



S I N G L E

Application of the LCA and RED III methodology to assess GHG emissions in the SINGLE ammonia value chain

HIGHLIGHTS

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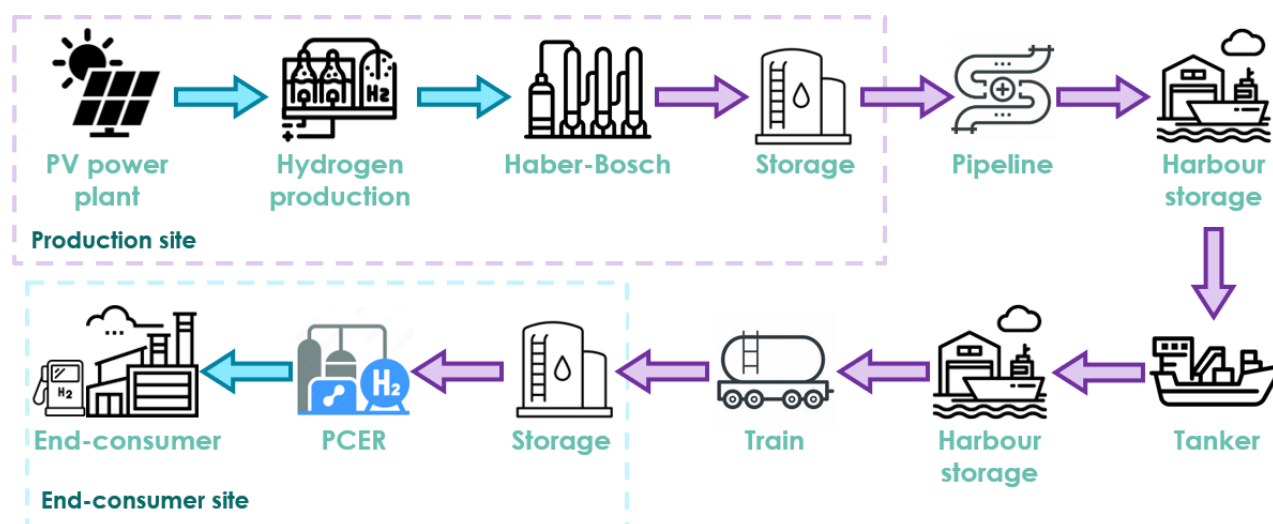


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SINGLE case study

The EU-funded SINGLE project focuses on the proton-ceramic-electron reactor for cracking the ammonia back into hydrogen and researches an alternative hydrogen transport via the ammonia value chain. Since we need low-carbon hydrogen if we want a successful energy transition, the ammonia value chain needs to be assessed from an environmental perspective. Two different methods can be used for the environmental assessment: The Life Cycle Assessment methodology and the Renewable Energy Directive III methodology.

In the workshop the application of two different methodologies for greenhouse gas emissions is presented and demonstrated for the ammonia value chain defined in the SINGLE project: (i) the Life Cycle Assessment (LCA) methodology and (ii) the Renewable Energy Directive (RED III) methodology.



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Life Cycle Assessment methodology

The life cycle assessment (LCA) methodology is a method standardized by the ISO standards ISO 14040 and ISO 14044 for assessing the environmental impacts in the life cycle phases of products or processes. The LCA methodology is scientifically recognized as a suitable methodology for assessing environmental impacts, as evidenced by the large number of scientific publications that include the LCA methodology in various research areas. The EU has also recognized the value of the LCA methodology, as practically every EU project must include an environmental assessment using the LCA methodology.

The LCA methodology consists of 4 steps:

- Goal and scope definition
- Life Cycle Inventory definition
- Life Cycle Impact Assessment
- Interpretation of the results

The scope of the LCA methodology extends from the cradle to the grave but can also be limited and still comply with ISO standards if it is presented transparently. In addition, the system boundaries, allocation and assumptions are arbitrary and must be stated transparently.

The LCA methodology comprises several Life Cycle Impact Assessment (LCIA) methods, each of which defines a large number of environmental indicators. The LCA methodology enables the selection of the LCIA method used in the study and the environmental indicators within the method. Therefore, the LCA study can focus only on specific environmental aspects or on a broader general set of environmental impacts.

RED III methodology

The EU Renewable Energy Directive III (RED III) is an important legislative framework to advance the European Union's renewable energy targets as part of the European Green Deal and the Fit for 55 package. Adopted in 2023, RED III sets a binding target of 42.5% for renewable energy by 2030, with ambitious sub-targets for the use of renewable hydrogen in industry (42% by 2030) and transport (1% by 2030).

For hydrogen to be considered renewable and count towards national targets, it must comply with the rules for renewable fuels of non-biological origin (RFNBO), which include the following:

- Renewable Electricity Link – RFNBOs must be generated with electricity from renewable sources, which must be proven by a direct connection or contracts.
- Additionality – New renewable energy capacity must be added specifically to support RFNBOs production.
- Temporal correlation – until December 31, 2029, RFNBO generation must match electricity generation from renewables on a monthly basis. Thereafter, it must be matched on an hourly basis.
- Reduction of greenhouse gas emissions – RFNBOs should demonstrate greenhouse gas emission savings of at least 70% compared to fossil fuels. For hydrogen, the threshold is 28.2 g CO₂ eq. / MJ or 3.4 kg CO₂ eq. / kg H₂.

The methodology for determining GHG emission reductions is set out in EU delegated act (2023/1185). In short, the methodology introduces a “simplified” lifecycle analysis of the hydrogen value chain. The analysis scope shall include the emissions related to energy use in the production process, conditioning, and transportation of RFNBOs, including the emissions occurring at the end of customer's use of hydrogen.

The most important simplifications compared to the standardised LCA methodology are:

- The upstream emissions for energy refer only to the supply of fuels (i.e. extraction, refining and transport).
- Emissions from the manufacture of machinery and equipment are not considered.
- The use of renewable energy sources is considered emission-free.

Table 1: Comparison of LCA and RED III methodology



	LCA methodology	RED III methodology
Standard/directive	ISO 14040 and ISO 14044	Commission Delegated Regulation (EU) 2023/1185
Scope	From cradle to grave (depends on the study)	Limited “well to wheel”
Environmental indicators	Wide range of environmental indicators	Focused only on the carbon footprint (CO₂ eq.)
Application	Any product or process	Only applicable to RFNBOs

Comparison of LCA and RED III methodologies in the SINGLE value chain

In the SINGLE value chain, the LCA methodology has been aligned as closely as possible with the RED III methodology. Therefore, the scope, system boundaries, allocation, and assumptions of the study are the same. We have also only assessed the climate change indicator within the LCA methodology. However, due to the different emission factors used in the two methodologies, we obtain different results. In the RED III methodology, the renewables have an emission factor of zero, while in the LCA methodology the emissions from the production of RES systems in the upstream value chain are included (see Table 2).

Table 2: Inclusion of emissions in the assessment of the carbon footprint

	General LCA	SINGLE LCA	RED III
Direct emissions from energy use in the production, processing, and transportation of H ₂	✓	✓	✓
Production of devices and machines within the value chain (e.g., electrolyser, storages...)	✓	✗	✗
Emissions from combustion of fossil fuels	✓	✓	✓
Upstream emissions associated with energy use			
• extraction, refining and transport of fossils fuels	✓	✓	✓
• production of upstream equipment for fossil fuels (drilling rig, PV panel, etc)	✓	✓	✗
• production of renewable energy sources plants	✓	✓	✗

