ecoinvent v3: System models & linking of datasets into systems
The situation in ecoinvent so far

Single system model

Enforced direct linking

Multiple system models

Direct & indirect linking possible
A system model is a collection of modelling choices made for the database.

System models differ in 2 main modelling choices:
- Resolving multi-output activities by allocation or by system expansion.
- The use of average or unconstrained suppliers.

In LCA, the attributional and consequential system models are the most well-known:
- Attributional uses allocation and average suppliers.
- Consequential uses substitution / system expansion and unconstrained suppliers.
System models in ecoinvent v3

- So far, the ecoinvent database applied one system model
  - Allocation (expert identified)
  - Average suppliers
  - Carbon corrections

- In version 3, multiple system models will be available
  - Allocation, Default (attributional LCA)
    - Uses allocation (expert identified, optional – revenue by default)
    - Average suppliers, carbon corrections
    - Maintains system model choices of ecoinvent v2.2
  - System models based on other allocation properties possible
    - Revenue allocation, mass, carbon content, … ?
In addition to allocation-based models, there are now substitution-based models available.

- **Consequential**
  - Uses substitution (i.e. system expansion), with constrained by-products, markets and technologies.

- **Substitution, constrained by-products**
  - Similar to the consequential model.
  - Does not use constraints due to markets and technology (i.e. average, not marginal suppliers).

Further system models possible as demand develops.
System models in ecoinvent v3

How are multiple system models possible?

- Cumulative LCI Data
  - Linked single-product datasets
    - Multiplication with LCIA factors
      - Matrix inversion
      - System model Y
      - System model X
      - Unlinked multi-output datasets
      - LCIA Results
      - Model Y
      - Model X
Indirect linking in ecoinvent v3

Indirect linking:

Producing Activity

Product

Consuming Activity

Products not independent of the activity

Producing Activity

Product

Consuming Activity

Linking done through markets/consumption mixes

Product
Benefits of indirect linking

- **Market datasets** provide all producing activities of a product for a region, they represent the consumption mix.
- Linking rules can be **modified** to create **multiple system models**.
- **Consistent availability** of consumption mixes is beneficial for data suppliers.
- **Flexible updating** of existing supply chains.
- **Additional information** can be added:
  - Transportation requirements
  - Losses & spoilage
  - …
- Direct linking **still possible** to specify supplying activities.
Flexible supply chain updates

- Producing Activity
- Market for product
- Consuming Activity
- Producing Activity
- New market for product
- Consuming Activity
- NEW!
System model linking

- **Separation** of product and activity names
- **Market datasets** are available for all products
- **Linking step** applies **system model rules** based on product names and geographical location
System model linking

Unlinked datasets with product markets

By-product constraints: Using the distinction between by-products and reference products

Technology constraints: Using the technology level classification

Average suppliers

Constrained suppliers

Market constraints: Using conditional exchanges (reduction in consumption)
System model linking

Models without constraints, using different allocation properties

Models with different constraints, using substitution

Allocation, Default

Revenue

Consequential: by-product and technology constraints

Subst., cbp: Only by-product constraints

One simple, unlinked system of datasets
The use of negative product flows

- An input can be modelled and displayed as a **negative output**
- An output can be modelled and displayed as a **negative input**
- Identical to normal linking, but with a negative sign
- Allows **maintaining mass balances** when modelling the physical and economic causalities for materials for treatment
The use of negative product flows

- **Mass balances** are maintained
  - Treatment activities can be modeled as services with a product of removing a material (negative output)
  - Treatments of **by-products and wastes** can only included in the supply chain if they appear as (negative) inputs

- Independent of the **display** of datasets
  - By-products entered as outputs, which is more **intuitive** for data providers, effects therefore internal
Implications for data providers

- No requirement to link to specific producing activities, product inputs available that are linked to market inputs
- No requirement to provide allocation factors (optional)
- No requirement to distinguish between by-products, recyclable materials or wastes
  - Database automatically identifies materials for treatment
- No need to supply market datasets
  - A global market is autogenerated for new products
  - Local markets or other information can be added
Implications for data providers

- **Correct choice** of intermediate **outputs** is important
  - Choice determines the **market** & **alternative producers**

- **Reference product** needs to be specified

- **Technology level** should be considered (optional)
  - Determines marginal suppliers in the consequential system model

- Contribution to existing markets shall be provided
  - Specified via production volumes of activities

- **New requirements** – **detailed guidance** is provided
**Implications for end users**

- **Multiple system models** are available
  - Different system models serve **different purposes**, so the **applicability** of the ecoinvent database is broadened
  - Based on the **same underlying data** → discussion on system model choice is removed from discussion on data quality
  - Results will be **significantly different** between system models for certain products
    - Areas of significant technological change

- Existing data in ecoinvent is **automatically updated** with improved supply chain data over updates
Implications for end users

- **Consistency** with the existing approach is maintained in the “Allocation, Default” system model.

- Data for **new system models** (technology levels, constraints) do not affect the quality of the default model.

- **Linked unit processes**, **cumulated system inventories** and **impact assessment** results are all available:
  - Data available on homepage in **ecospold2** and as **excel-sheets**
  - **Software tools** can **use the data** without implementing the linking algorithms.
Thank you for your attention!

www.ecoinvent.org