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Swiss Centre for Life Cycle Inventories

A joint initiative of the
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48th Discussion Forum, Dübendorf

ecoinvent v3: System models & linking of datasets into systems

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The situation in ecoinvent so far

Single system model	Enforced direct linking
↓	↓
Multiple system models	Direct & indirect linking possible

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System models for an LCI database

- 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, … ?

System models in ecoinvent v3

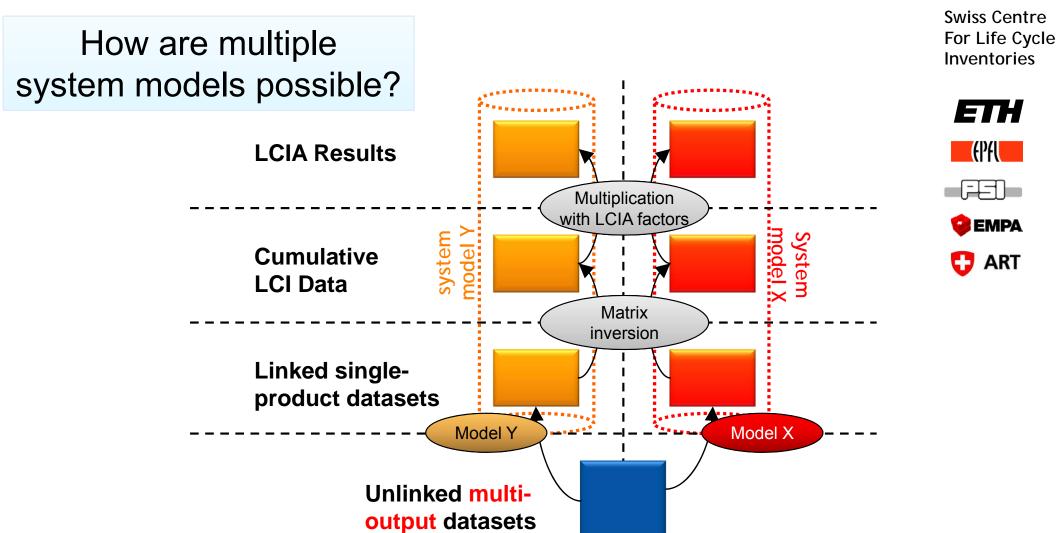■ In addition to **allocation-based** models, there are now **substitution-based** models available

   ◆ **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)

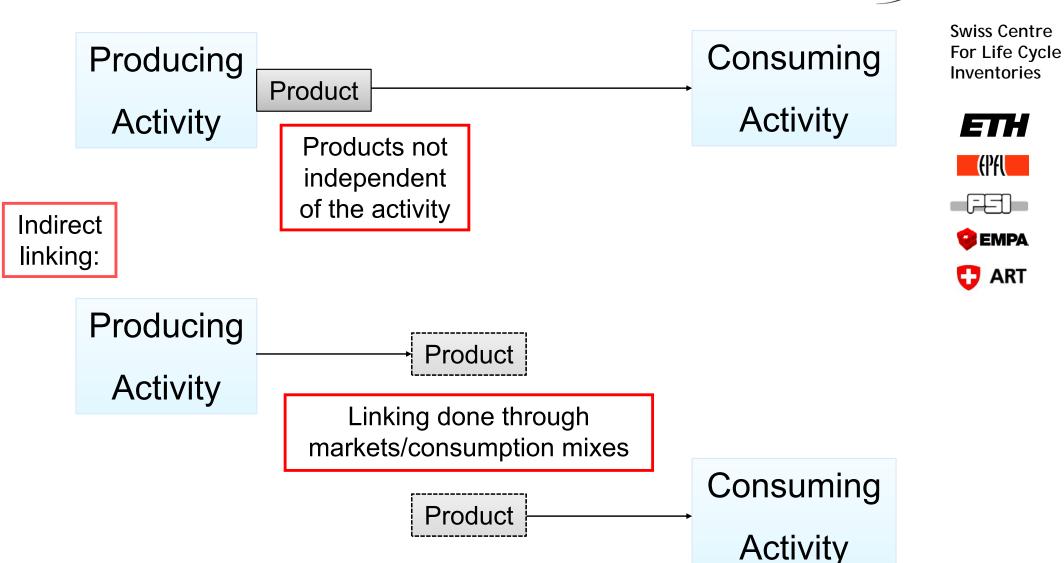■ Further system models possible as demand develops

System models in ecoinvent v3

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How are multiple system models possible?

LCIA Results

Cumulative LCI Data

Linked single-product datasets

system model Y

System model X

Multiplication with LCIA factors

Matrix inversion

Model Y

Model X

Unlinked multi-output datasets

Indirect linking in ecoinvent v3

Producing Activity →[Product]→ Consuming Activity

Products not independent of the activity

Indirect linking:

Producing Activity →[Product]

Linking done through markets/consumption mixes

[Product]→ Consuming Activity

Benefits of indirect linking

- **Market datasets** provide all producing activities of a product for a region, they represent the consumption mix

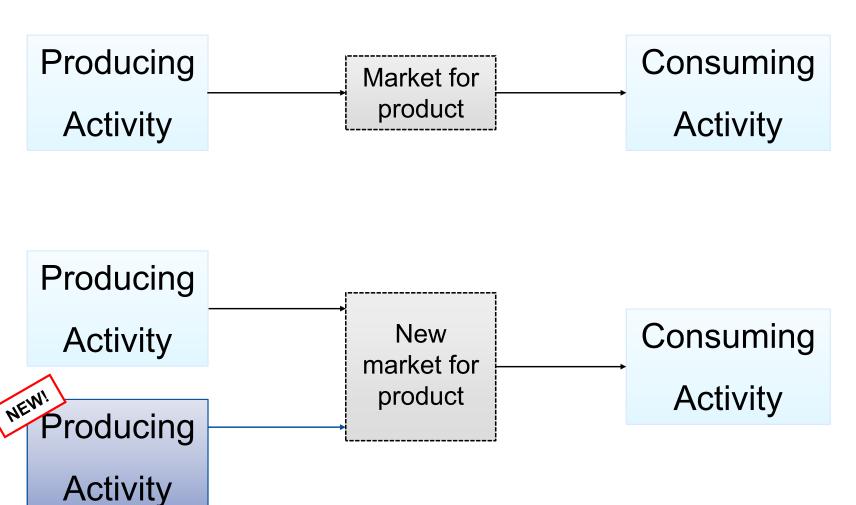- Linking rules can be **modified** to create **multiple system models**

- **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

System model linking

- **Separation** of product and activity names

- **Market datasets** are available for all products

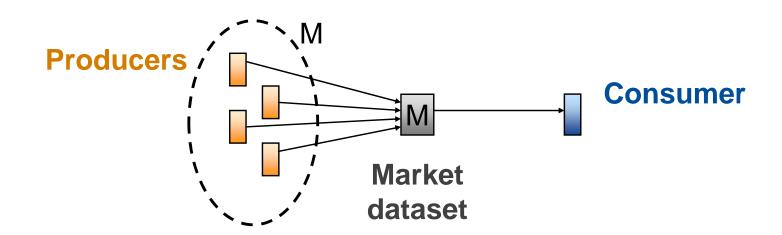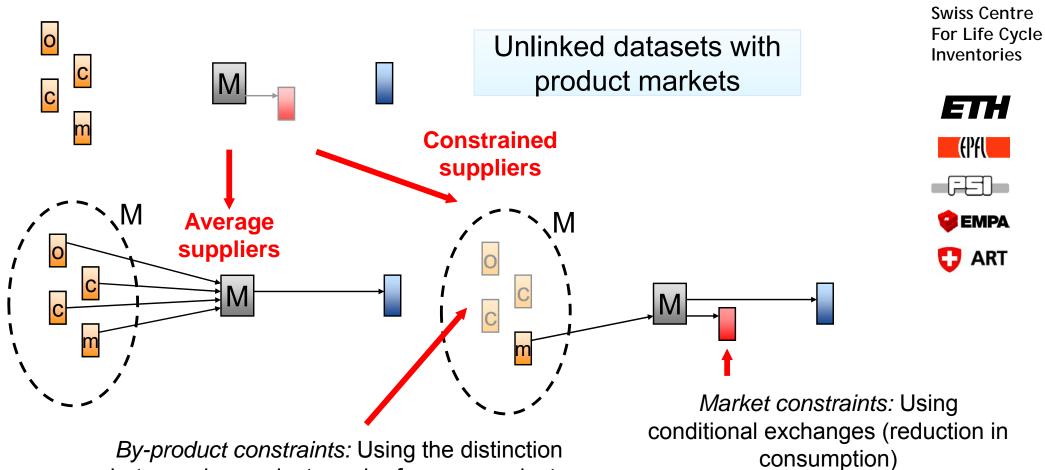- **Linking step** applies **system model rules** based on product names and geographical location

System model linking

Unlinked datasets with product markets

Constrained suppliers

Average suppliers

M

M

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

Technology constraints: Using the technology level classification

Market constraints: Using conditional exchanges (reduction in consumption)

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System model linking

One simple, unlinked system of datasets

Models without constraints, using different allocation properties

Allocation, Default

Revenue

(other)

Models with different constraints, using substitution

Consequential: by-product and technology constraints

Subst., cbp: Only by-product constraints
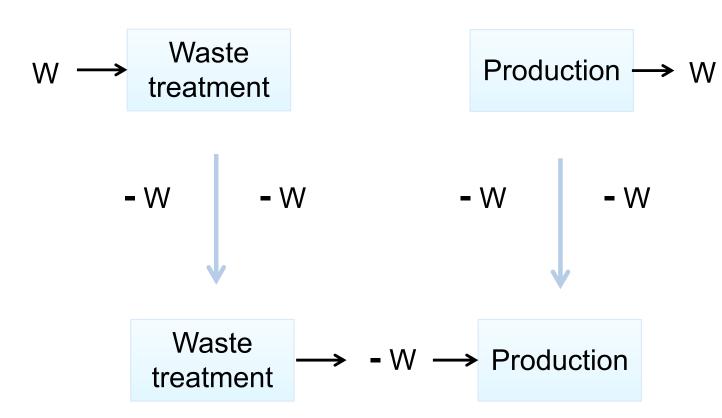
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The use of negative product flows

- 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**

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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

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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

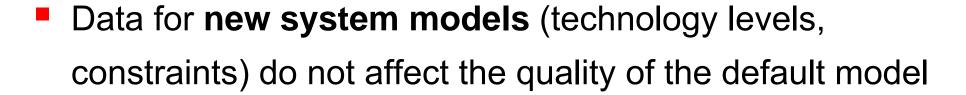- Existing data in ecoinvent is **automatically updated** with improved supply chain data over updates

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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

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