Life Cycle Methods for evidencing consequences of change, e.g. innovation, scaling up

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C-SINK Seminar: Leveraging Life Cycle Assessment in Mining– Advancing Sustainability in Raw Material Supply Chains

UK Research and Innovation

Introductions

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Our vision is a sustainable, resilient and equitable net-zero future

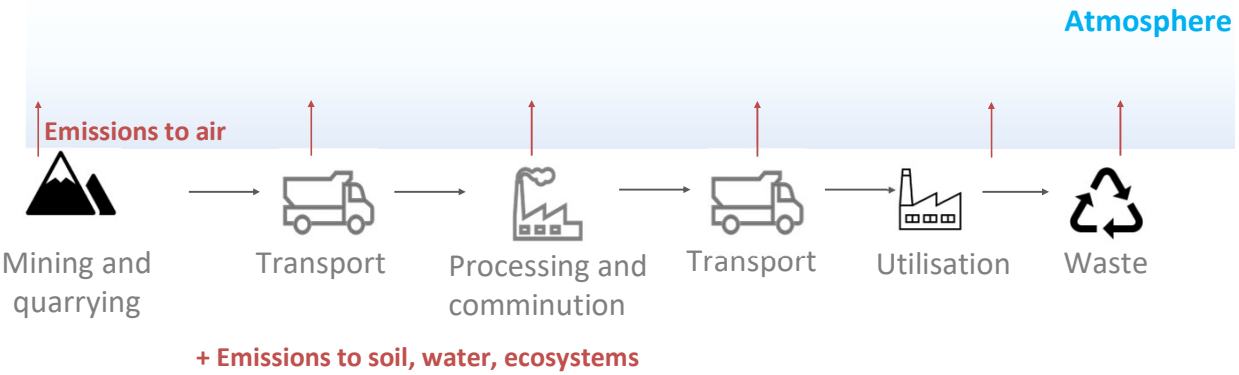
- Chemical engineer by background, significant experience in developing and applying LCA methods
- Current projects: Carbon Dioxide Removal focus
  - Harmonisation of LCA methods for CDR assessment (CO_2RE Hub + 5 GGR-D Demos)
  - Holistic evaluation framework for credible CDR (CO_2RE Hub)
  - Open source IAMs: global bioenergy and CDR modelling (DIAMOND EU project), prospective LCA (PREMISE)
- Past recent projects:
  - LCA bioenergy and international food supply chains
  - Tools for estimating scope 3 GHG emissions, e.g. waste treatment, hospital supply chains

Key points raised by MNLT

LCA is a critical tool supporting decision making in raw material supply chains

- Identify environmental hotspots
- Compare different products/technologies/services on the same basis
- Transparency across full life cycle, including end of life, further inviting to consider recycling and circularity, all key for sustainable decarbonisation.

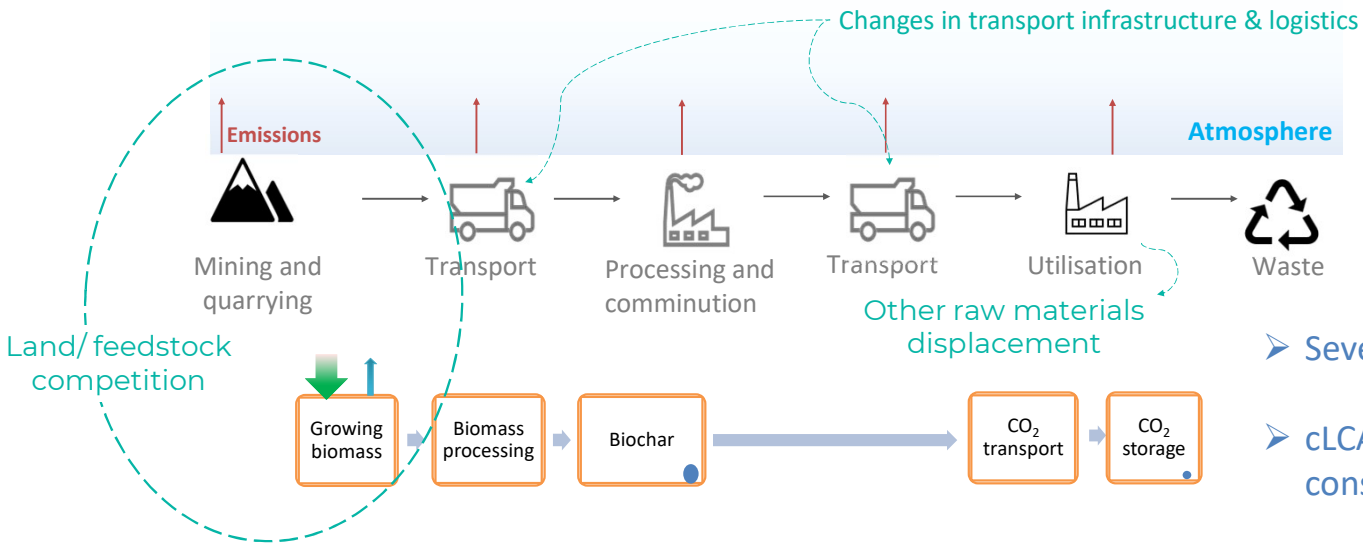
Attributional LCA



Consequential LCA (complementary) uses (to aLCA)

Support decision making in raw material supply chains:

- Which are the wider consequences of opening a new mine?
- Change of hotspots as the wider system decarbonises or innovation in one stage of the supply chain
- Identification of potential environmental hotspots in scaled-up versions of emerging technologies, e.g. in 2050



- Several scenarios of change are possible
- cLCA allows identification of environmental consequences of these changes

Consequential LCA analysis requires

Consequential LCA study to allow for estimation of systemic effects of scaling up

- System boundaries include direct, indirect and **market mediated** supply chains
- Definition of a **baseline** against which the intervention is assessed
- Capture co-benefits and trade-offs

Goal and scope definition

Collect inventory data for both intervention and baseline

- **Time dependent inventory** to capture changes in size and background system
- Report emissions and sinks by type, including carbon store leakages when they occur
- Go **beyond GHG emission reporting**: include resource extraction and pollutants affecting other environmental categories

Inventory

Consider wider impact categories and co-benefits

- Need for **new impact metrics**, e.g. Global Cooling Potentials

Impact assessment

Assess GHG emissions, environmental co-benefits and trade-offs over full life cycle *and* in comparison to a baseline

- Reflect on the permanence of carbon storage
- Perform **sensitivity and uncertainty analyses**

Interpretation

Adapted from Butnar, Lynch et al., 2024. A Review of Life Cycle Assessment Methods to Inform the Scale-up of Carbon Dioxide Removal Interventions. WIRES Energy and Environment. https://doi/10.1002/wene.540

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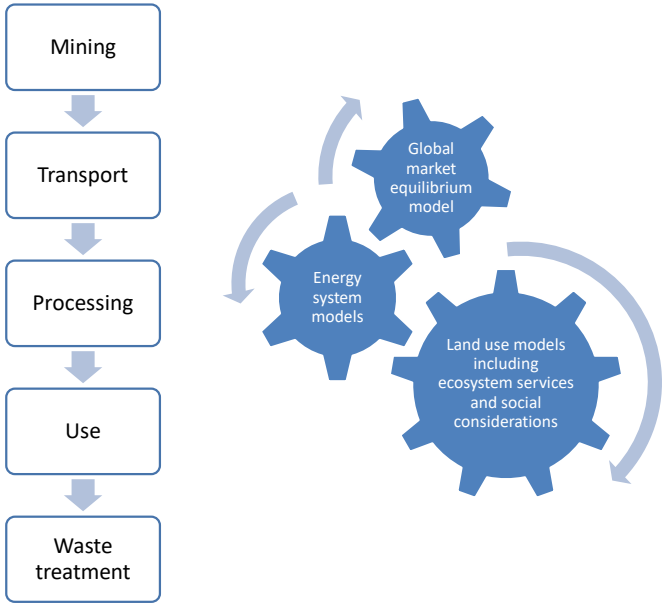
Complementary LCA uses for decision-making & Common LCA challenges

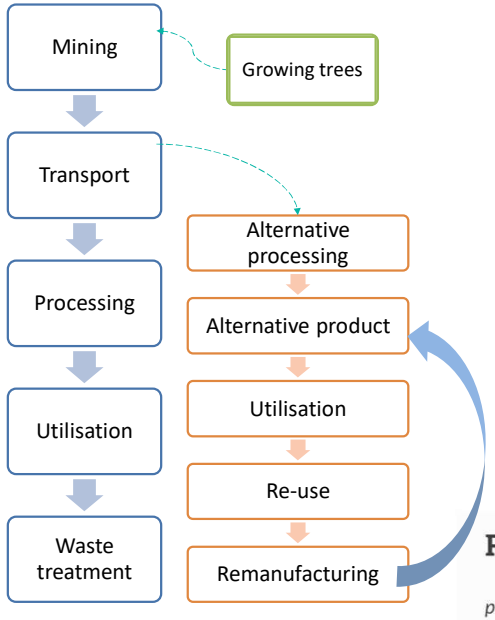
Attributional LCA

Defined system boundaries
Impacts directly quantifiable



Consequential LCA

Wide system boundaries
Includes projections into the future



LCA results only as good as the input data => need harmonised methods and data

- Need harmonised methods and data for foreground systems, e.g. system boundary, impacts to be evaluated, etc.
- Need harmonised and publicly available data for background systems, e.g. scenario type, time scale, energy system conditions, etc.

Purpose

- PREMISE database

premise enables the alignment of life cycle inventories within the ecoinvent 3.6-3.10 database, using either a "cut-off" or "consequential" system model, to match the output results of Integrated Assessment Models (IAMs) such as REMIND, IMAGE or TIAM-UCL. This allows for the creation of life cycle inventory databases under future policy scenarios for any year between 2005 and 2100.

Decision making related to:

e.g. Monitoring Reporting and Verification
GHG savings as compared to benchmark
…

Decision making on:

e.g. Industrial strategies
Rules for Emission Reduction subsidies/ tax relief
…

Thank you!

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https://co2re.org/ggr-evaluation/