Sustainability assessment of CO_2 valorisation routes for Latvia

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RIGA TECHNICAL UNIVERSITY
Institute of Energy Systems and Environment

The main research directions of the Institute

- INCREASING ENERGY EFFICIENCY OF ENERGY END-USER
- PRODUCTION AND USE OF RENEWABLE ENERGY RESOURCES AND RELATED ENVIRONMENTAL ASPECTS
- FUEL COMBUSTION TECHNOLOGIES
- CLIMATE TECHNOLOGY SOLUTIONS
- ECO-DESIGN AND LIFE CYCLE ASSESSMENT
- SOCIO-ECONOMIC ASPECTS OF ENERGY PLANNING AND UN ENERGY SUPPLY

Projects


Life


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European Commission
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Interreg
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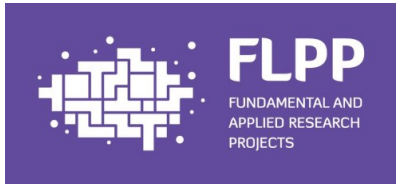
ENERGY TRANSITION
CommitClimate


FLPP
FUNDAMENTAL AND
APPLIED RESEARCH
PROJECTS


ENERGY TRANSITION
Energy Equilibrium


L V A F
Latvijas
vides
aizsardzības
fonds


Circular
Bio-based
Europe
Joint Undertaking


Bio-based Industries
Consortium


Co-funded by
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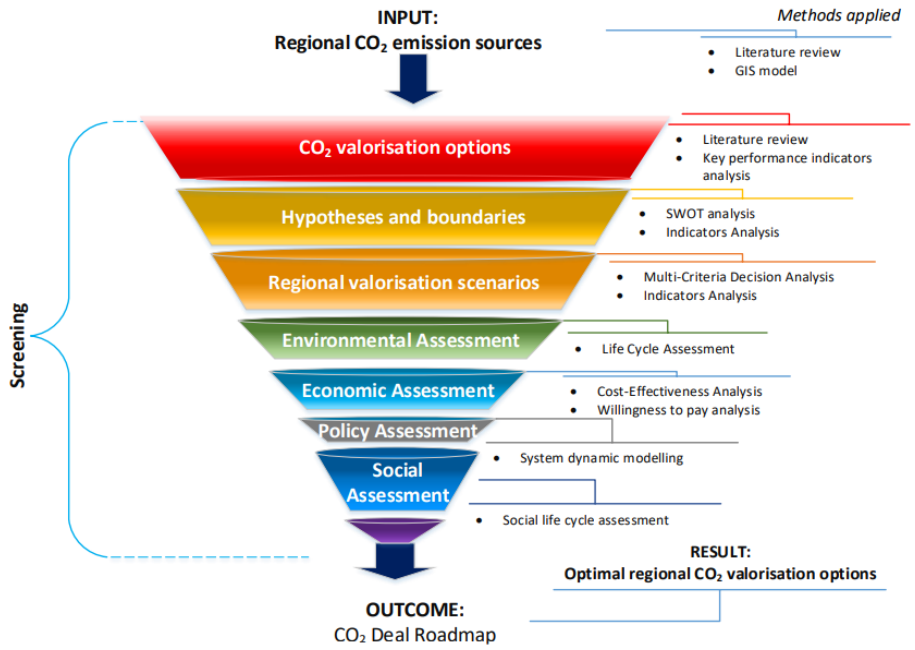
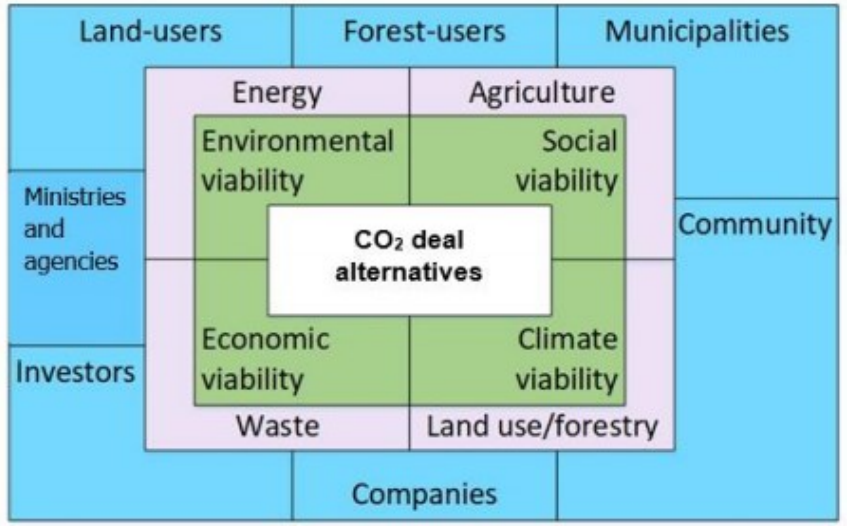
CO_2 Deal project

Project objective:

Develop a roadmap for decision-makers on the effective valorisation of CO_2 in regions of Latvia in an environmentally sound, resilient and business based manner in connection with low-carbon circular economy principles.

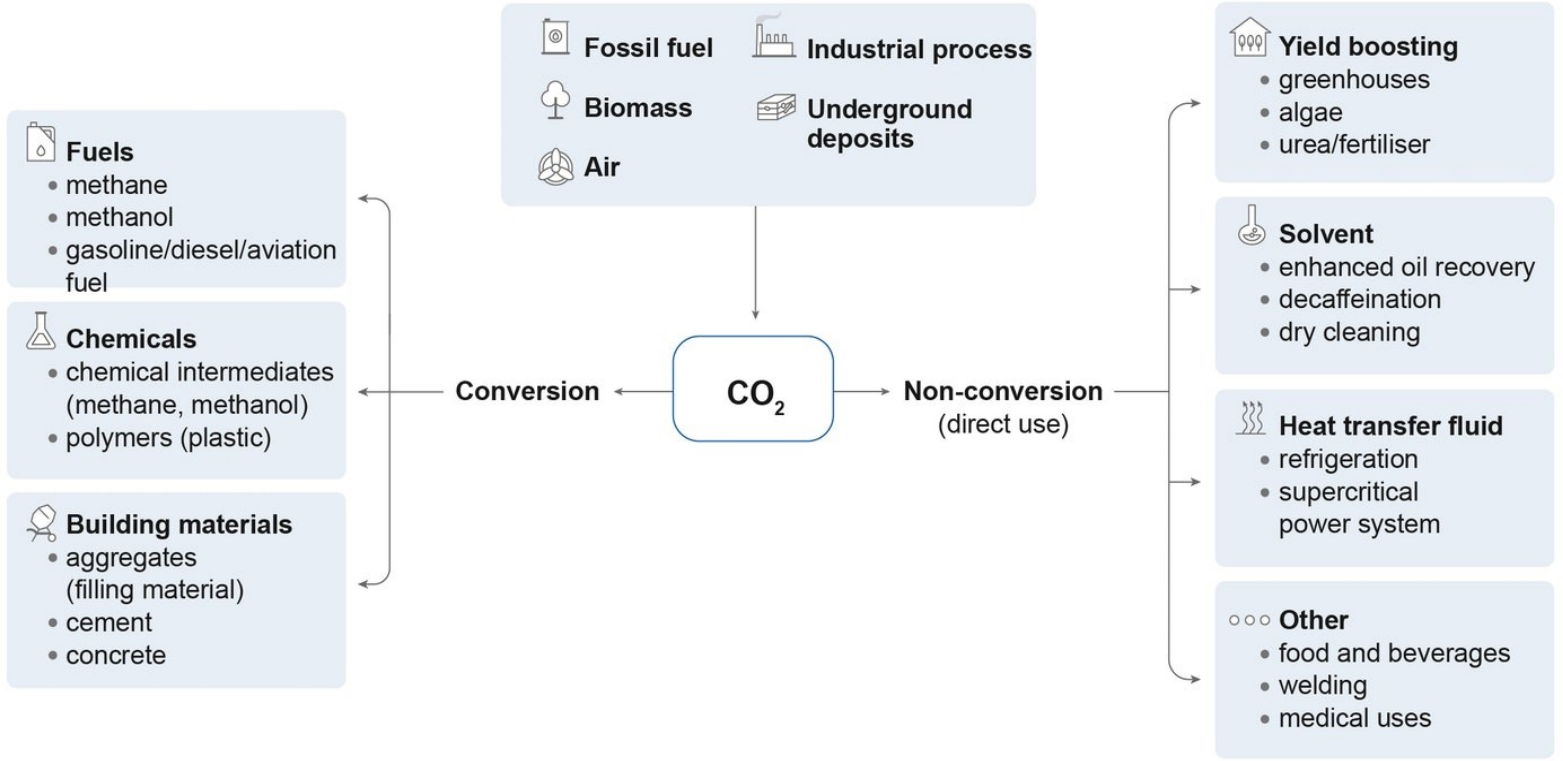




CO_2 valorisation

Any process providing a positive effect on the reduction of CO_2 emission levels in the atmosphere:

- Direct CO_2 capture and utilisation using CO_2 as a feedstock for industrial processes;
- Transformed CO_2 utilisation;
- Pre-process CO_2 utilisation, reduction of potential emissions prior to its generation.



IEA 2019

Pre-process CO_2 utilisation, reduction of potential emissions prior to its generation

Forestry

CO_2 Storage in Logging Residue Products with Analysis of Energy Production Scenarios

Agriculture

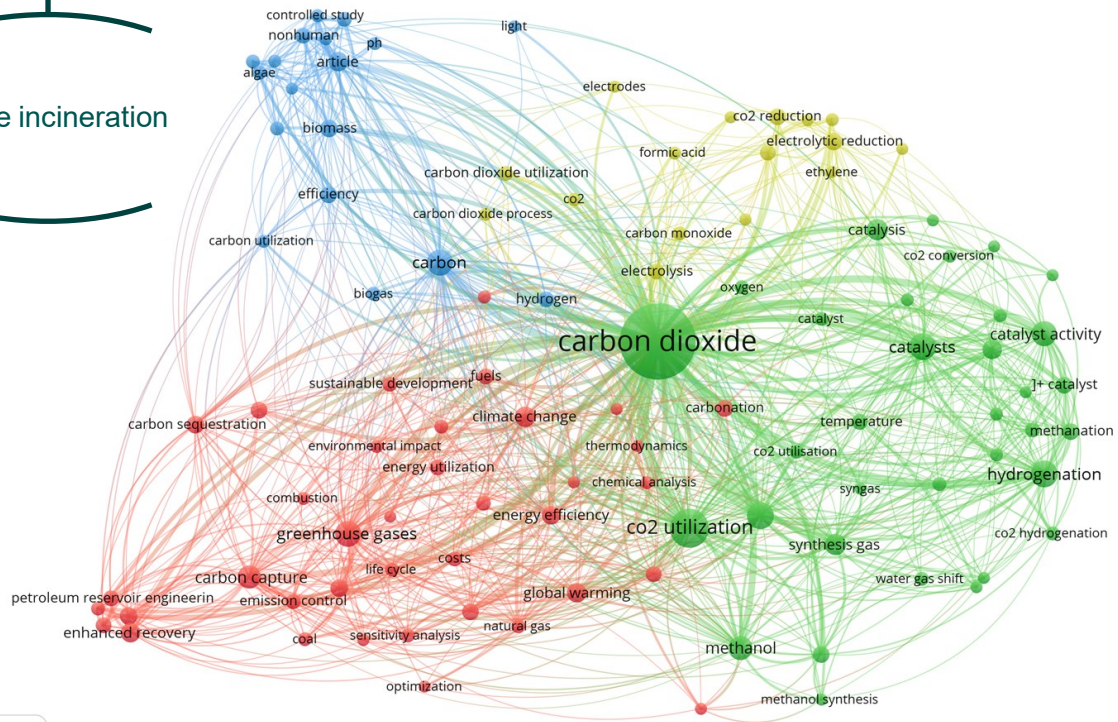
Common Agriculture Policy: analysis of Measures and Identification of the blind spots

Development and assessment of carbon farming solutions

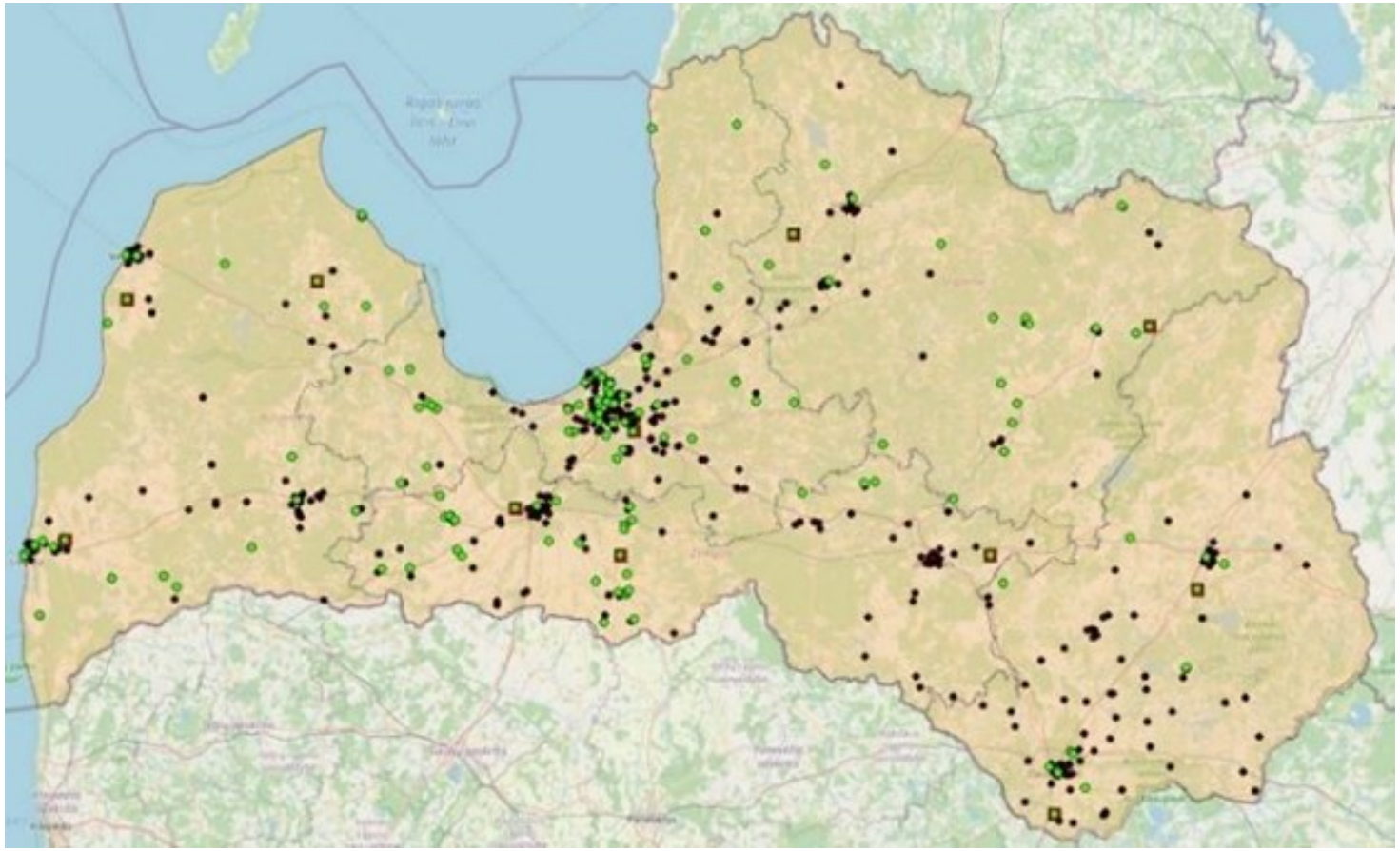
Towards climate neutrality via sustainable agriculture in soil management

Waste management

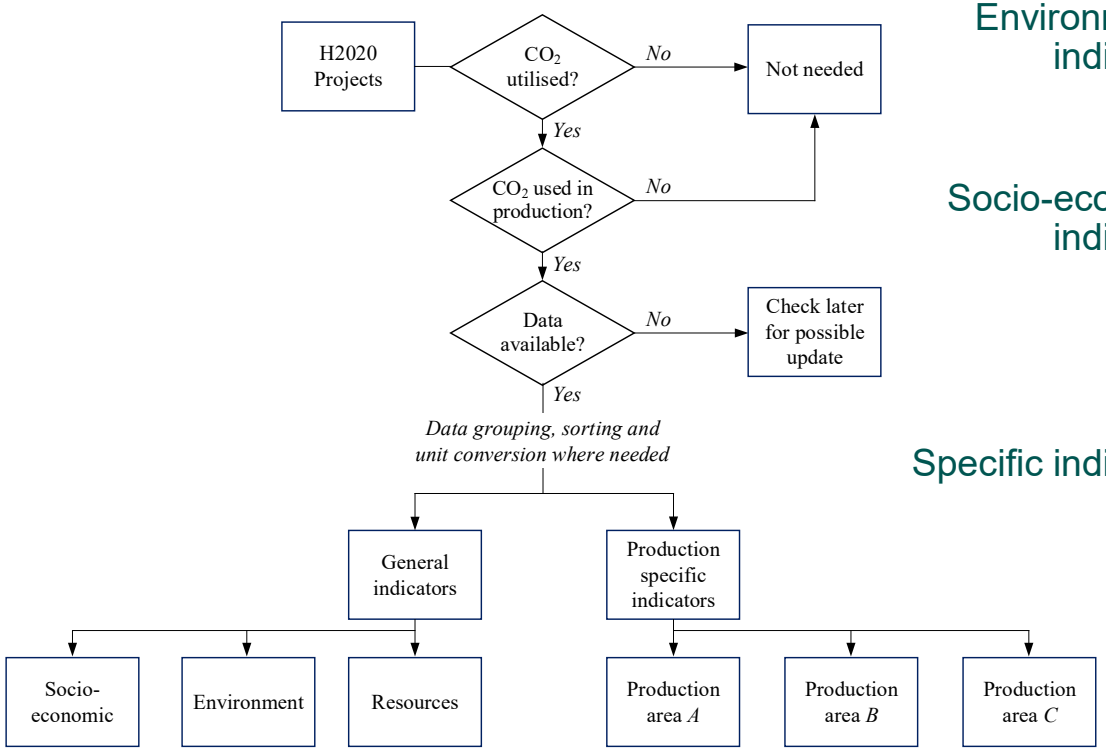
Waste incineration



Mapping of CO_2 emissions sources in Latvian regions



CO_2 utilisation: definition of KPI



Technical indicators (use of resources)

- Electric energy per 1t product
- Energy required for pre-treatment
- Water consumption
- tCO_2 in-/outflow during production process (Use of CO_2 as raw material in production process)
- Produced CO_2 and required CO_2 ratio

Environmental indicators

- Total emission production during production process
- Possible CO_2 capture system efficiency
- Waste generation

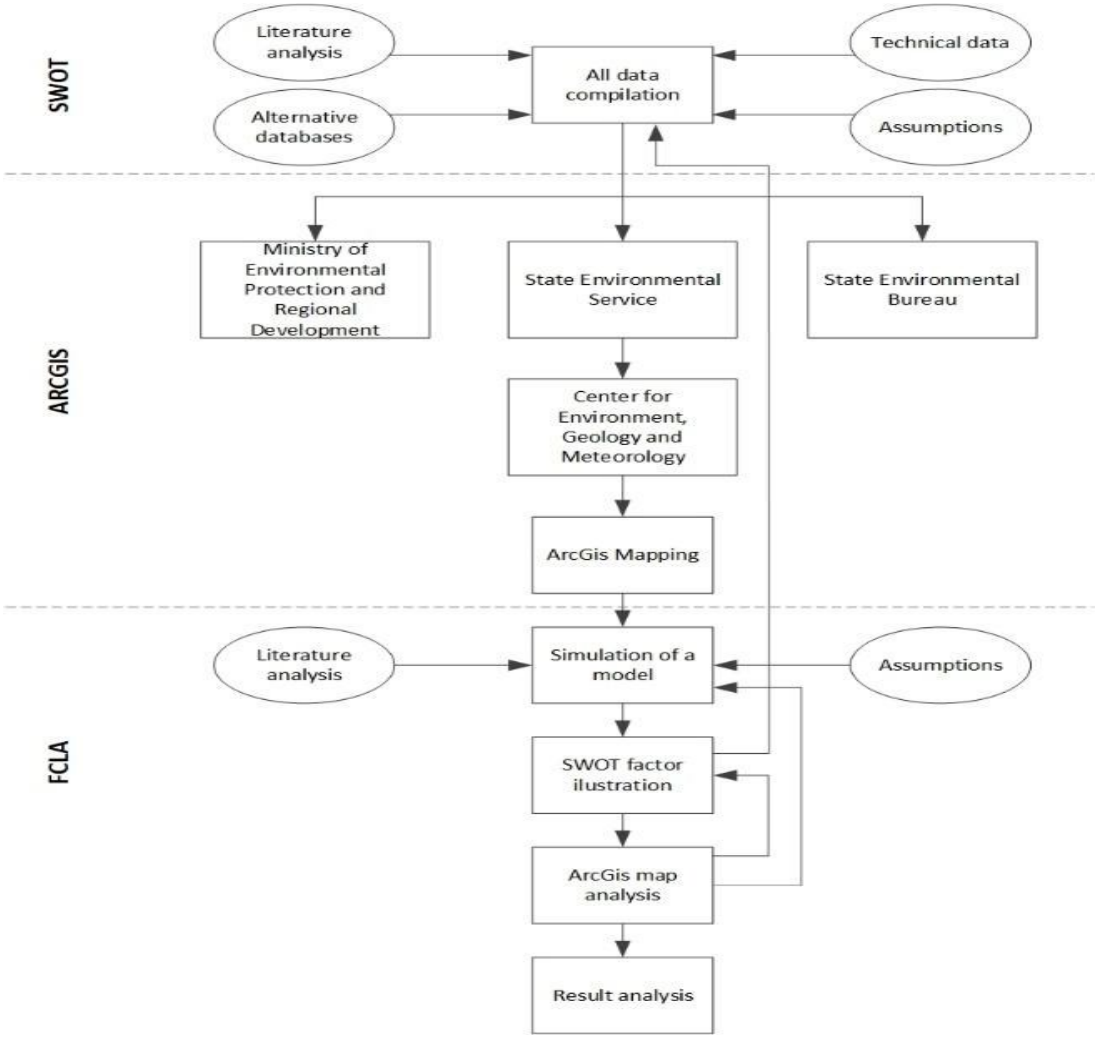
Socio-economic indicators

- Total costs for CO_2 if doing nothing
- Costs of CO_2 if buying
- Spent on CO_2 avoidance and spent on CO_2 production ratio

Specific indicators

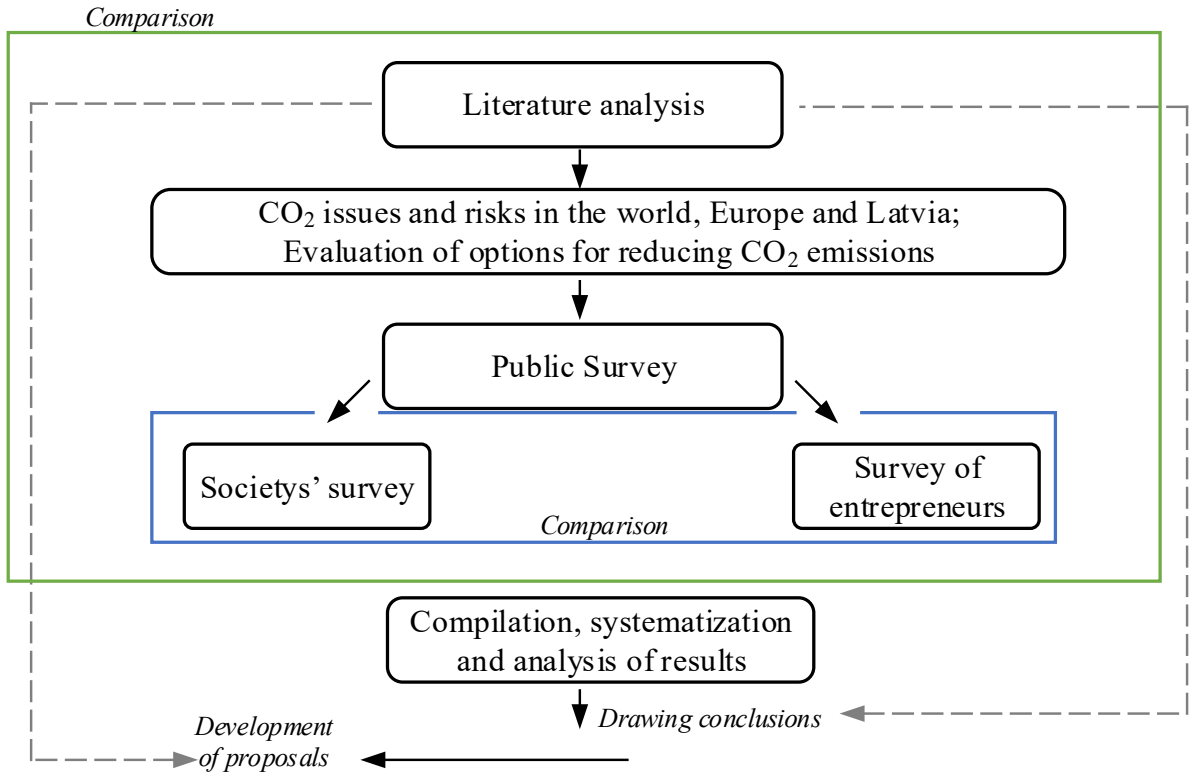
- CO_2 that is converted in the reactor of the synthesis process
- Heat production from animal metabolism per t CO_2
- CO_2 emissions from production of 1 tonne of clinker due to calcination;
- Specific CO_2 emissions (gross). Gross CO_2 emissions per tonne;
- CO_2 fixation

Barriers and driving factors for sustainable development of CO_2 valorisation



- The SWOT analysis showed that the main factors influencing the implementation of CCU technologies are political and financial.
- Analysis of the FLCA visually showed the dependence of the factors indicated in the SWOT and made it possible to determine which of them directly affect the introduction of new technologies and which ones affect indirectly
- FLCA analysis showed that the human factor plays an equally important role. The population's rejection of new products can slow the speed of new technology implementation.
- The negative impact of the human factor can be reduced by conducting educational and awareness-raising courses for both workers and the public.

Willingness to pay analysis



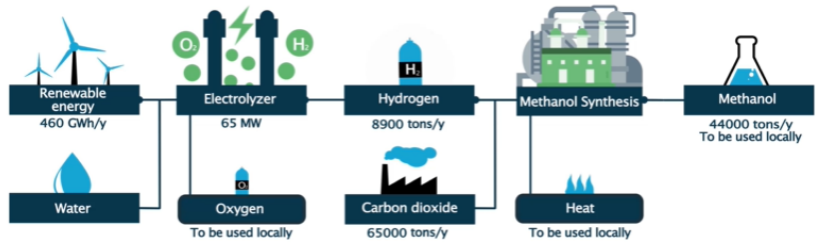
- Lack of public knowledge about CCS/CCU, misconceptions.
- Lack of communication strategy
- Competition between alternative technologies
- Lack of long-term policy of CCU/CCS implementation
- Controversial economic efficiency, capital-intensity, weak market-based mechanism
- Lack of trust in some stakeholders
- NIMBY reaction

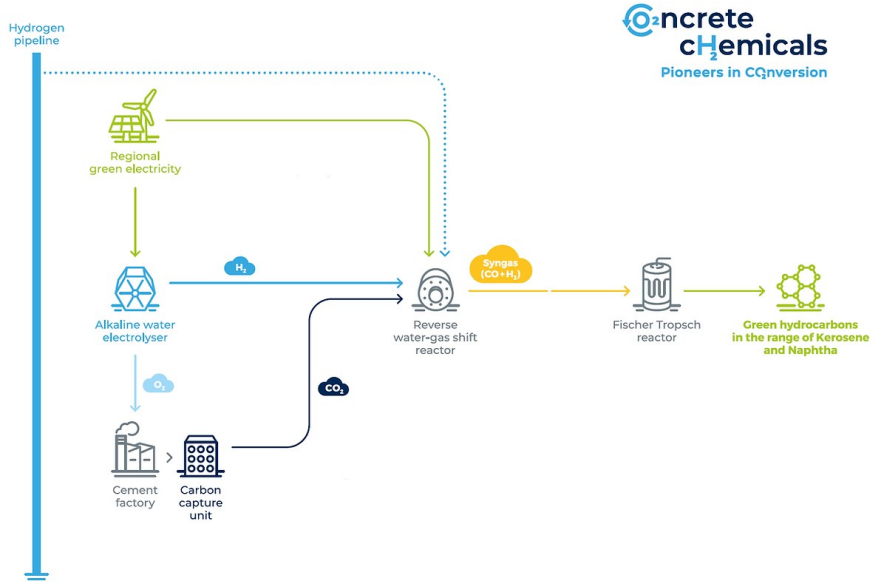
CO_2 valorisation routes for Latvia

- Scenario 1 – Methanol production
- Scenario 2 – SAF Production
- Scenario 3 – Algal ponds

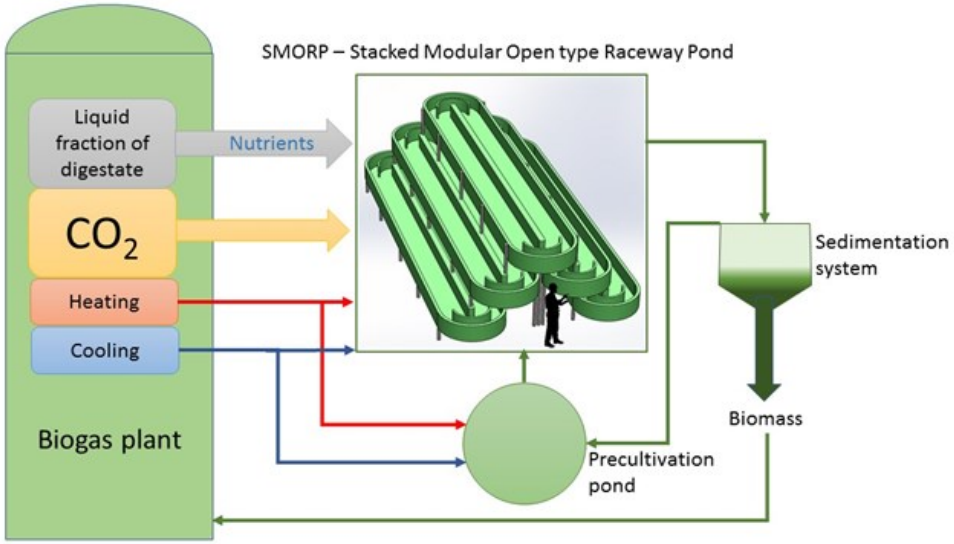
NORTH C METHANOL

The North-C-Methanol project

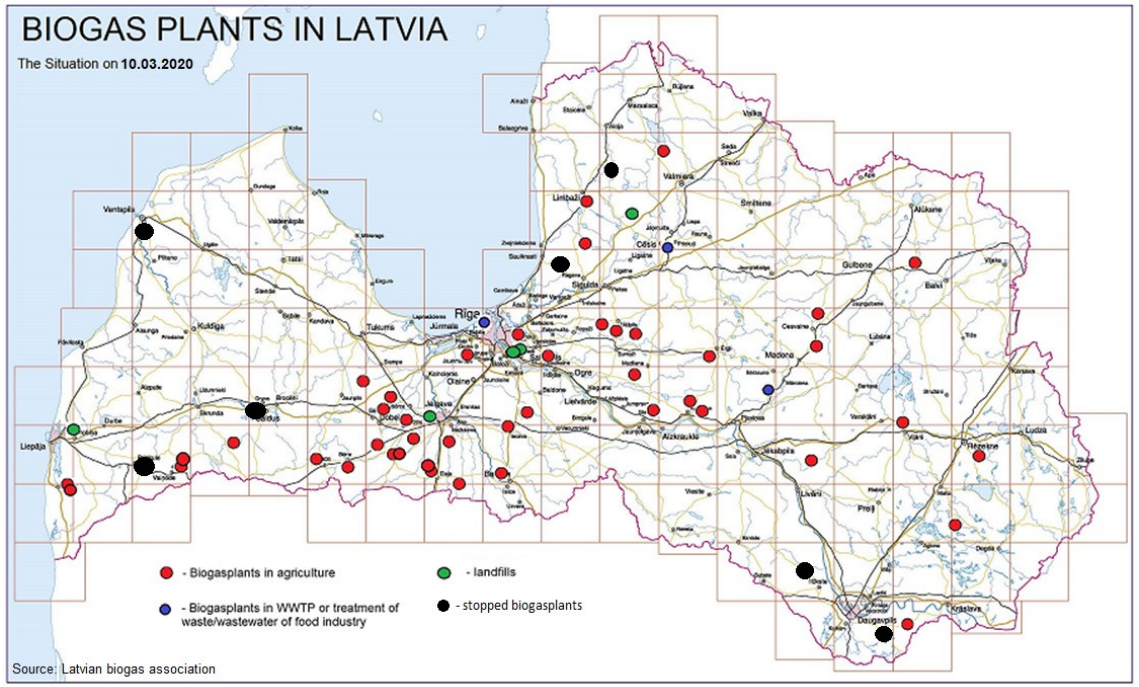


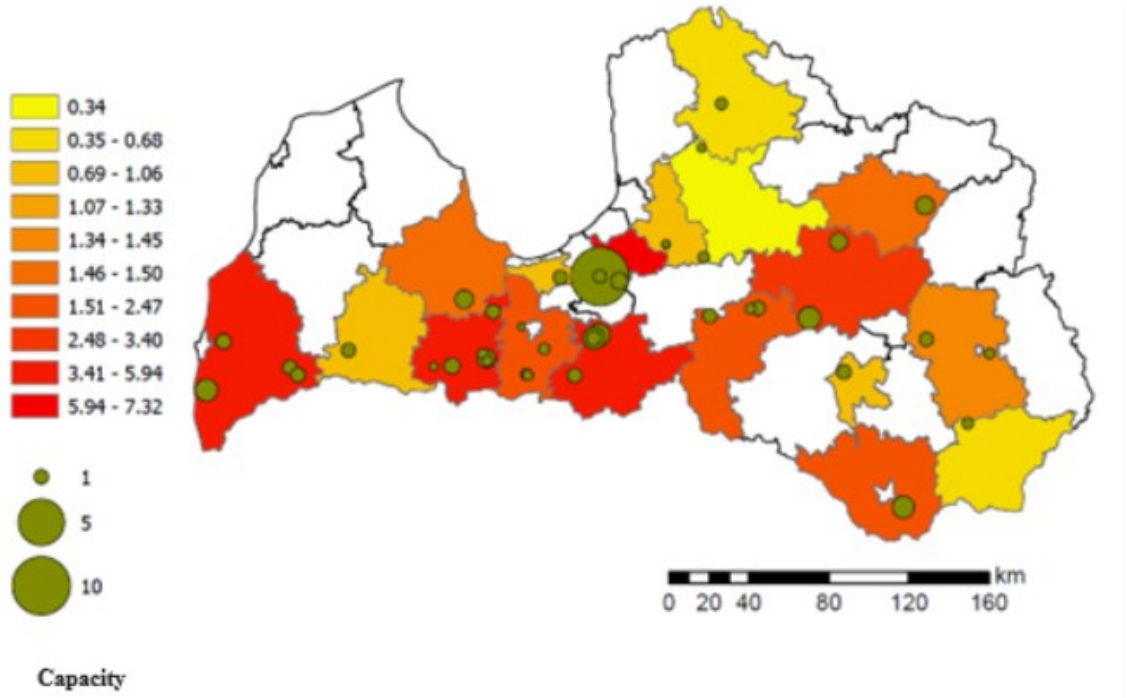


Concrete cHemicals
Pioneers in CO2nversion



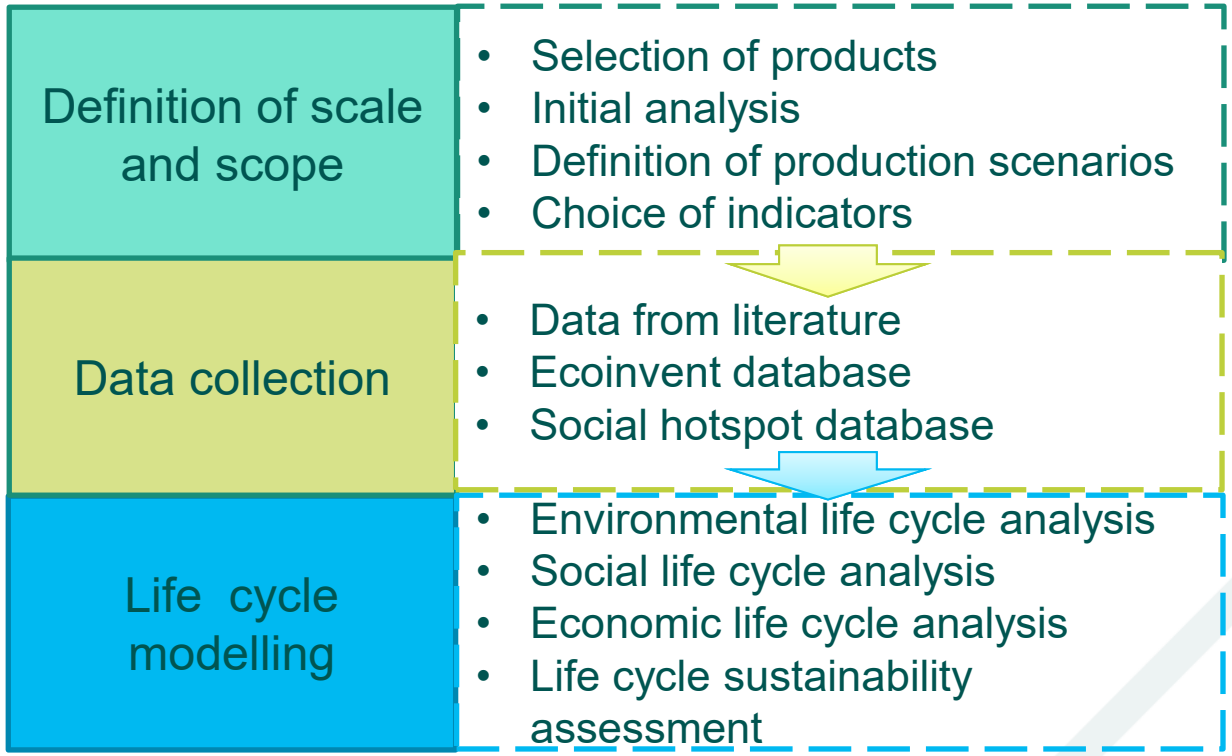
Biogas production in Latvia





Biogas plant capacity by regions, MW

Sustainability assessment of CO_2 valorisation routes for Latvia



LCA methodology

ISO Standards

ISO 14040

- Released in 1997
- Principles and framework
- Product system definition.

ISO 14044

- Came later in 2006
- Requirements and guidelines
- LCA Methodology is described

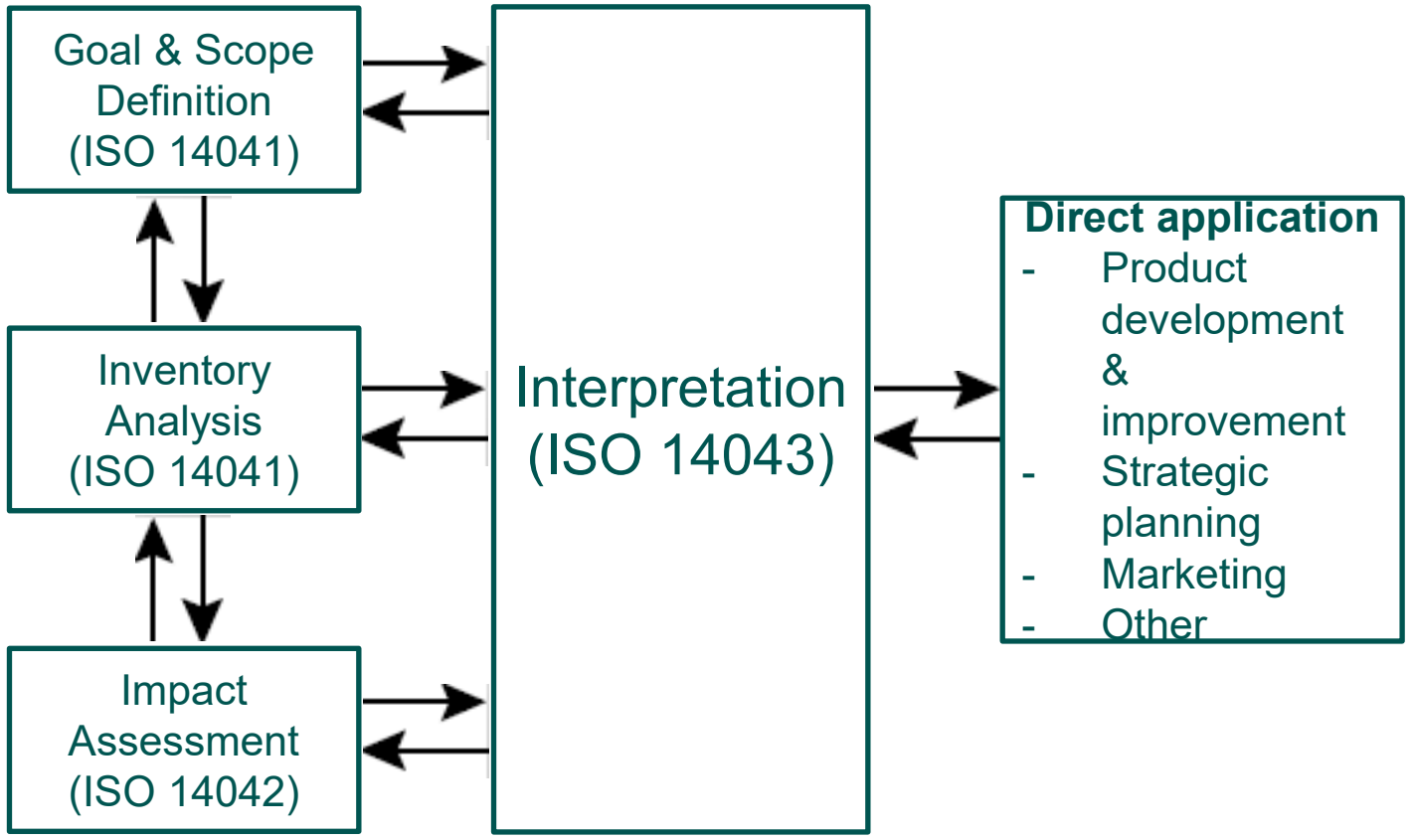
ISO 14047, 14048, 14049

- Impact assessment
- Data documentation format
- Goal and scope definition and inventory analysis

LCA Methodology

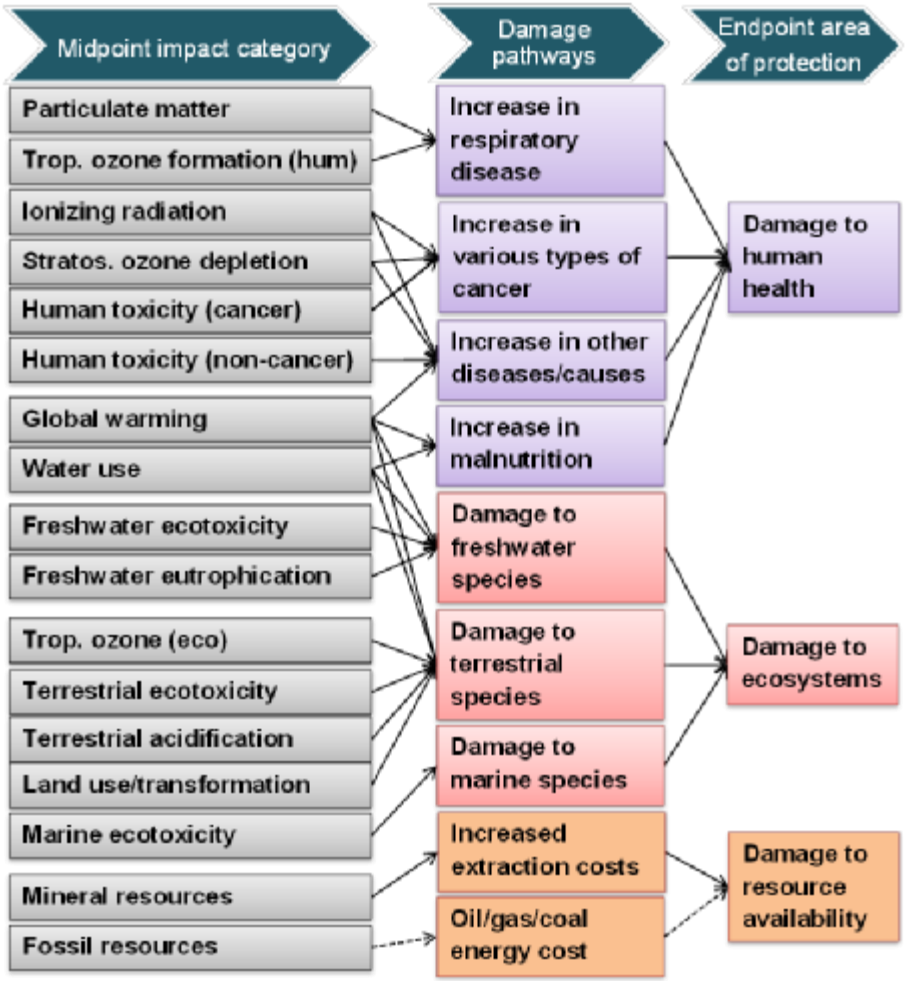
LCA Steps

- Goal & Scope
- Inventory analysis
- Impact assessment
- Interpretation



LCIA: the ReCiPe model

- ReCiPe is a method for the impact assessment in a LCA.
- Life cycle impact assessment translates emissions and resource extractions into a limited number of environmental impact scores by means of so-called characterisation factors.
- There are two mainstream ways to derive characterisation factors, i.e. at midpoint level and at endpoint level. ReCiPe calculates:
  - 18 midpoint indicators
  - 3 endpoint indicators



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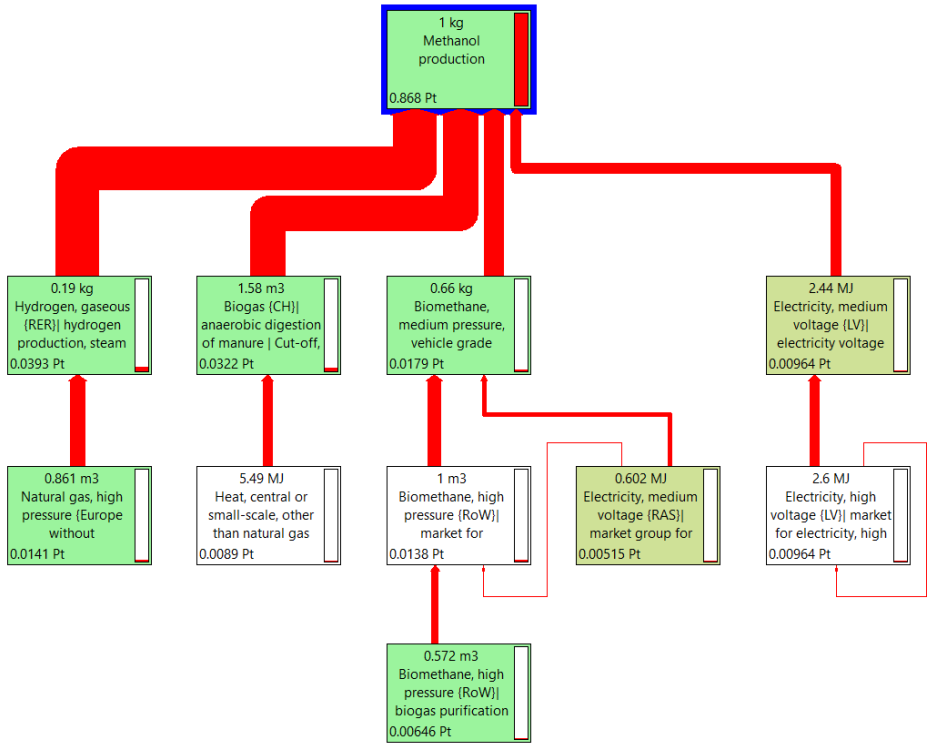
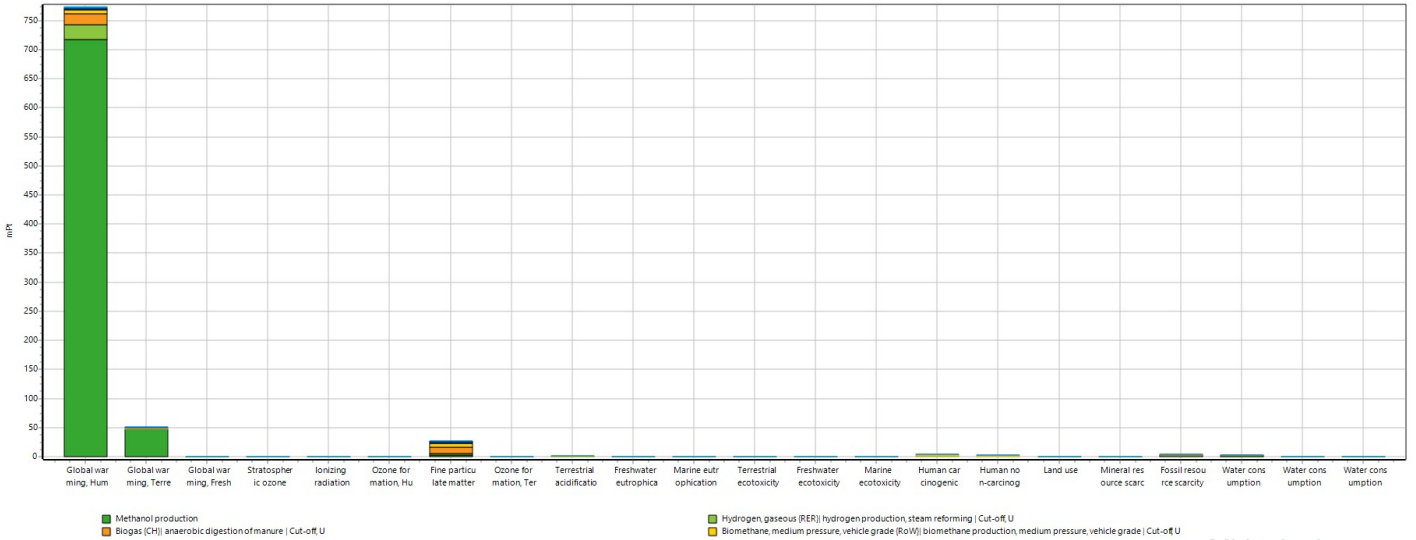
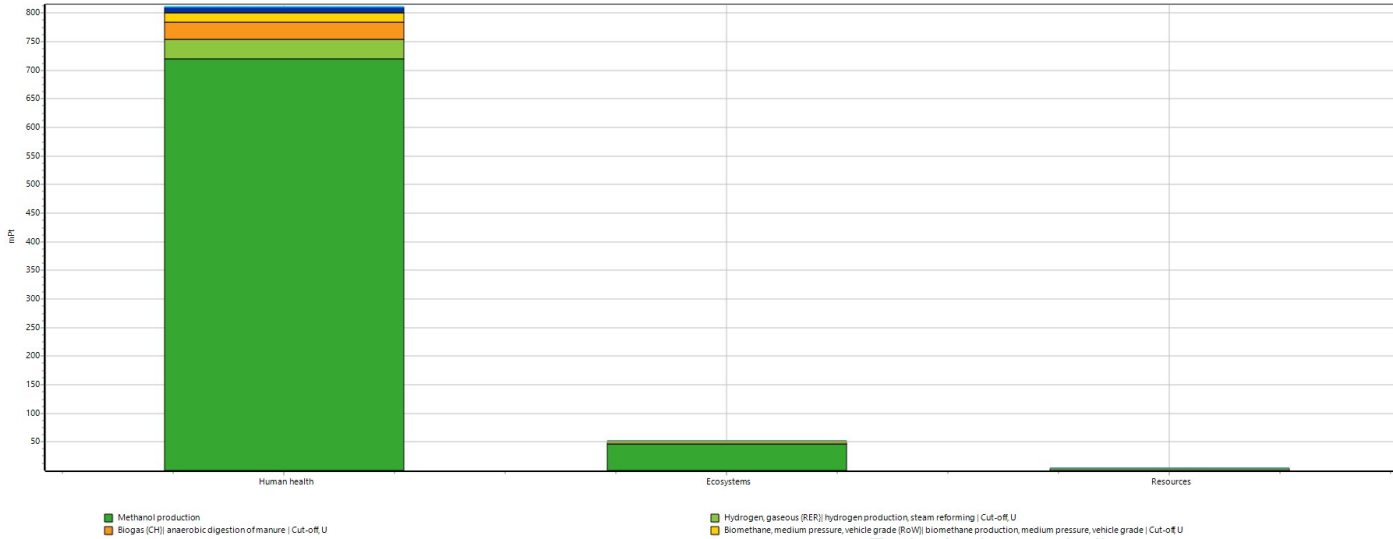
LCA results for methanol production



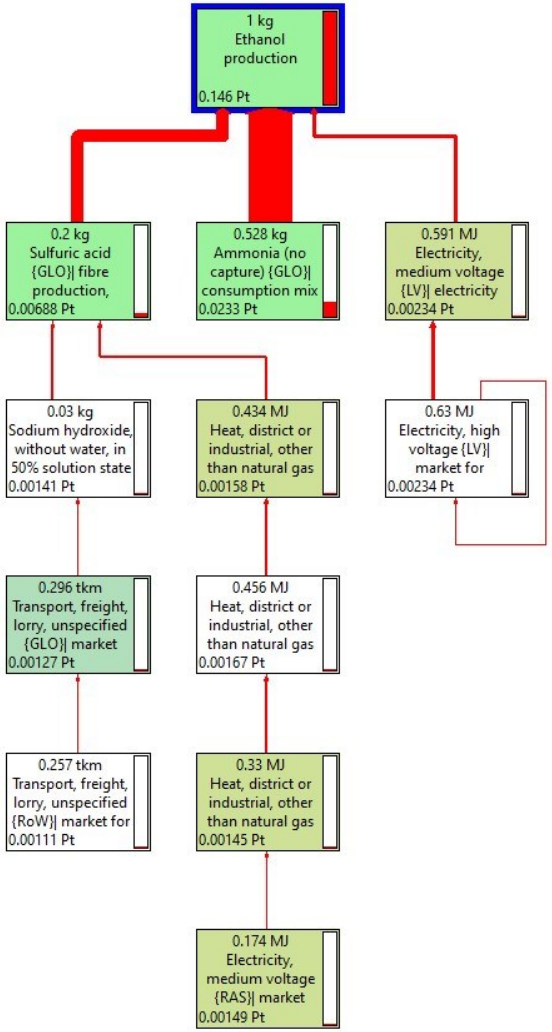


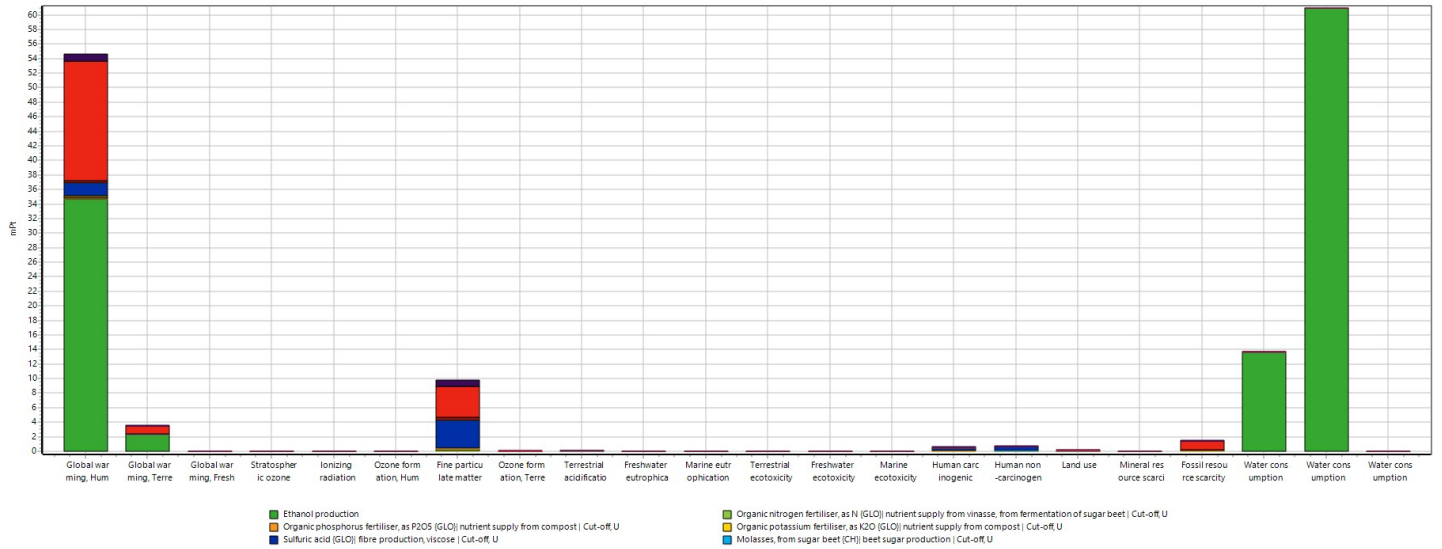
Midpoint impact categories



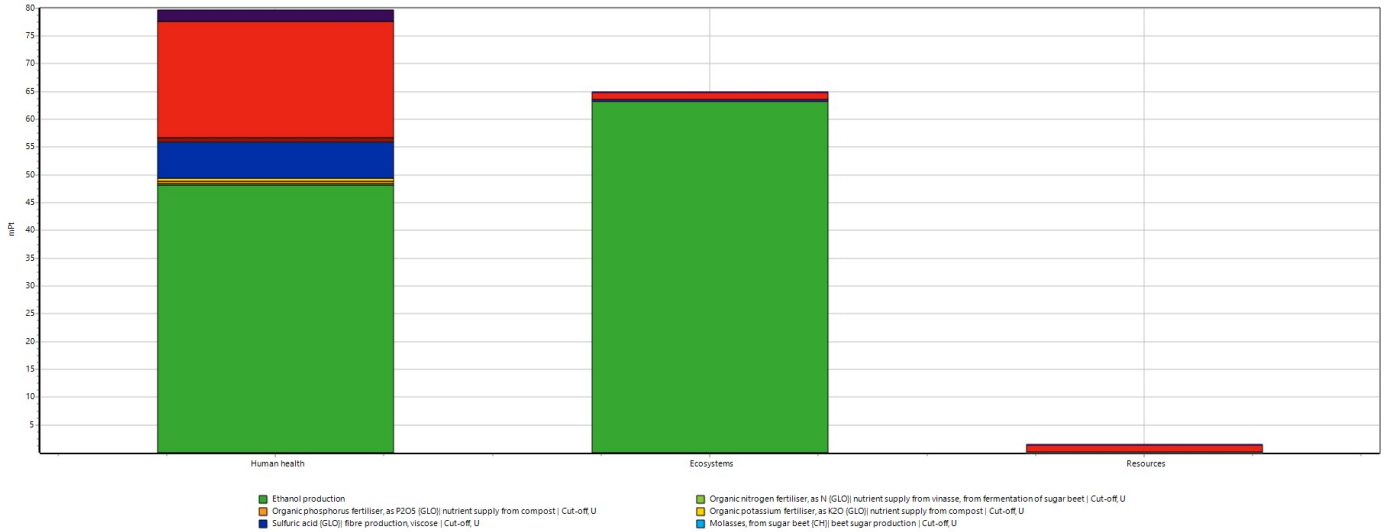
Endpoint impact indicators

LCA results for SAF Production



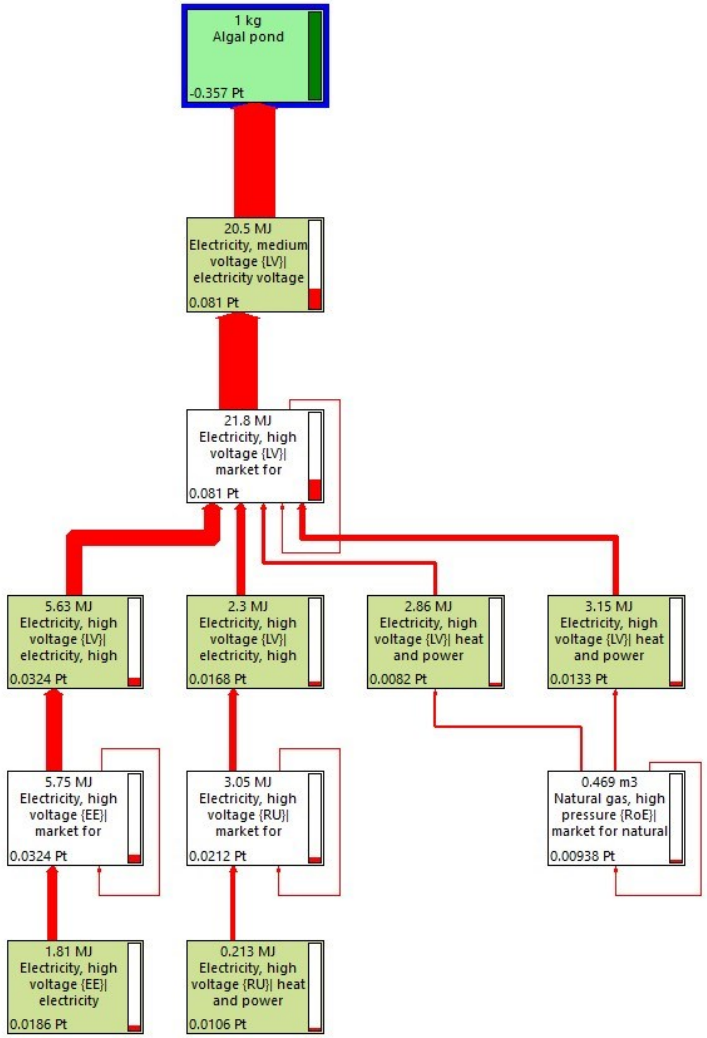


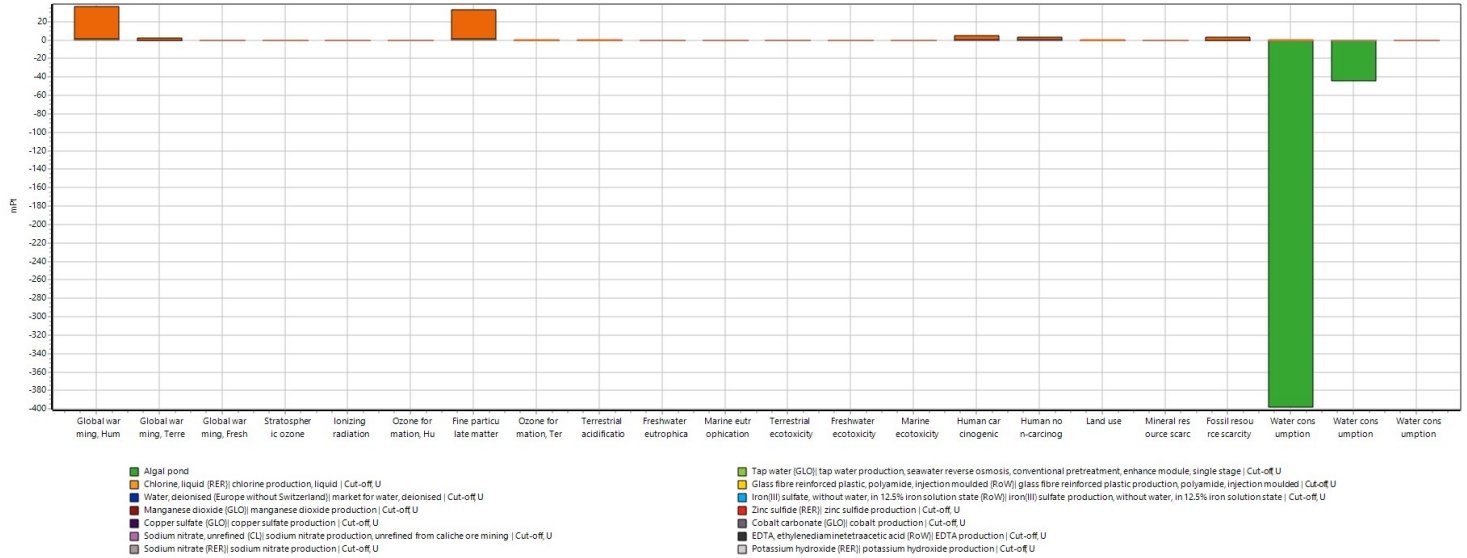
Midpoint impact categories



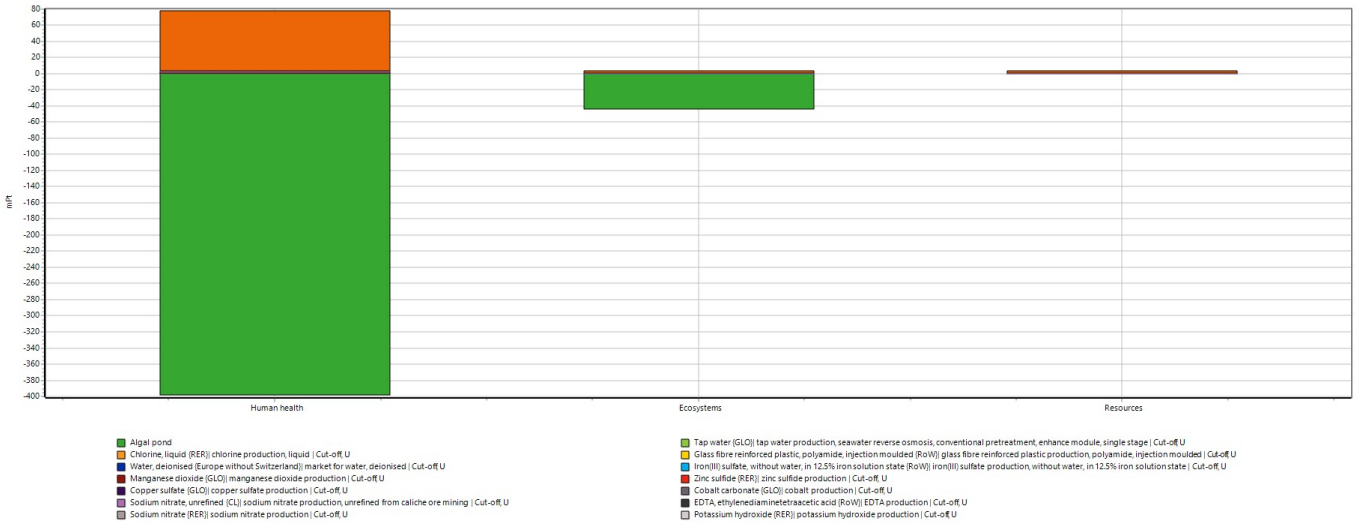
Endpoint impact indicators

LCA results for algal ponds



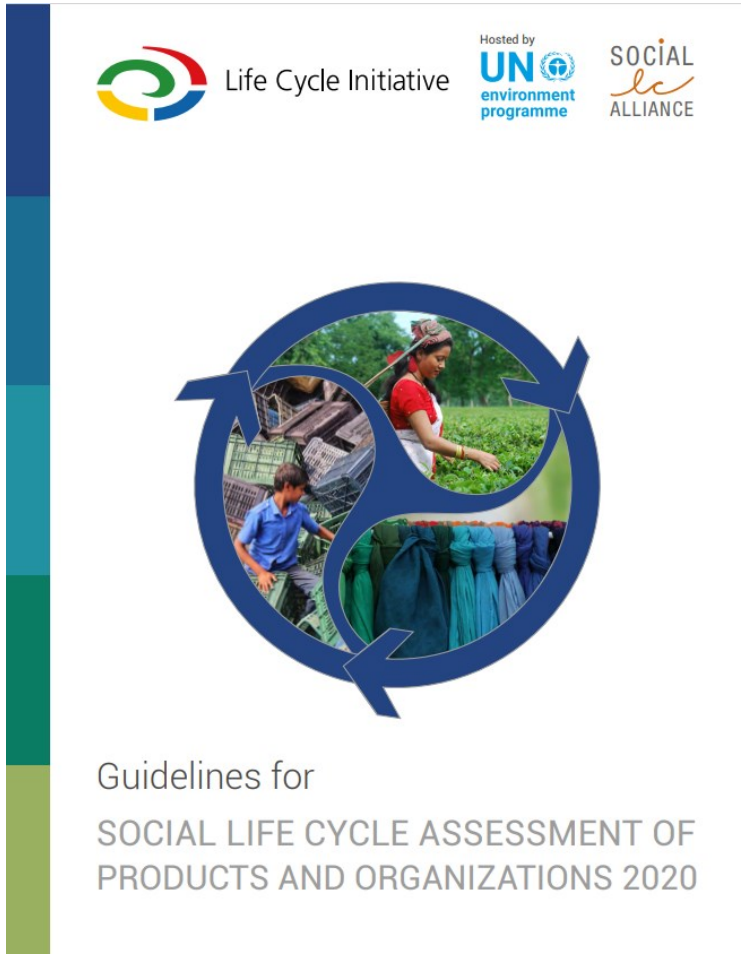


Midpoint impact categories



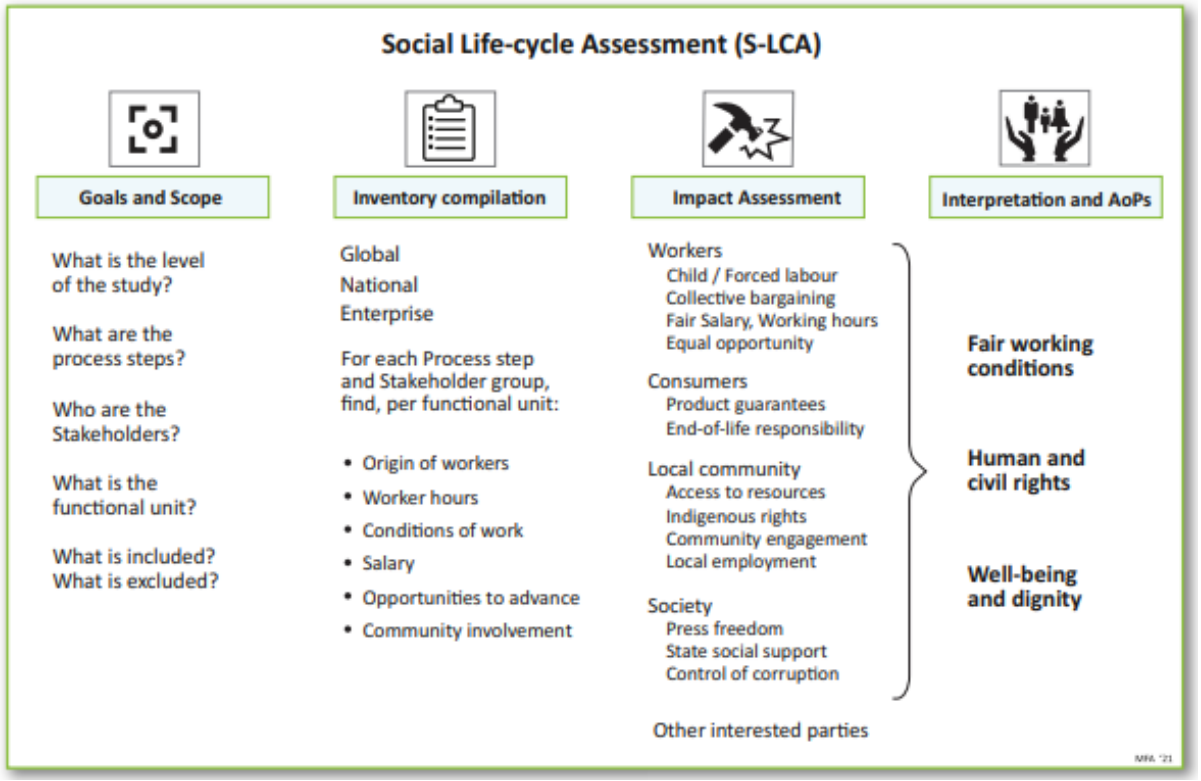
Endpoint impact indicators

Social life cycle analysis



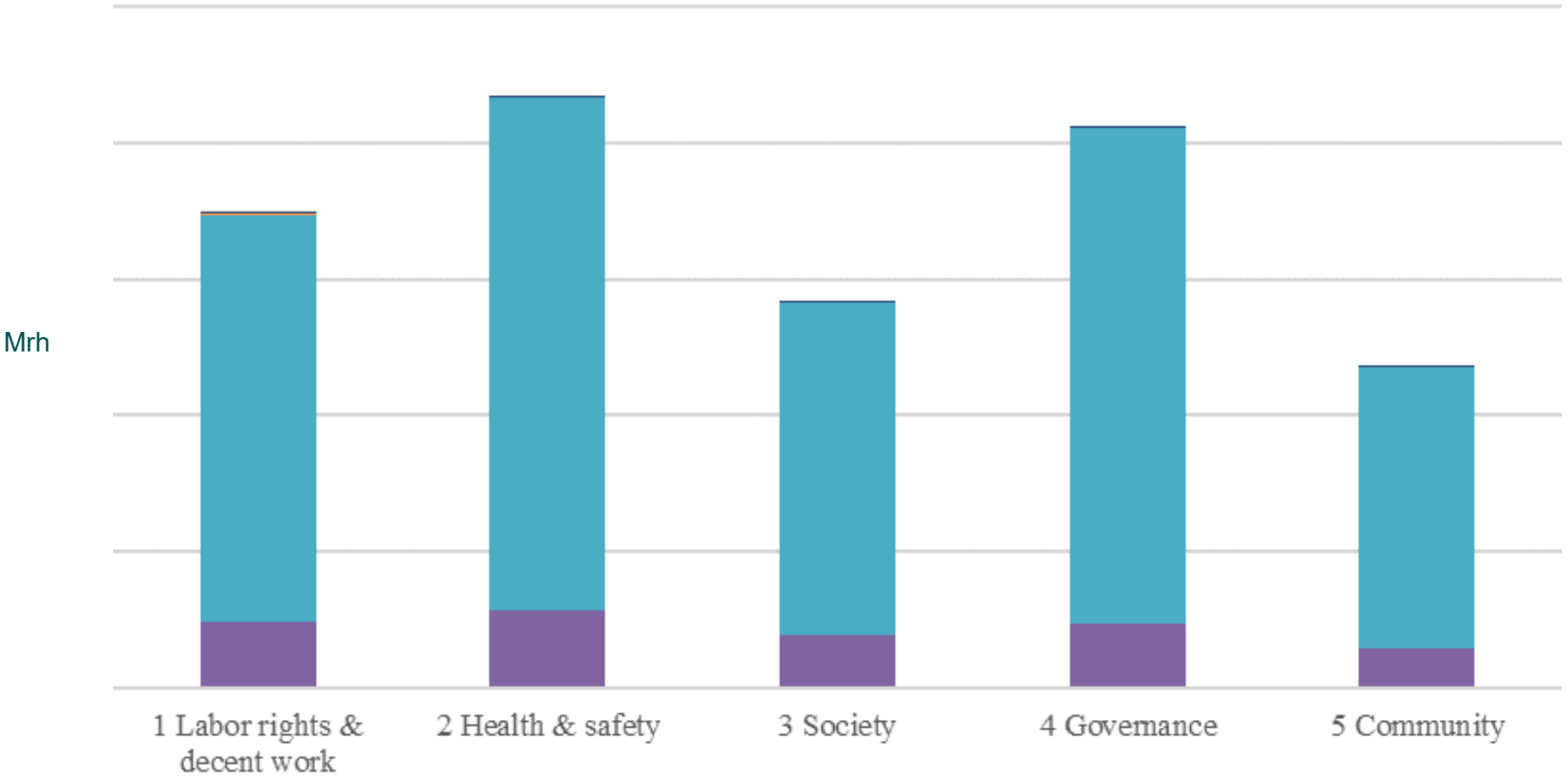
- The ultimate goal of an S-LCA is to improve social conditions and socio-economic performance.
- It does this by identifying social hotspots; points of contact between stakeholders and aspects of the materials, manufacture, distribution, use or disposal of the product that may, potentially, be socially damaging or could be influenced in a positive way

The scope of the S-LCA

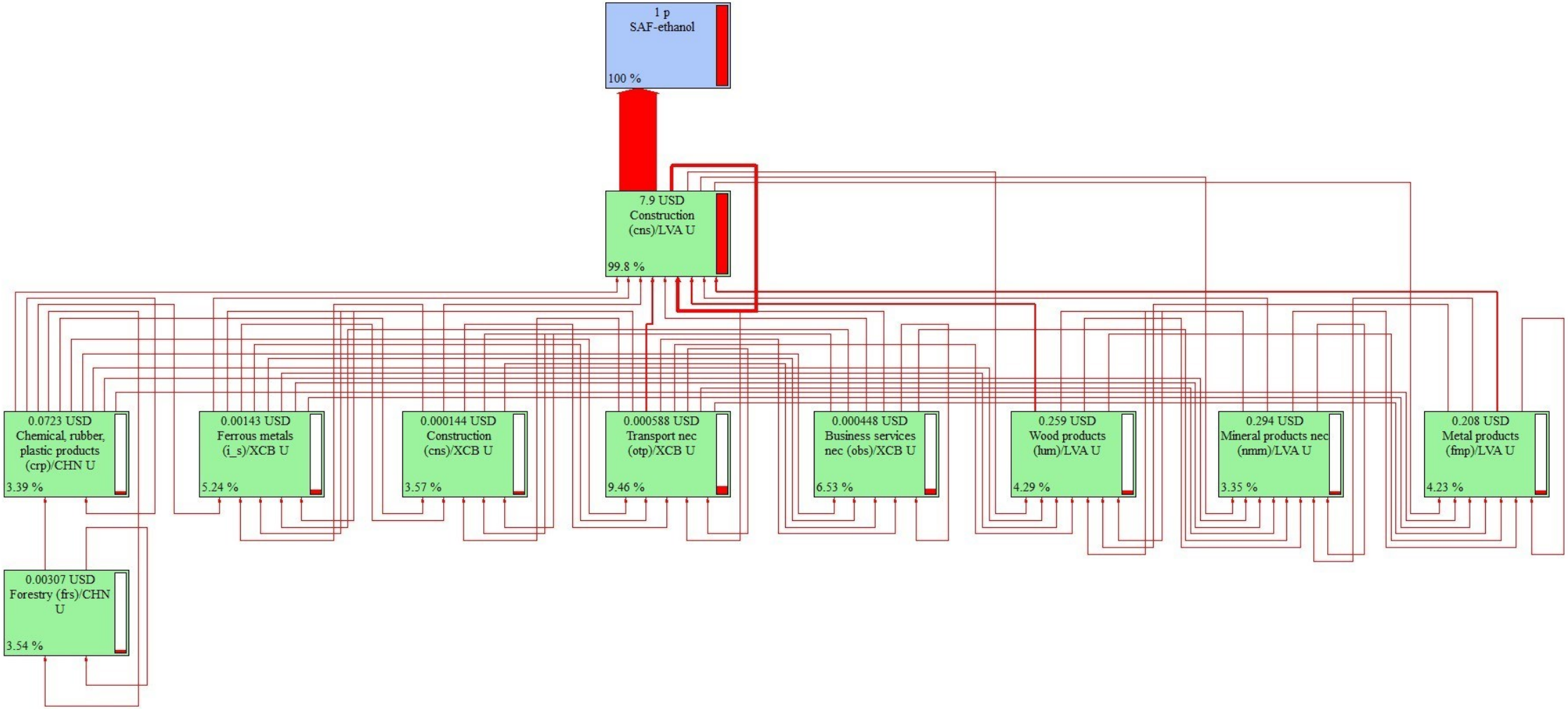


- Identification of the social issues relevant to the CO_2 utilisation in 3 scenarios;
- Assessment of the potential social impacts of CO_2 utilisation, including both positive and negative impacts;
- Analysis of the stakeholders affected by the CO_2 utilisation and their perspectives on the social impacts;
- Evaluation of the current management practices and policies in place for mitigating the negative social impacts and enhancing the positive ones;
- Identification of the gaps and challenges in the current management practices and policies;
- Recommendations for improving the social sustainability of CO_2 utilisation in 3 scenarios.

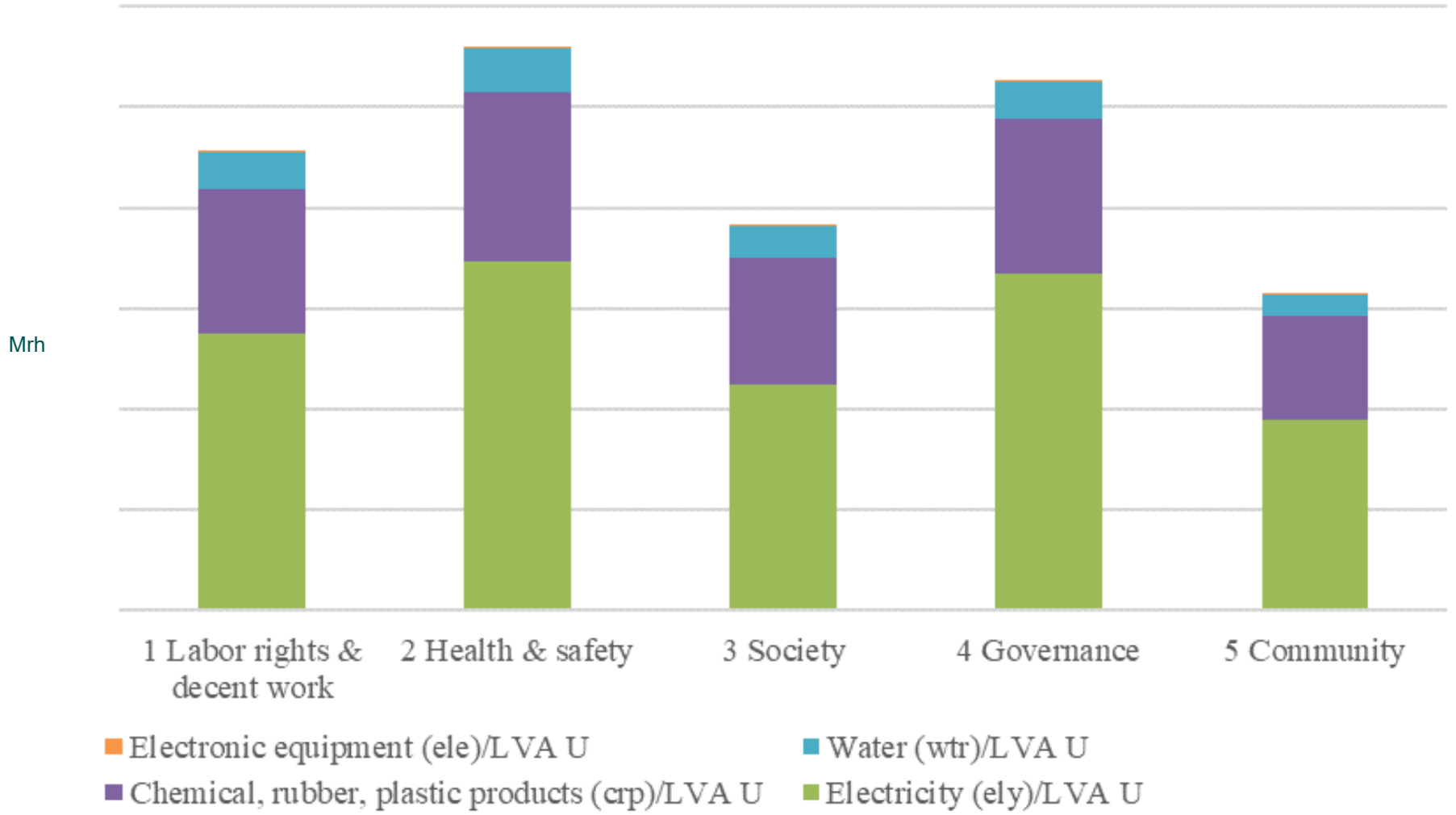
S-LCA results for methanol production



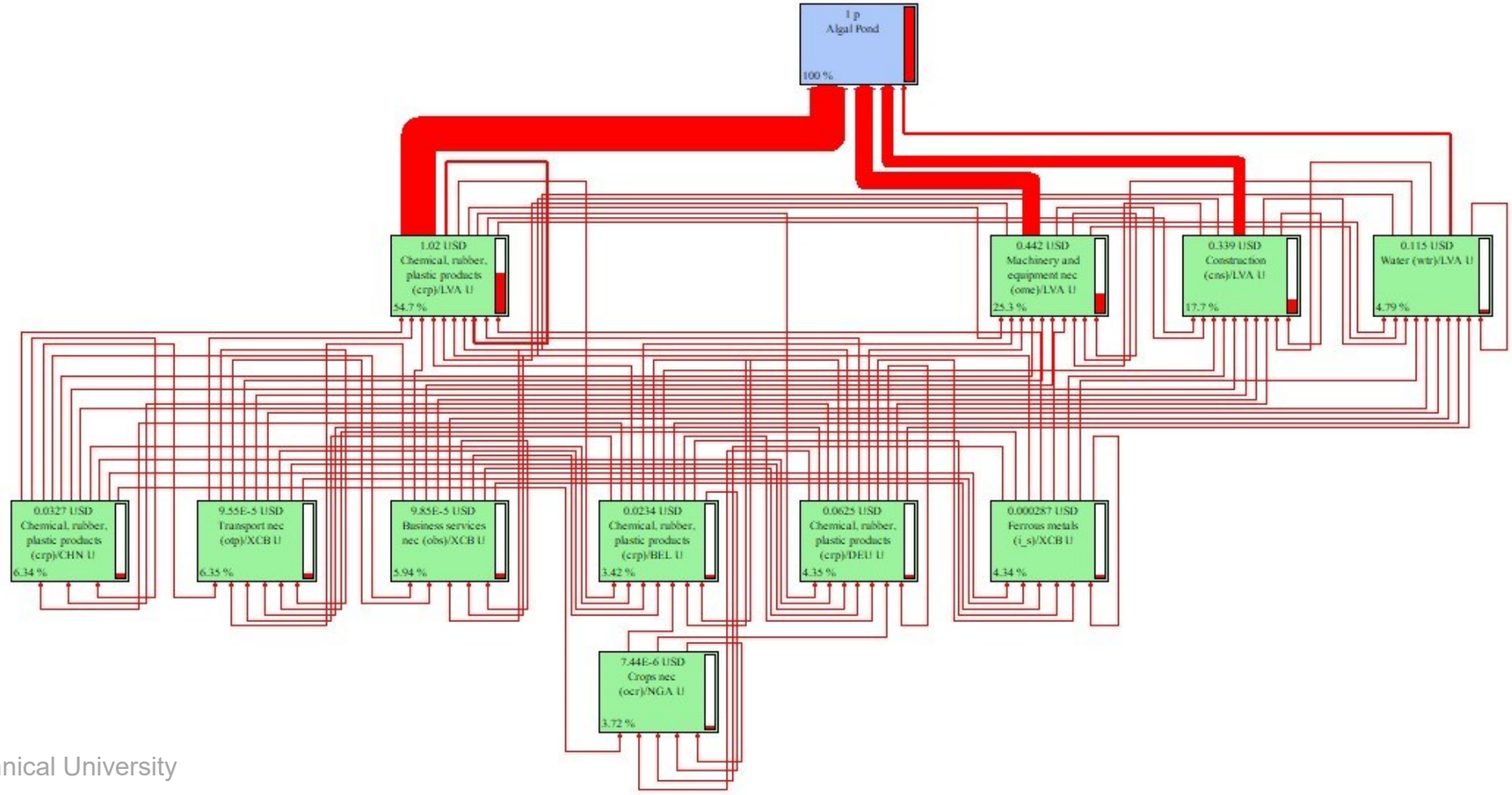
S-LCA results for SAF Production



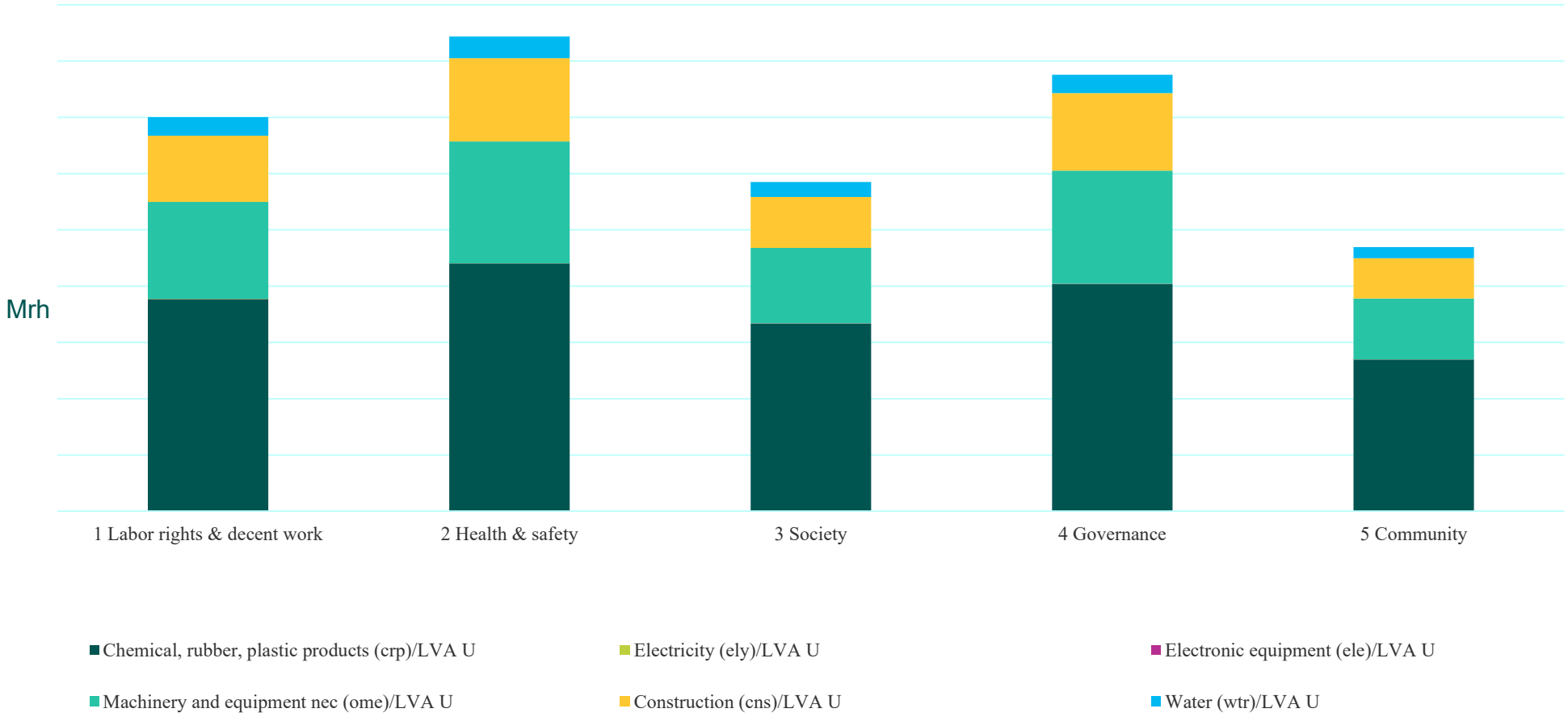
S-LCA results for SAF Production



S-LCA results for algal ponds



S-LCA results for algal ponds



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