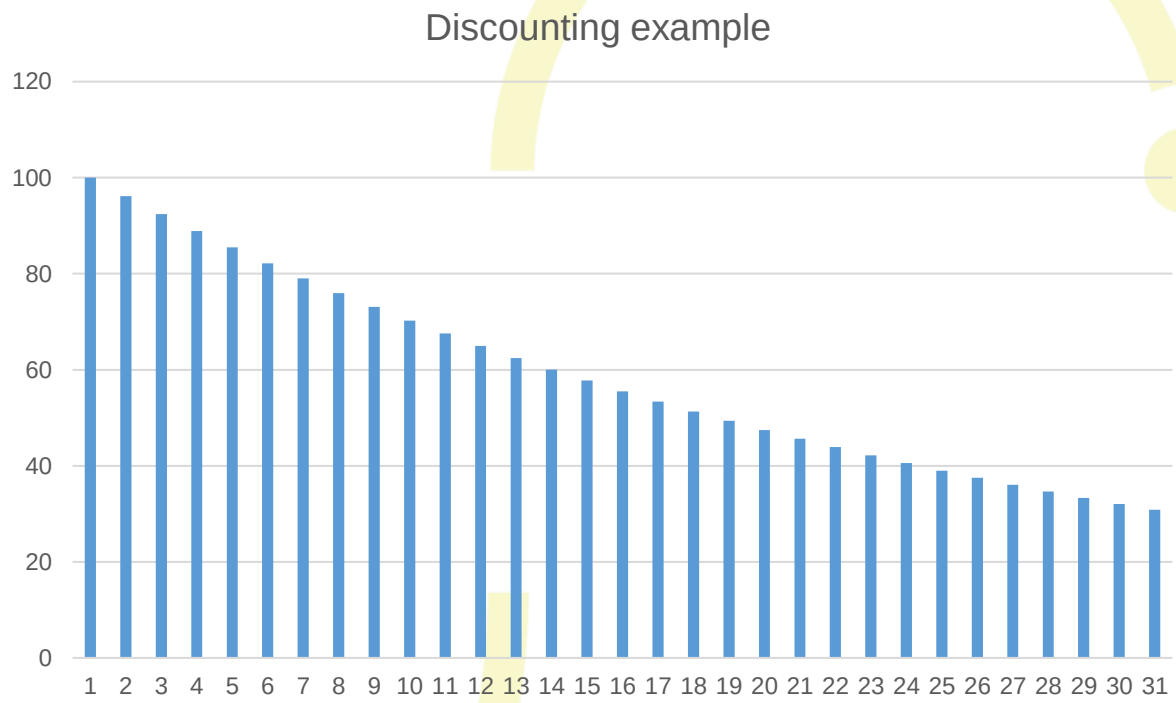
A more complete example: Evaluating time dependent equations, Discounting

amount	1+r	n	discounted ar
100	1.04	0	100
100	1.04	1	96.1538462
100	1.04	2	92.4556213
100	1.04	3	88.8996359
100	1.04	4	85.4804191
100	1.04	5	82.1927107
100	1.04	6	79.0314526
100	1.04	7	75.9917813
100	1.04	8	73.0690205
100	1.04	9	70.2586736
100	1.04	10	67.5564169
100	1.04	11	64.9580932
100	1.04	12	62.459705
100	1.04	13	60.0574086
100	1.04	14	57.7475083
100	1.04	15	55.5264503
100	1.04	16	53.3908176
100	1.04	17	51.3373246
100	1.04	18	49.3628121
100	1.04	19	47.4642424
100	1.04	20	45.6386946
100	1.04	21	43.8833602
100	1.04	22	42.1955387
100	1.04	23	40.5726333
100	1.04	24	39.0121474
100	1.04	25	37.5116802
100	1.04	26	36.0689233
100	1.04	27	34.681657
100	1.04	28	33.3477471
100	1.04	29	32.0651415
100	1.04	30	30.8318668

$$P = F\left[\frac{1}{(1+r)^n}\right]$$



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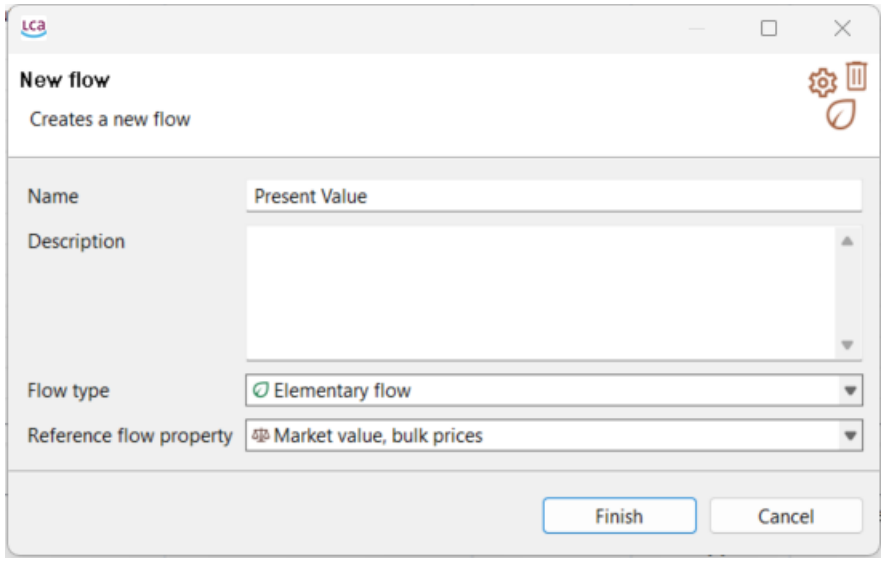
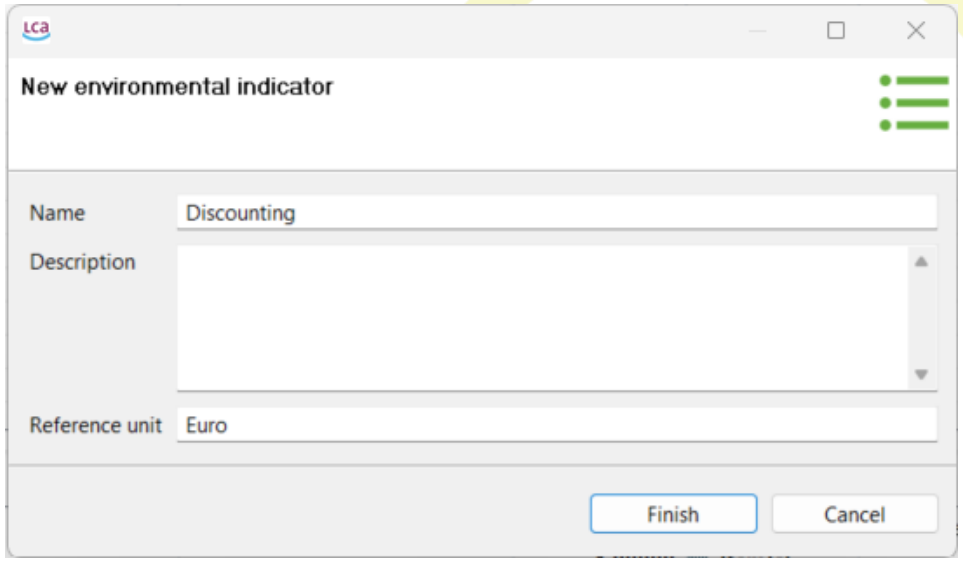
Steps on using time-variable

Create a new elementary flow



Create a new impact category



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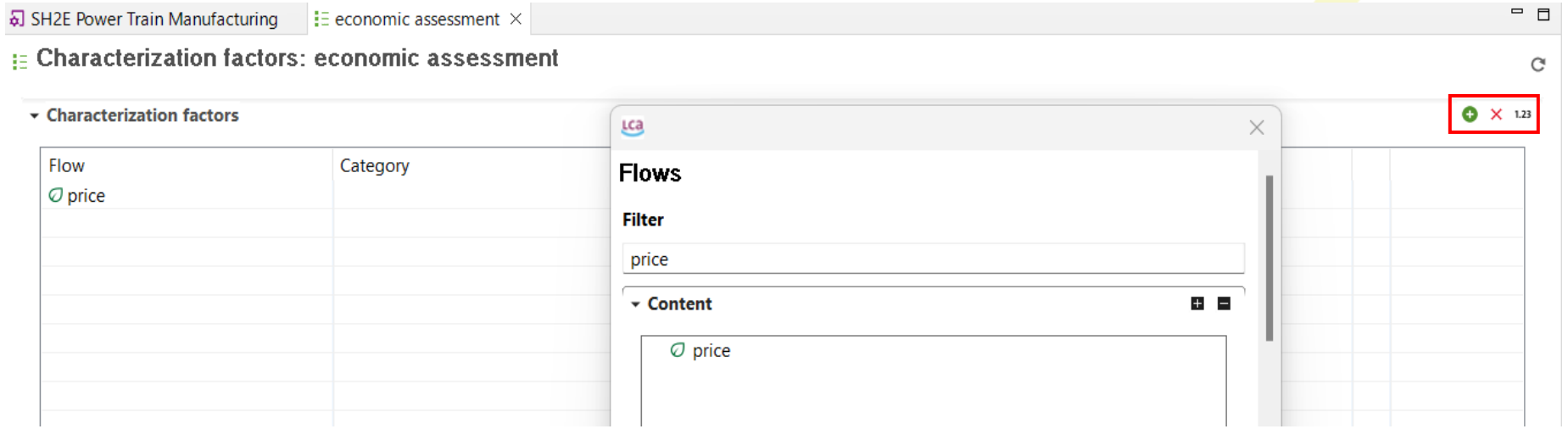
Steps on using time-variable

Add the newly created flow into the new impact category



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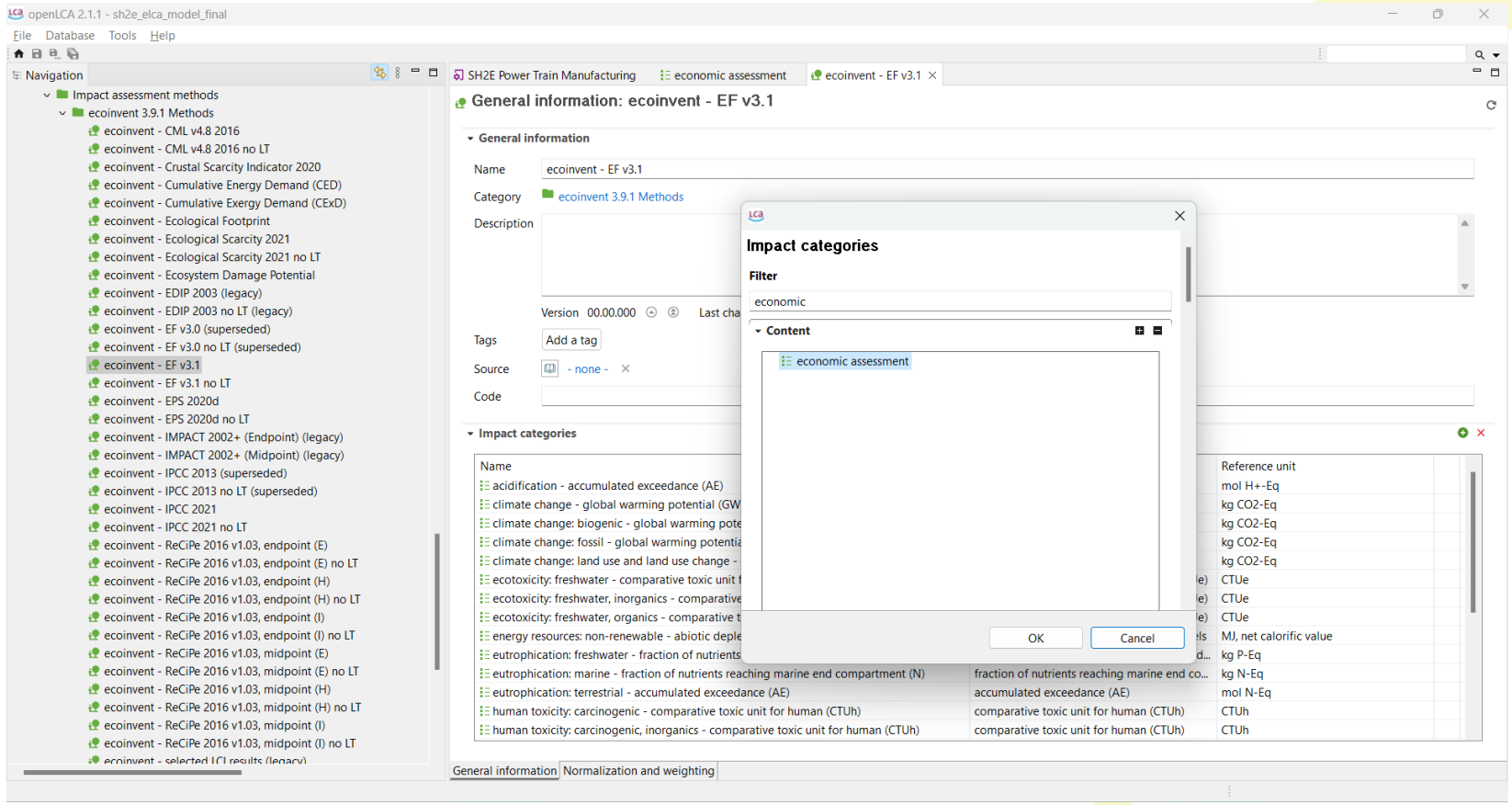
Steps on using time-variable

Create a new method/add the created category in an existing method



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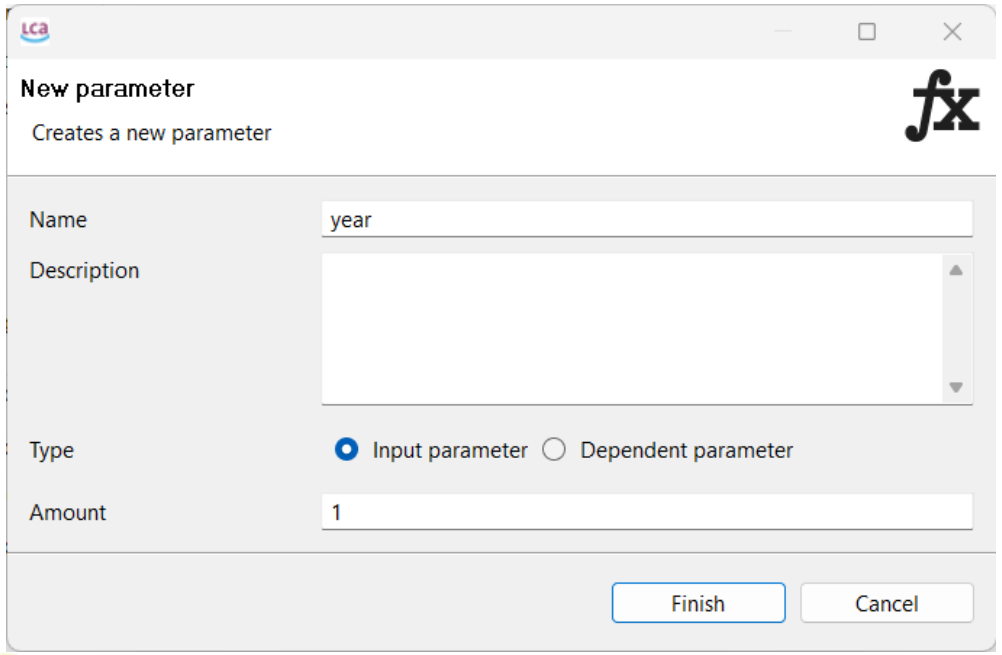
Steps on using time-variable

Create a new global parameter



Users then select input parameter option and insert the value

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Steps on using time-variable

Set up the equation in the selected process

economic assessment | ecoinvent - EF v3.1 | rate | year | SH2E Hydrogen Production Spain | electricity production, photovoltaic, 570kWp open ground installati...

Inputs/Outputs: SH2E Hydrogen Production Spain

Inputs

Flow	Category	Amount	Unit	Costs/Reve...	Uncertainty	Avoided w...	Provider	Data qualit...
copper, cathode	242:Manufacture of basic...	0.65000	kg		none		market f...	(1; 2; 3; 4; 2)
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		none		market f...	(1; 2; 3; 2; 1)
titanium	242:Manufacture of basic...	0.76000	kg		none		market f...	(1; 2; 3; 3; 1)
price		9.0E7*0.017*(1+rate)^year	EUR 2000		none			

$$F = P(1 + r)^n$$

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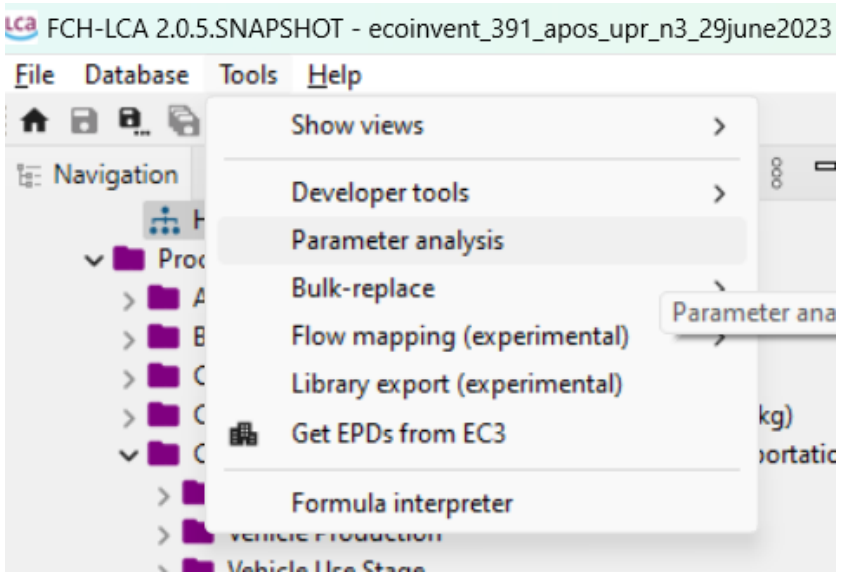
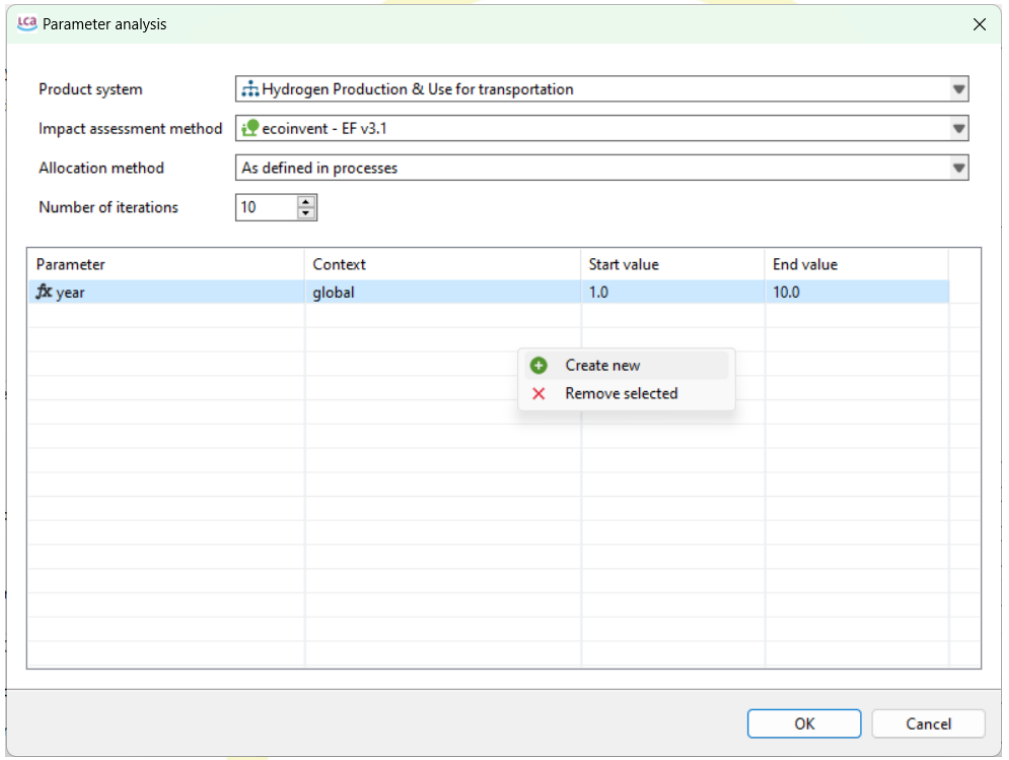
Steps on using time-vale

Go to -> tools -> parameter analysis



Add the parameter and adjust end value (10 years)



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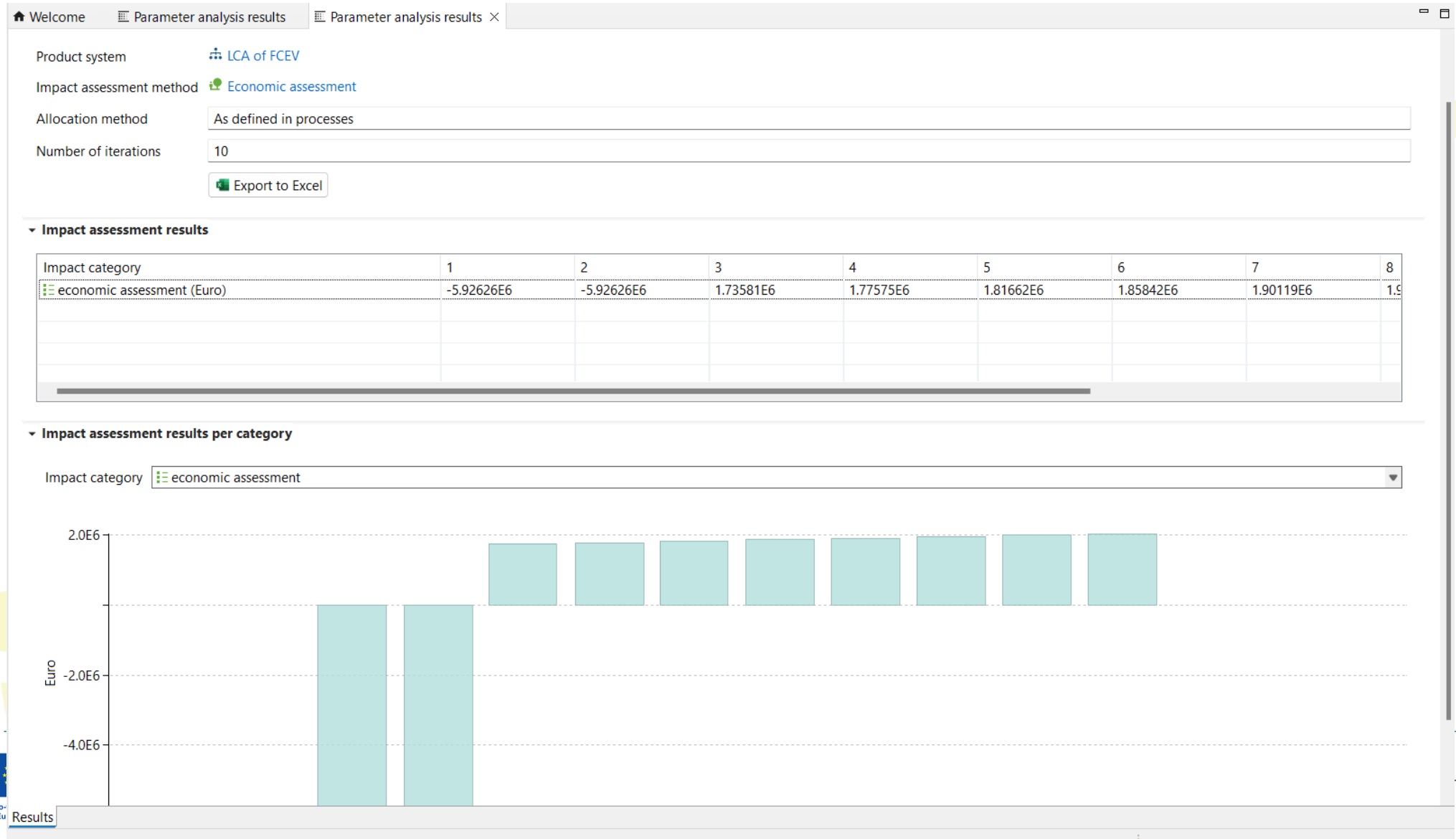
Results; net costs of installation of a hydrogen production plant, with discounting



upport from the

A note on formulas

Formulas can be complicated and e.g also contain if-clauses: If year < 3 then no sales, plant is still constructed.

This allows to address events in the life cycle, and other changes.

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Conclusions

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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. One of the features is to allow time-modeling in LCA and LCSA
- We hope this is useful for the community. Feedback welcome.
- The SH2E tool is available here for download: https://share.greendelta.com/index.php/s/R3uc0nuziZt6cGV/download, the git repository is here: https://github.com/GreenDelta/sh2e-tool
- Next step for us: bringing the time modeling into openLCA; working on know-how, data, methodology for the time dimension in LCA
- Alignment with other developments in this field (premise, Brightway)

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SH2E

SUSTAINABILITY ASSESSMENT OF HARMONISED HYDROGEN ENERGY SYSTEMS

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GreenDelta, Berlin

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ashrakat@greendelta.com

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