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Using parameteriation to handle combined & joint co-production



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Inventories

Presentation for the 48th Swiss LCA Discussion Forum

Zürich, 2012.06.13.

ETH



Bo Weidema

ecoinvent Centre



Content

- Combined and joint co-production
- Combined production: Modelling the physical relationships
- Joint production: Partitioning or substitution
- Parameters for allocation: Revenue or physical properties
- Allocation at the point of substitution
- Substitution: Modelling market constraints



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Combined and joint co-production



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- **Variable** output proportions: **Combined** production
→ subdivision according to physical relationships
- **Fixed** output proportions: **Joint** production
→ substitution (system expansion), or
→ partitioning (allocation)

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Combined production: Modelling the physical relationships



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- In v. 1 & 2:
 - Individual allocation property for each exchange, OR
 - One dataset per product: Manual subdivision
- In v. 3:
 - Mathematical relations from each exchange to the co-product that causes the exchange: $E = 2 \cdot A + 3 \cdot B$
 - Automatic subdivision of dataset: $E_A = 2A$ and $E_B = 3B$

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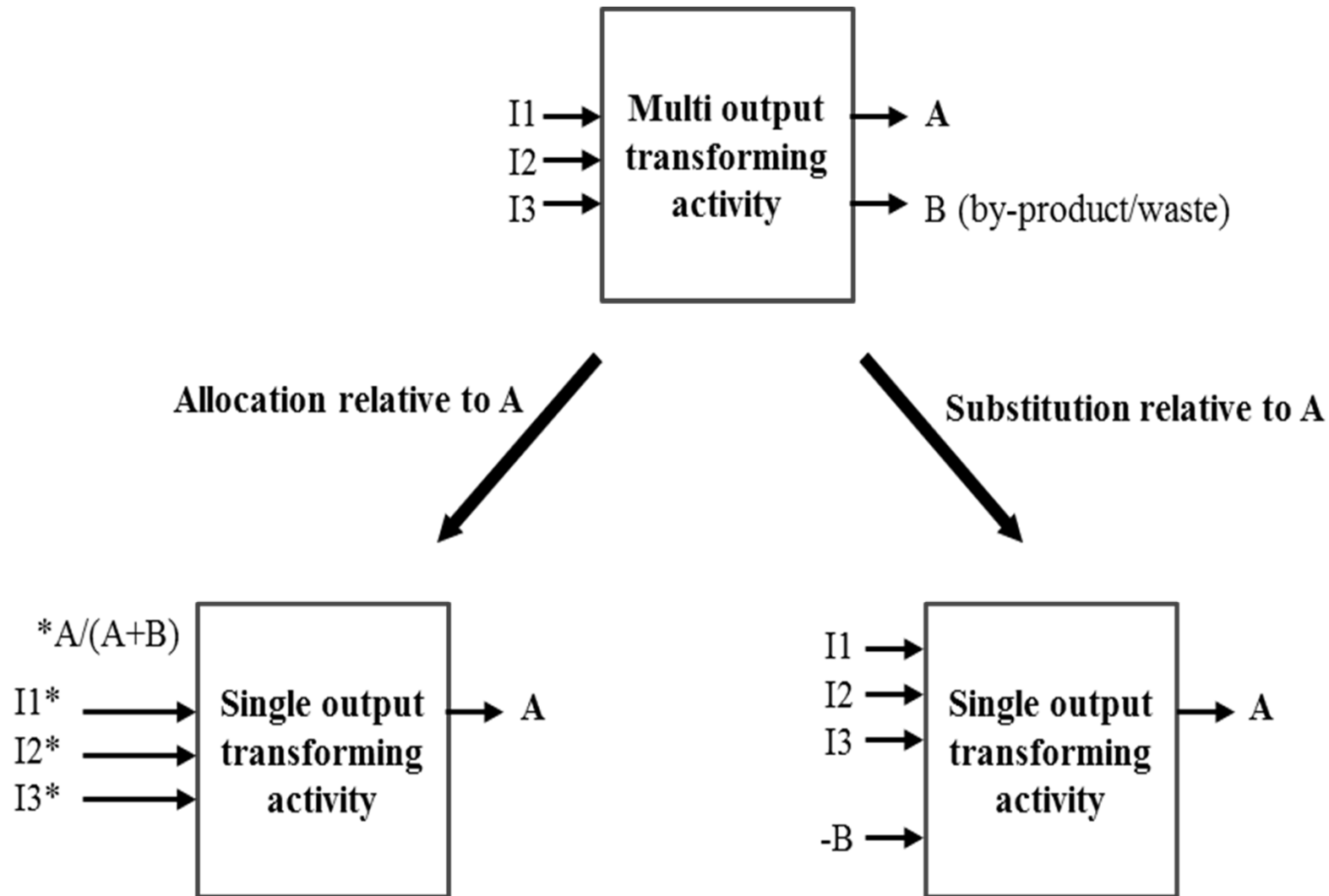
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Joint production: Partitioning or substitution



Parameters for **allocation**: Revenue or physical properties



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- Two rationales:
- Revenue as the driver for the production (“economic causality”)
- Physical output as the driver for the input
- Mutually exclusive: A choice has to be made
- One system model for each allocation algorithm:
- Prerequisite: allocation property present in all intermediate outputs
- Revenue = **Price** * Amount
- True value = Revenue * **True value relation (e.g. exergy)**
- Mass = **Dry mass** * Amount (not for LCA)
- Carbon = Mass * **Carbon content** (not for LCA)

The logo for ETH (Eidgenössische Technische Hochschule), consisting of the letters 'ETH' in a bold, italicized font.

The logo for EPFL (École Polytechnique Fédérale de Lausanne), consisting of the letters 'EPFL' in a bold font inside a red rectangle.

The logo for PSI (Paul Scherrer Institut), consisting of the letters 'PSI' in a bold font inside a grey rectangle.

The logo for EMPA (Empa - Eidgenössische Anstalt für Materialprüfung), consisting of a red shield with a white cross and the letters 'EMPA' in a bold font.

The logo for ART (Anstalt für Ressourcennutzung, Technologieentwicklung und -bewertung), consisting of a red shield with a white cross and the letters 'ART' in a bold font.



Parameters for **allocation**: Revenue or physical properties



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- Two rationales:
- Revenue as the driver for the production (“economic causality”)
- Physical output as the driver for the input
- Mutually exclusive: A choice has to be made
- **The ecoinvent default allocation - a compromise:**
- True value as allocation property
- Allocation correction for carbon: To ensure carbon balance

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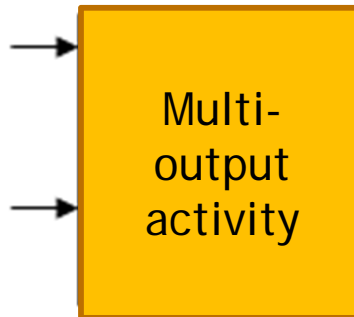


Allocation corrections (automatic)

Before allocation:

1.7 kg product Z;
C_content 0.2 kg/kg

0.5 kg resource R;
C_content 0.52 kg/kg



1 kg product X; price 9 EUR/kg;
C_content 0.5 kg/kg

0.5 unit product Y; price 2
EUR/unit; C content 0 kg/unit

0.2 kg emission E; C_content 0.5 kg/kg

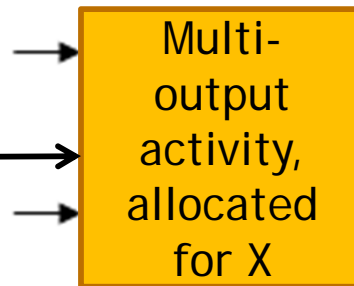
$$\text{Total revenue (EUR): } 1 * 9 + 0.5 * 2 = 9 + 1 = 10$$

After allocation:

Allocation
correction
for carbon

$1.7 * 9/10 = 1.53$ kg
product Z; 0.306 kg C

$0.5 * 9/10 = 0.45$ kg
resource R; 0.234 kg C



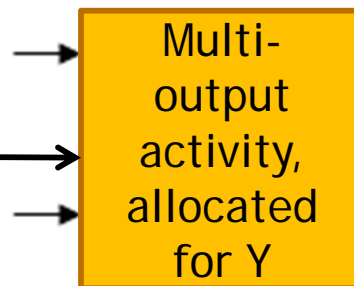
1 kg product X; 0.5 kg C

$0.2 * 9/10 = 0.18$ kg emission E;
0.09 kg C

Allocation
correction
for carbon

$1.7 * 1/10 = 0.17$ kg
product Z; 0.034 kg C

$0.5 * 1/10 = 0.05$ kg
resource R; 0.026 kg C



0.5 unit product Y; 0 kg C

$0.2 * 1/10 = 0.02$ kg emission E;
0.01 kg C

↑
0.1832 kg CO₂ from
air; 0.05 kg C

Parameters for allocation: Revenue or physical properties



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- Two rationales:
- Revenue as the driver for the production (“economic causality”)
- Physical output as the driver for the input
- Mutually exclusive: A choice has to be made
- **The ecoinvent default allocation - a compromise:**
- True value as allocation property
- Allocation correction for carbon: To ensure carbon balance
- **Why only for carbon?**
 - Carbon is environmentally relevant both as input and output

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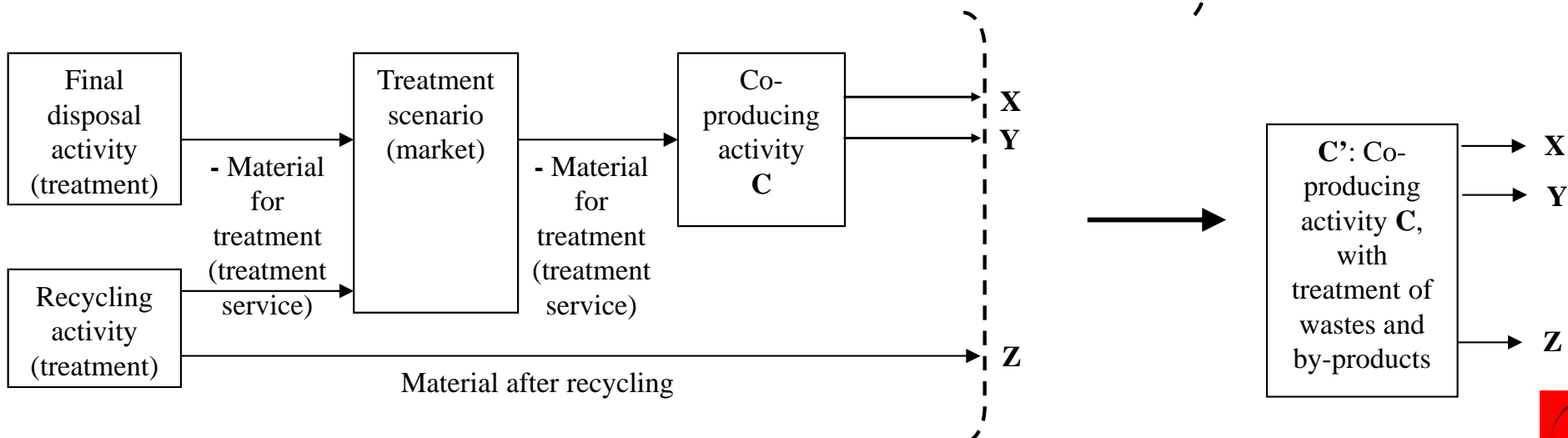
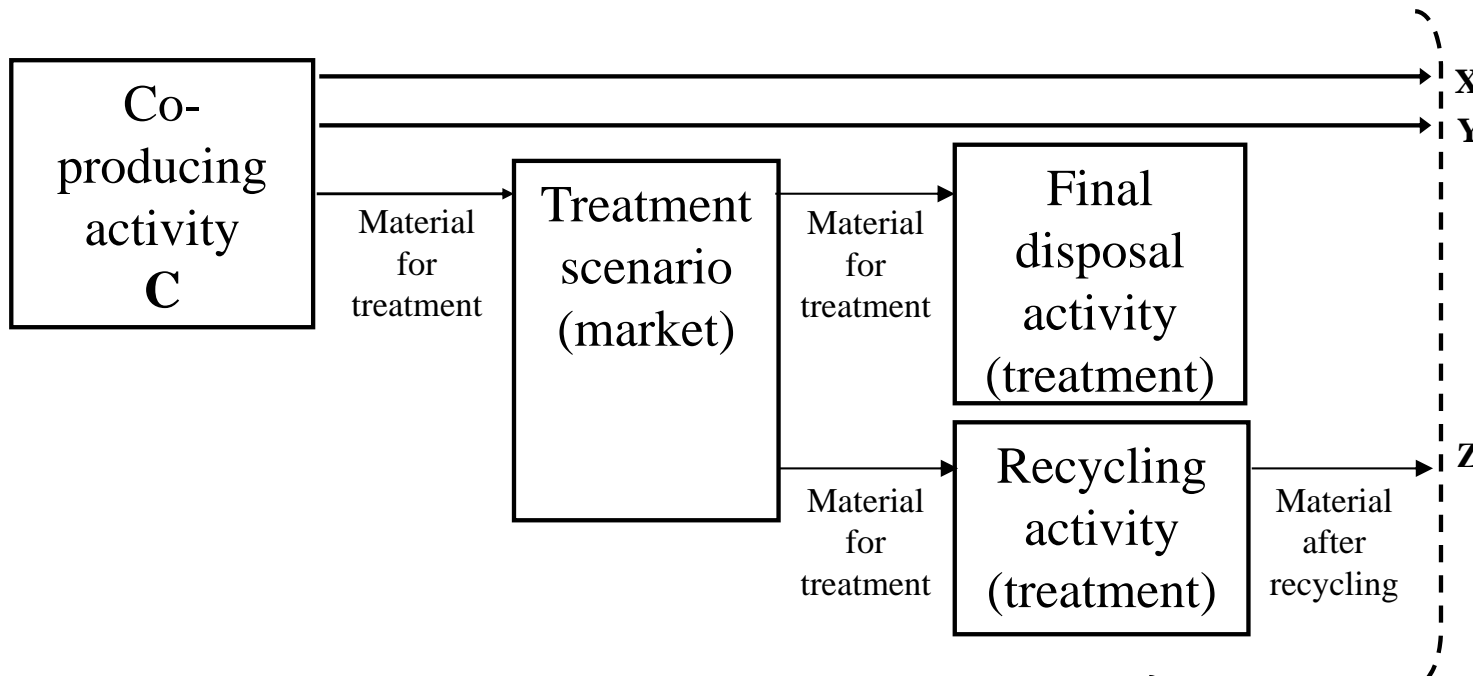


Allocation

- at the point of substitution:



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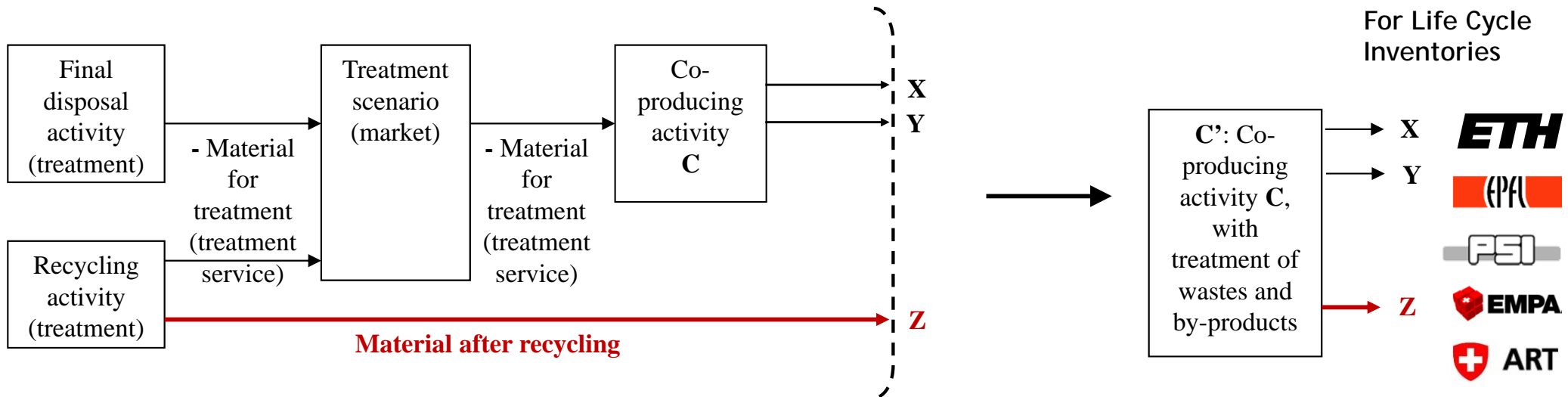


Allocation

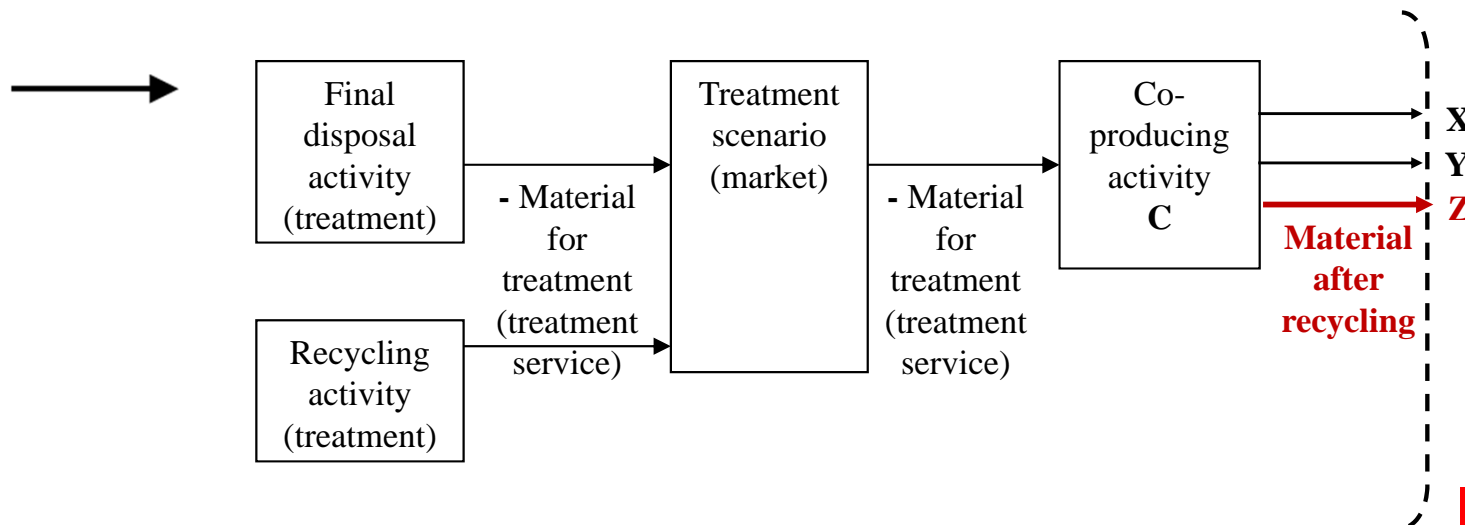
- at the point of substitution:



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OR



Allocation

- at the point of substitution:

- All treatment activities are attributed to the activities that produce the materials that need treatment, disregarding whether these are defined as wastes or by-products
- Allocation result unaffected by choices of the degree of detail (result cannot be manipulated by moving treatment in or out)
- The full value of the by-products is attributed to the product system that gives rise to these by-products (any value-correction unnecessary)
- Price of the by-product is always available (while the price of a waste or by-product before or during treatment often can only be estimated, and if available may often be influenced by irrelevant properties of other wastes or regulatory conditions)



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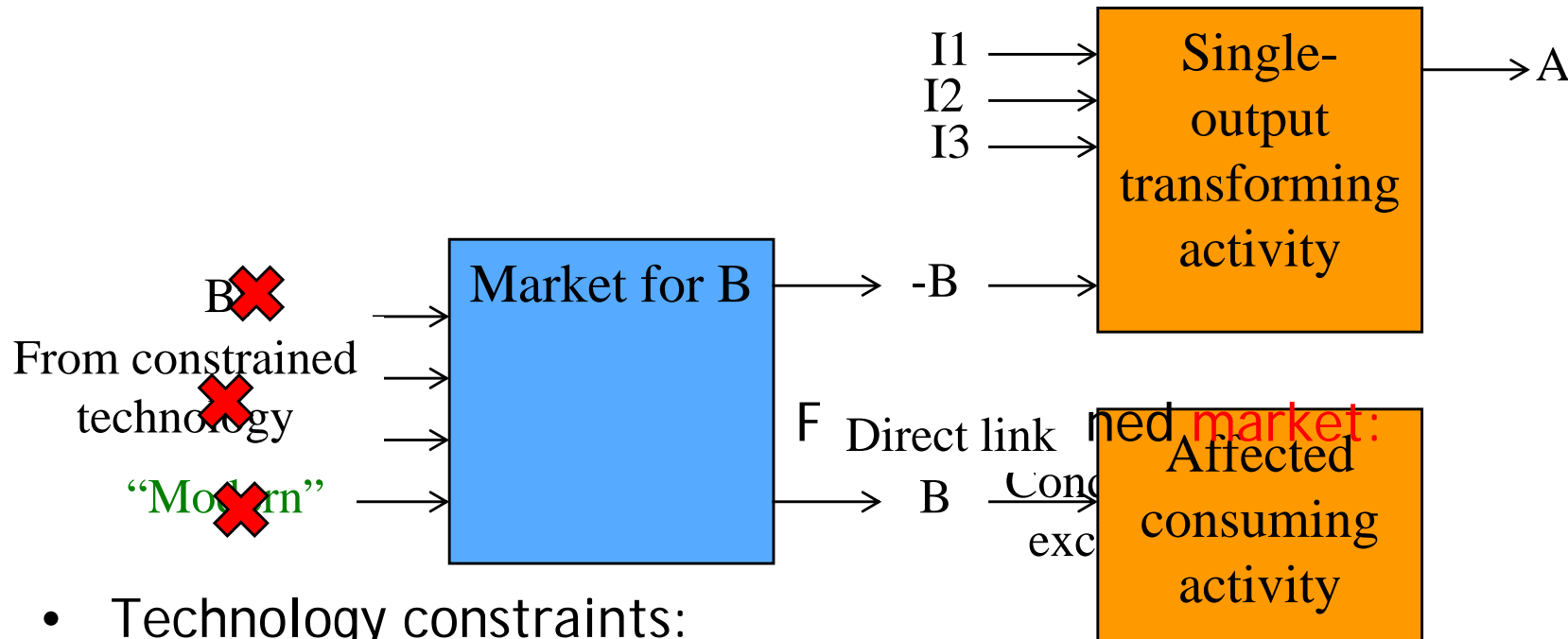
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Substitution: Modelling market constraints

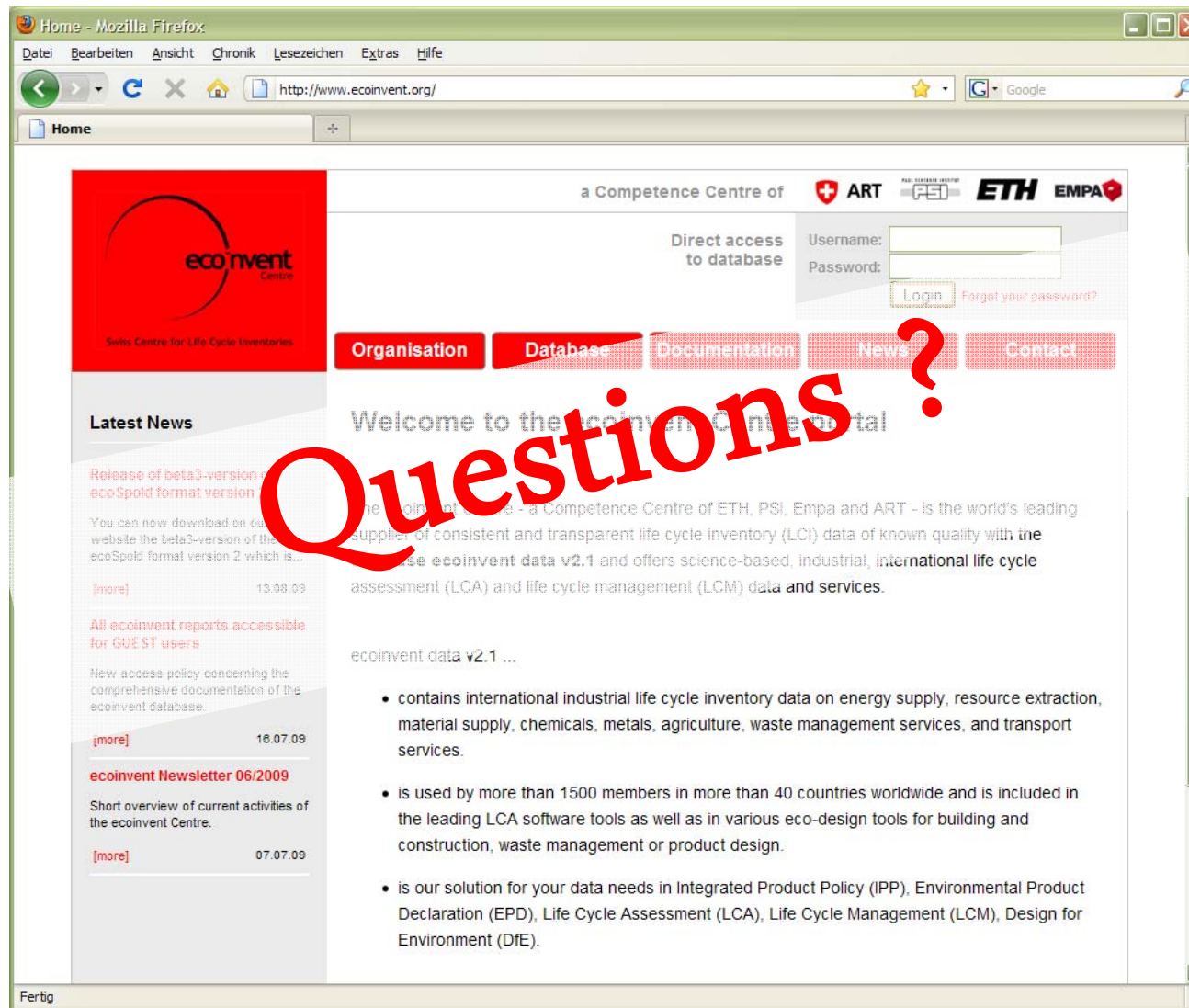


- Technology constraints:

- Technology level as a machine-interpretable activity field:

Outdated, Old, Current, Modern, New (classification)

- System model algorithm identifies which of the technologies are unconstrained, i.e. are available for substitution in markets: in most cases "Modern" if available (depends on market trend)



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