



BIOTRANSFORM

TRANSITION PATHWAYS TO CIRCULAR BIO-ECONOMY

2nd working group: Environmental sustainability assessment in
BIOTRANSFORM pilot regions

Luxembourg Institute of Science and Technology (LIST)

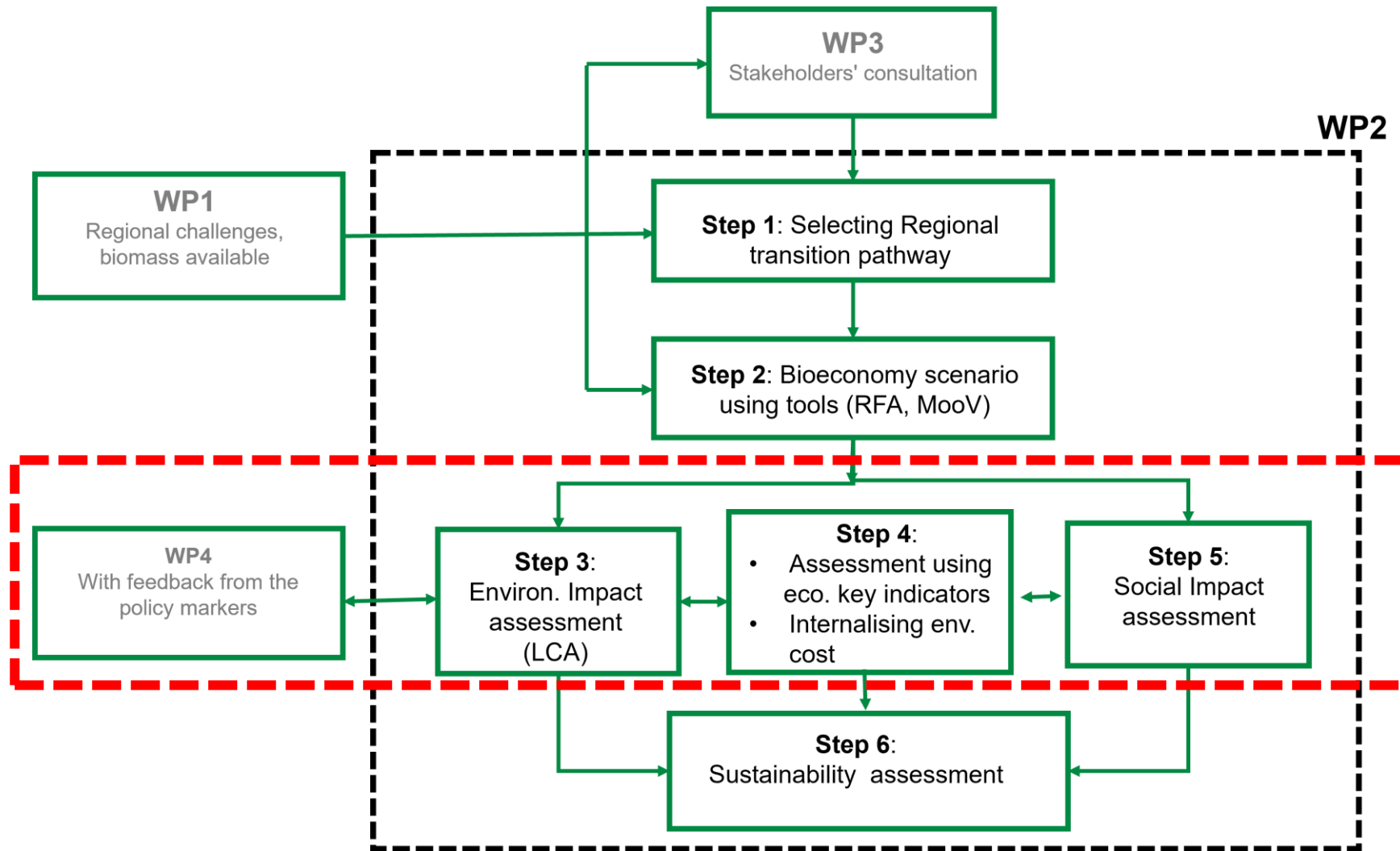
Gitanjali Thakur, PhD



Contents:

- WP2: Assessment framework
- Regional transition pathway
- Environmental impact assessment of Finish transition pathway

Work package (WP) 2 in BIOTRANSFORM:



BIOTRANSFORM: Pilot regions and bioeconomy scenario

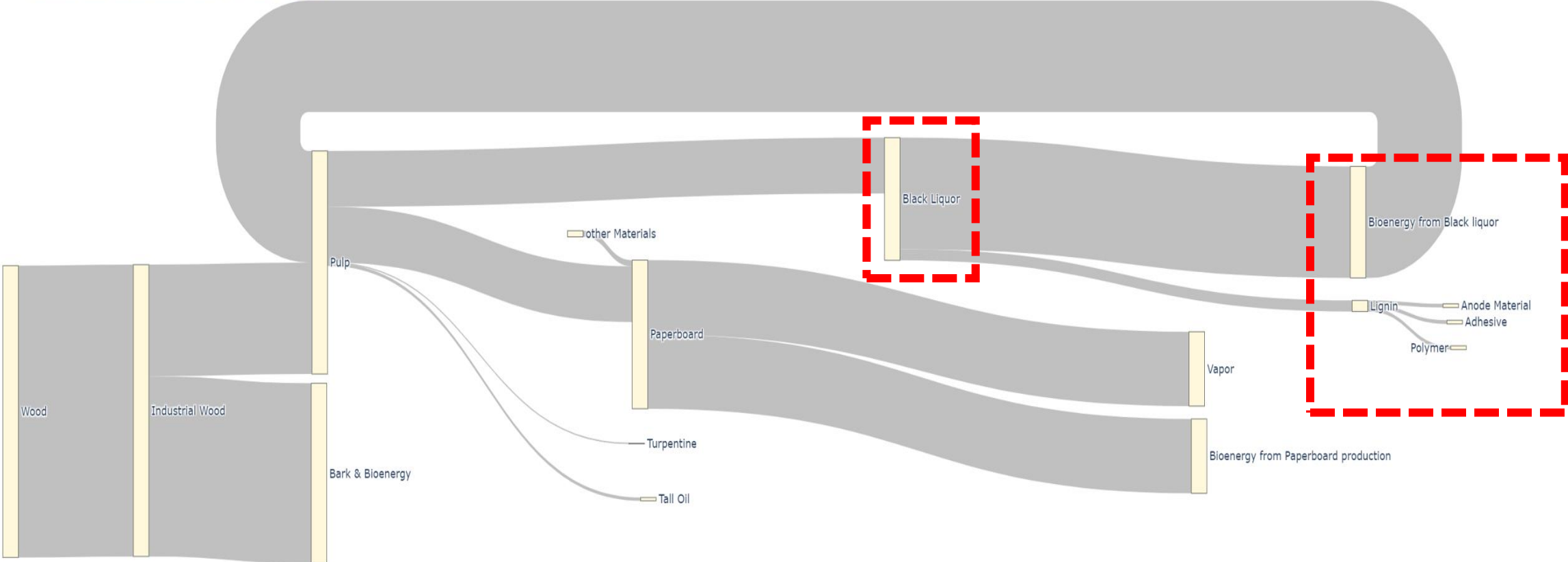


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Region	Scenario
Finland	Lignin extraction from paper and pulp industry
West Macedonia (Greece)	Using sewage sludge to produce green hydrogen
North Rhine-Westphalia (Germany)	Using organic feedstocks (beet sugar leaves) for chemical industry
Northen Burgenland (Austria):	Creating renewable goods from straw, vineyards residues, reed and sludge from lakes
Andalusia (Spain)	Biomass from olive sector (olive pomace, olive stones, pruning waste) to create high-value renewable goods and bioenergy
Charles SPA region (Czech Republic)	Valorisation of food waste

Finnish bioeconomy scenario:

Sankey test black liquor to lignin and energy



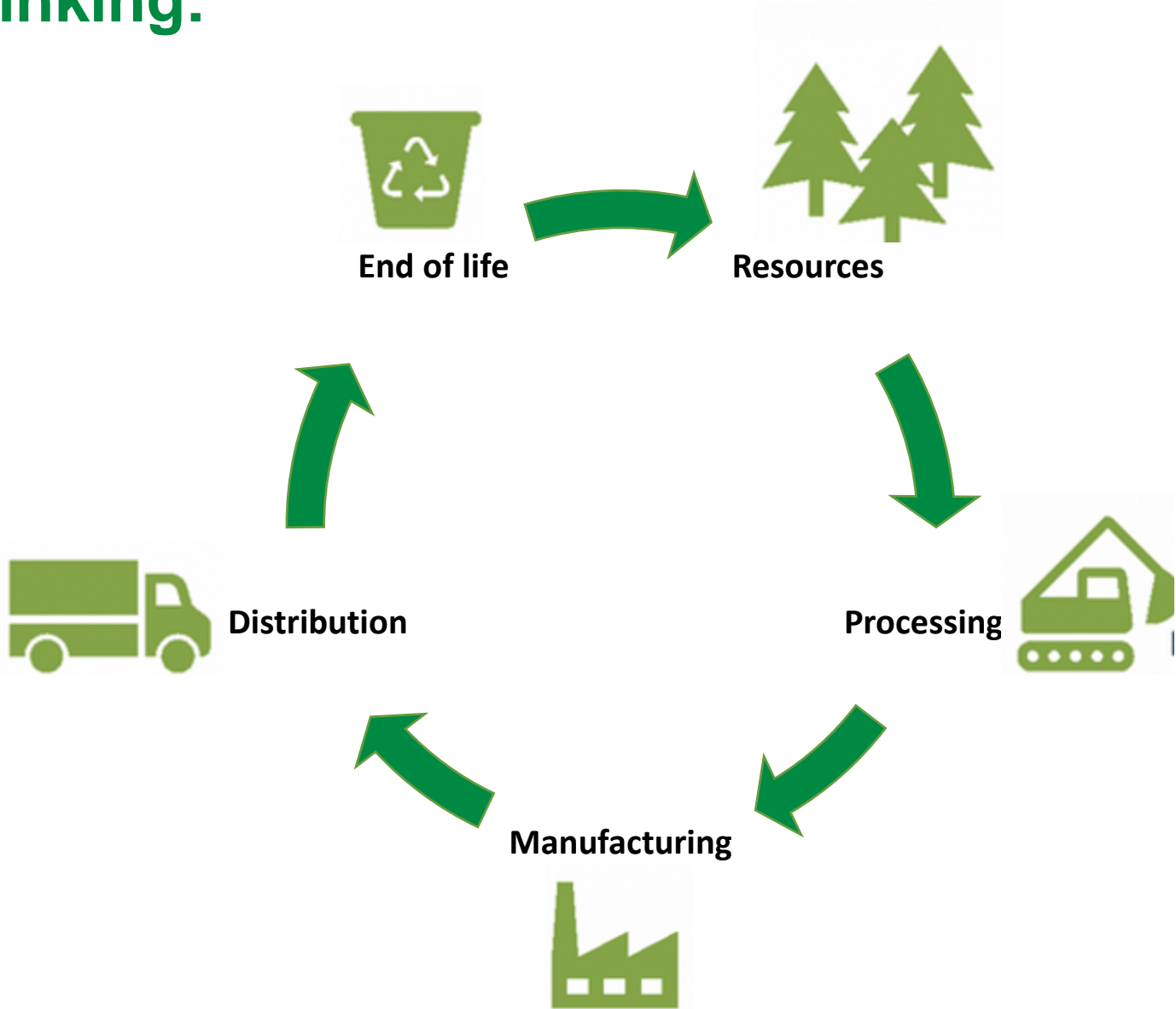


Lignin as anode material

1 kg of anode = 0.96 kg of lignin replacing **synthetic graphite** + water
+ electricity + additives

0.96 kg of synthetic graphite 0.96 kg of **petroleum coke** + 0.24 kg of coal tar

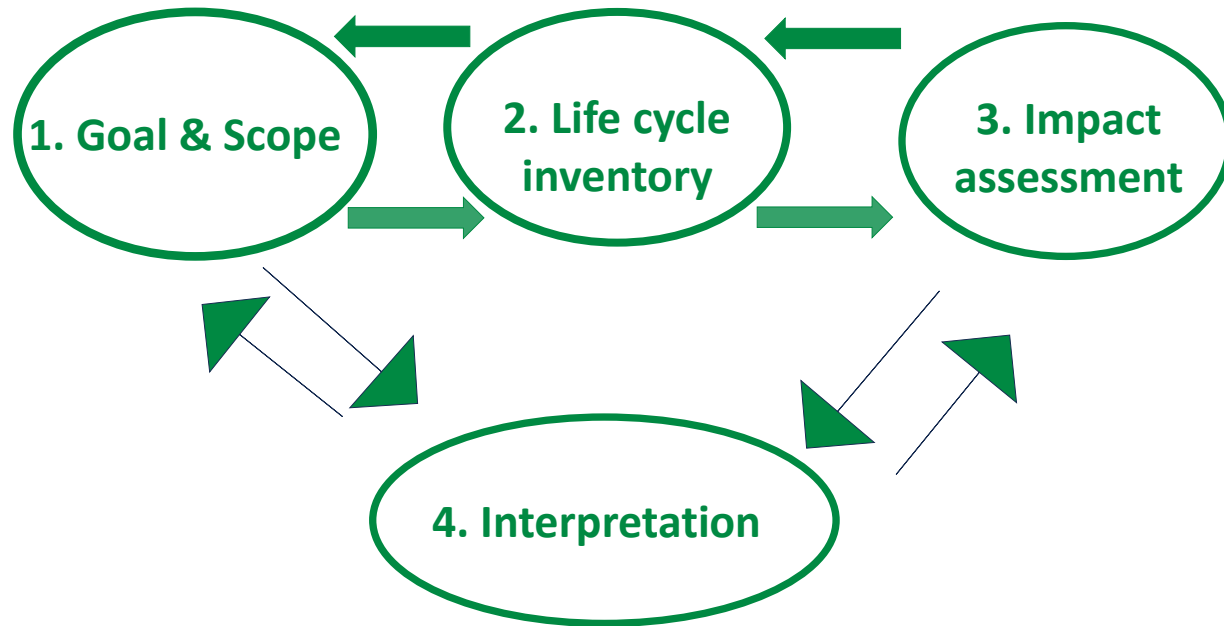
Life cycle thinking:



Life cycle impact assessment:



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1. Goal and scope: To assess the environmental impact for producing **1 kg of anode using lignin** extracted from paper and pulp industry in Finland

2. Life cycle inventory :

- 0.96 kg of lignin (1kg lignin -1.5kwh electricity)
- 1.47 kwh of electricity
- 0.01kg carbon black
- 0.7835 kg deionised water
- Chemical producing factory
- 0.03 kg carboxymethyl cellulose powder

Life cycle impact assessment (LCIA): Indicators



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- Environmental footprint (EF) v3.1 method of assessing life cycle impact
- Indicator value = emission in the compartment * characterisation factor

No.	Proposed EF impact category	Unit (environmental impact category indicator)
1	Climate change, total	GHG emissions, GWP100 (kgCO ₂ eq)
2	Water use	Water stress (m ³ of H ₂ O equivalents)
3	Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)
4	Eutrophication, marine	Fraction of nutrients reaching marine end compartment (kg N eq)
5	Material footprint	Material footprint (tonnes of cultivated biomass, extracted mineral ore and fossils)
6	Acidification	Accumulated Exceedance (mol H ⁺ eq)
7	Eutrophication, terrestrial	Accumulated Exceedance (mol N eq)

No.	Proposed EF impact category	Unit (environmental impact category indicator)
8	Human toxicity, cancer	Comparative Toxic Unit for humans (CTUh)
10	Particulate matter	Impact on human health (DALYs)
11	Photochemical ozone formation, human health	Tropospheric ozone concentration increase (kg NMVOC eq)
12	Land-use related biodiversity loss	(Global m ³ PDF years)
13	Ionising radiation	Human health effect
14	Resource use, fossils	Kg oil-eq
15	Resource use, mineral and metals	kg Cu-eq
16	Ozone depletion	kg CFC-11 equivalent

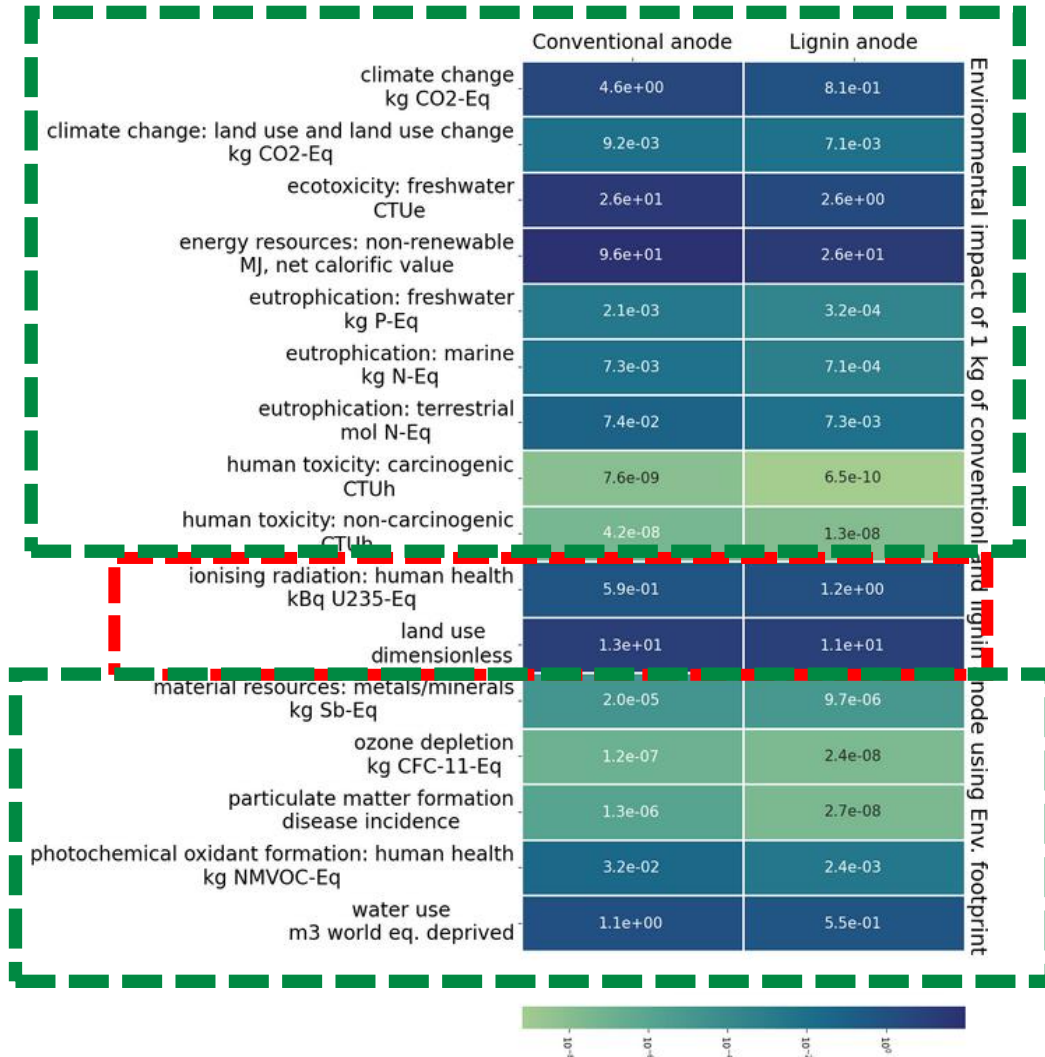
Environmental impact of producing anode using lignin in comparison to the conventional anode?

LCIA: Total Impacts

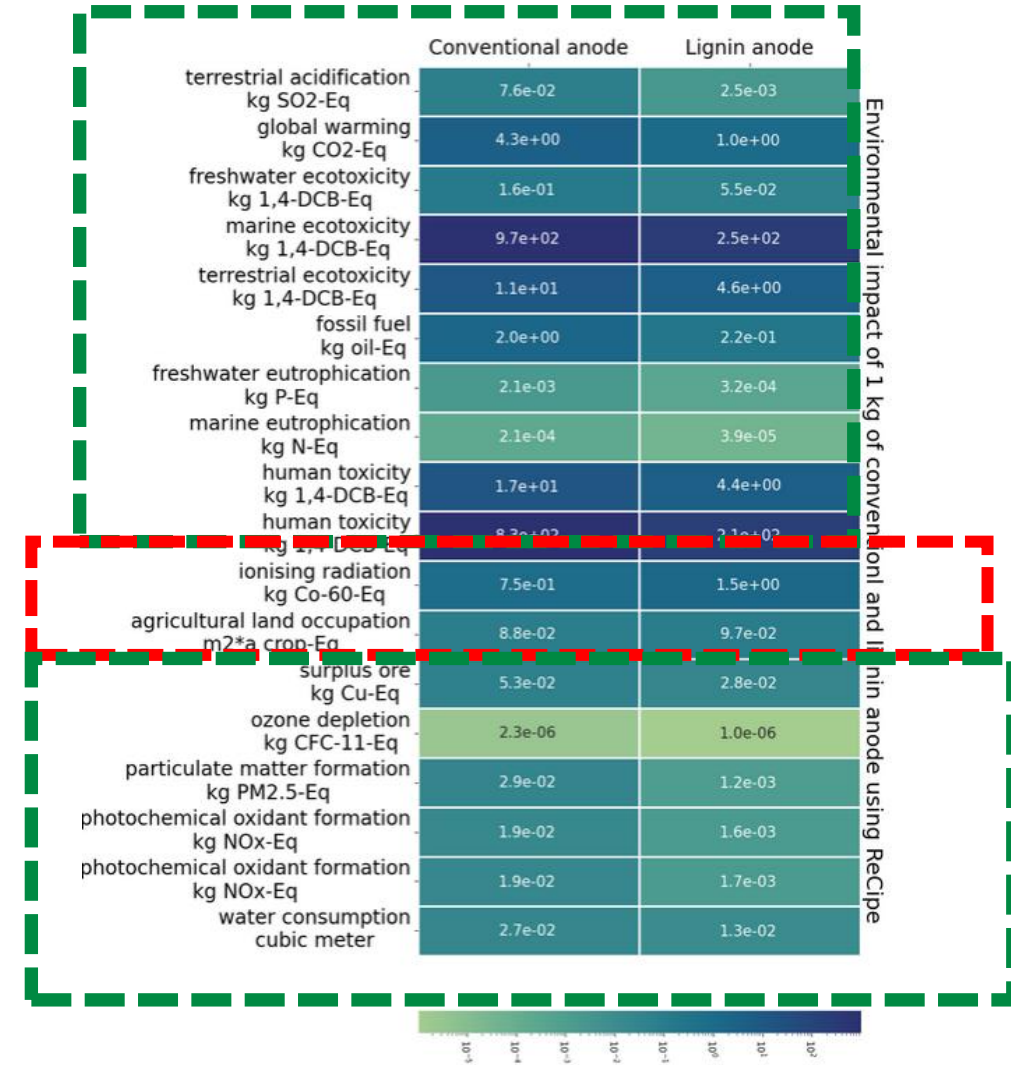


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Environmental footprint, LCIA method



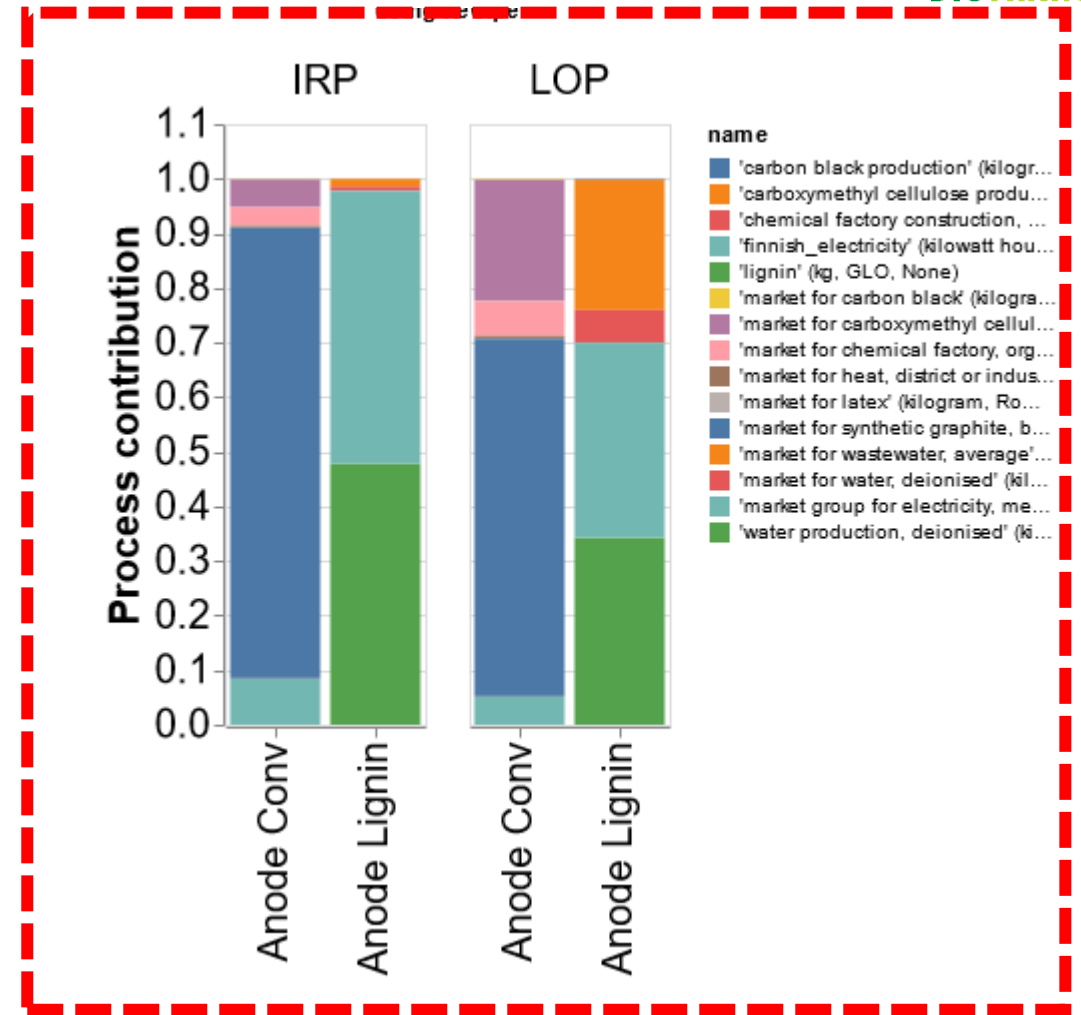
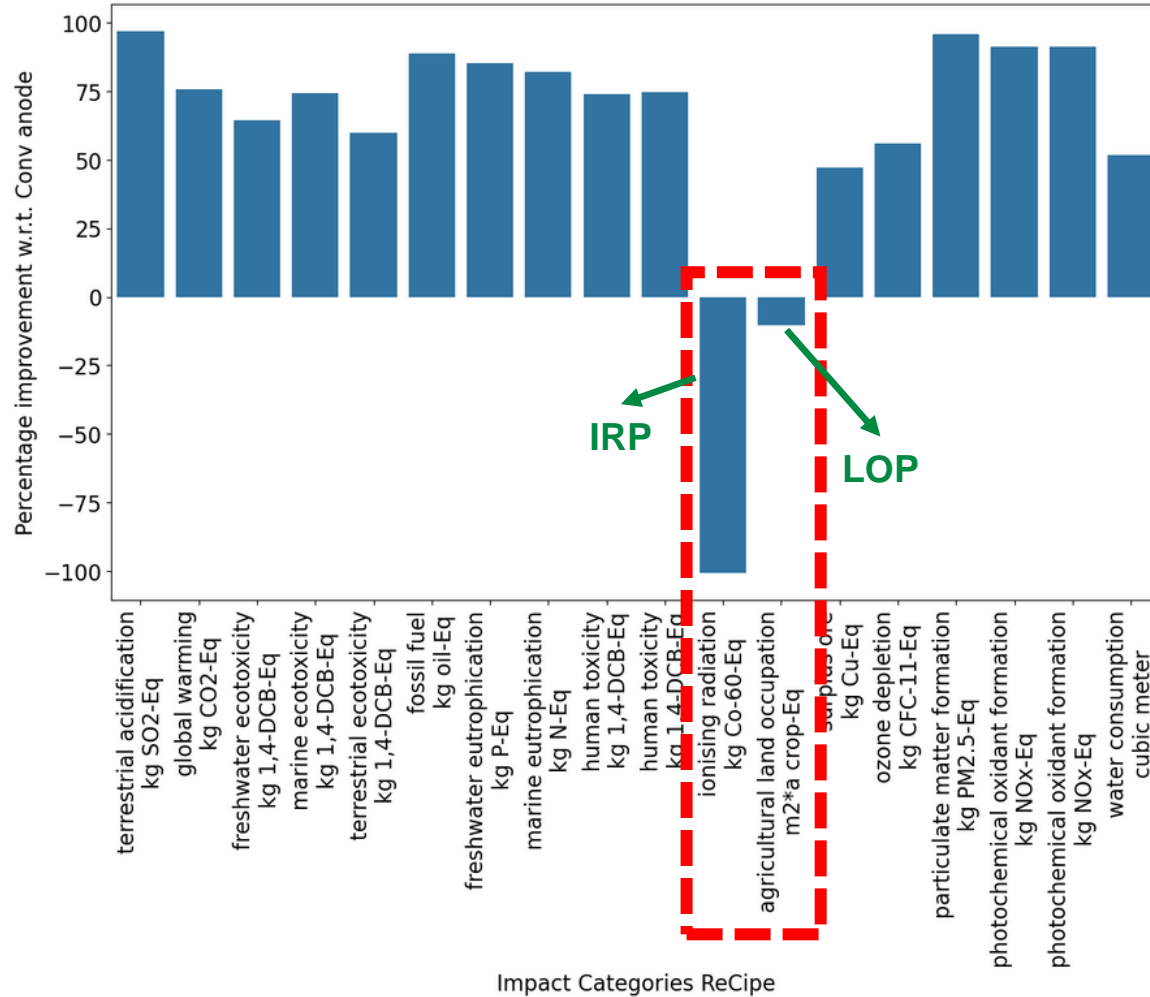
ReCiPe 2016 v1.03, LCIA method



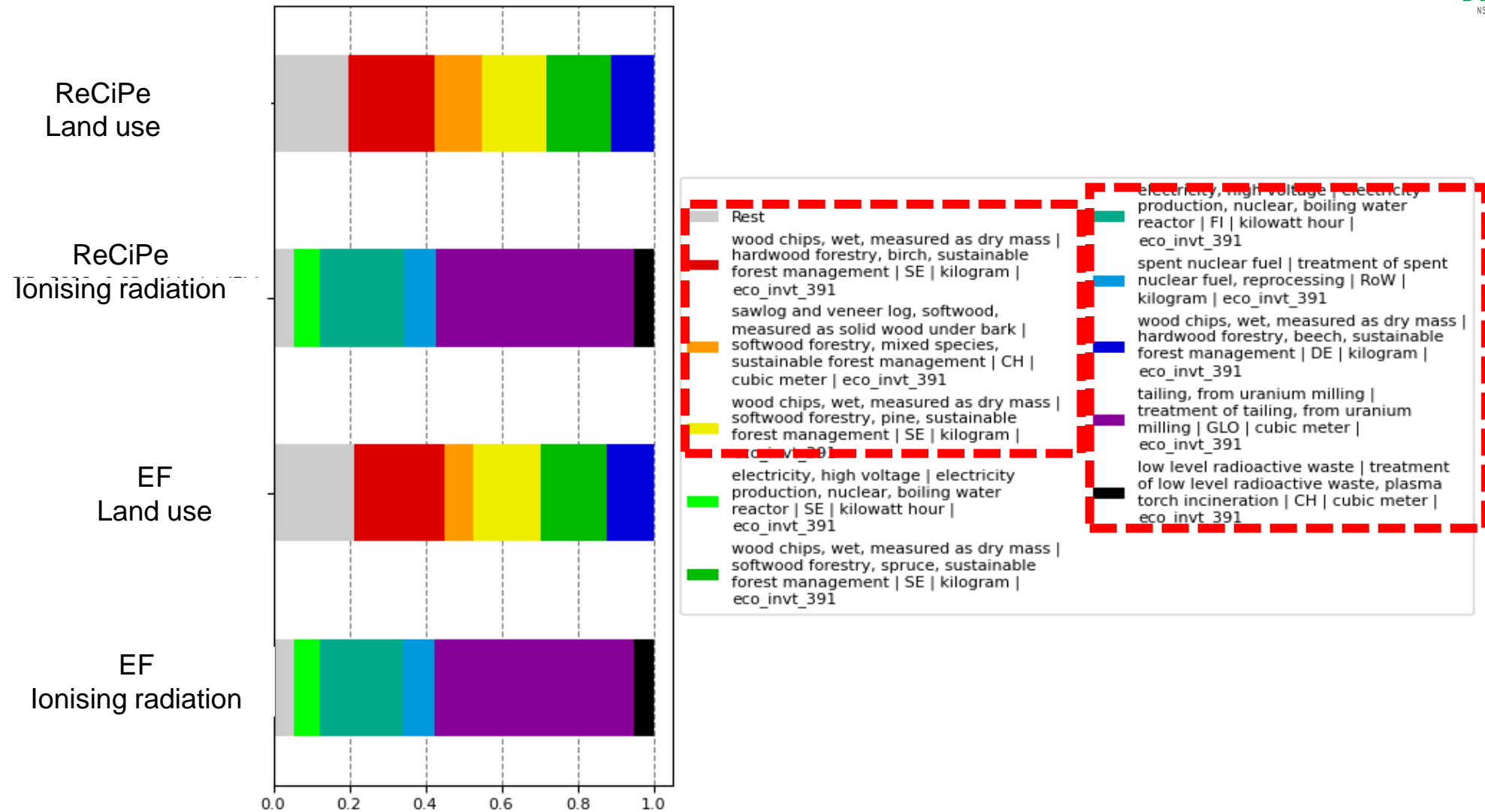
LCIA: Comparative impact



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LCIA: Impact of processes



Interpretation:

Environmental impact is producing anode using lignin in comparison to conventional anode:

- has **lower** impacts for **most of the impact categories (climate change, water use, human toxicity etc.)**
- has **higher** for two impact categories (ionising radiation potential, land use)

Finnish electricity mix → contribution from nuclear electricity

→ contribution from forestry which has higher impact for land use

Now based on the regional priority the policy makers can decide

Environmental sustainability assessment: Anode production



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From one mill we can obtain 300,000t of lignin



312 500t of anode

Environmental :

Reduced emissions: **1184 Mt** CO2-equivalent

Reduced human toxicity: **0.0021171875 kg** DCB eq

Increased ionizing radiation potential: **187.5Mt** kBq U235-eq

Increased Impact of land use: 937.5 m2 crop-equivalent

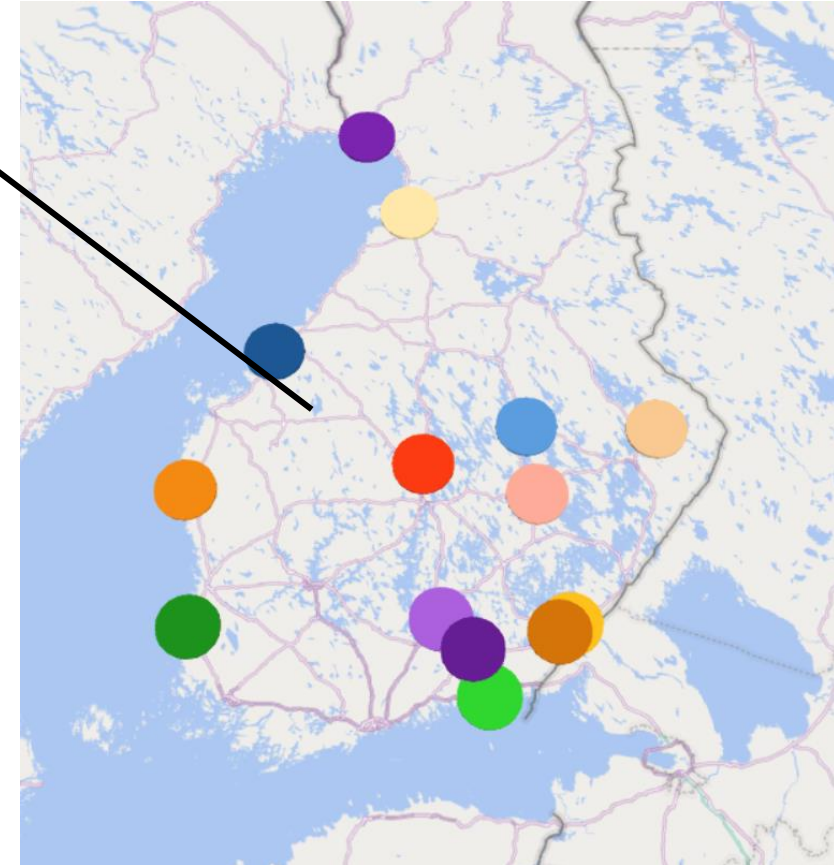


Fig: Location of Finnish paper 14 paper mills

Questions and Answers



Contact Details

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Appendix: background data

- Ecoinvent is recognized as the world's leading supplier of consistent and transparent life cycle inventory data
- The database contains more than 3500 industrial processes, and these are extensively documented
- Data are available for the following sectors:
 - Energy, transport, building materials, chemicals, washing agents, paper & board, agriculture and waste management.
- The database is described at www.ecoinvent.ch





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