


# CONSEQUENTIAL MODELLING

## - IN LIFE CYCLE INVENTORY ANALYSIS

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# Overview of videos

- 1) Attributional and consequential responsibility
- 2) ISO 14040/44: A standard for consequential LCA
- 3) How to fully reflect both physical and monetary causalities in LCA
- 4) Temporal issues in LCA
- 5) Learning from non-intuitive results
- 6) *The comparability algorithm*: Defining the functional unit
-  7) *The linking algorithm*: Composing a consumption mix
- 8) Identifying determining products
- 9) *The co-product algorithm*
- 10) Errors in background databases

# The linking algorithm:

## What do the standards say?

Unfortunately, the guidance is not very easy to find

- ISO 14044:2006 Clause 4.3 on Life cycle inventory analysis (LCI) references **ISO/TR 14049 Clause 6.4**, where the following guidance can be found on “**the identification of the upstream system for intermediate product inputs**” (ISO 14044:2006 amendment 2:2020 Clause D.2.1):
  - “The supplementary processes to be added to the systems must be those that would actually be involved when switching between the analysed systems. To identify this, it is necessary to know:
    - whether the production volume of the studied product systems fluctuate in time (in which case different sub-markets with their technologies may be relevant), or the production volume is constant (in which case **the base-load marginal is applicable**),
    - (...) whether (...) the inputs are delivered through an open market, in which case it is also necessary to know:
      - whether any of the processes or technologies supplying the market are **constrained** (in which case they are not applicable, since their output will not change in spite of changes in demand),
      - which of the unconstrained suppliers/technologies has the highest or lowest production costs and consequently is **the marginal supplier/ technology** when the demand for the supplementary product is generally decreasing or increasing, respectively.”

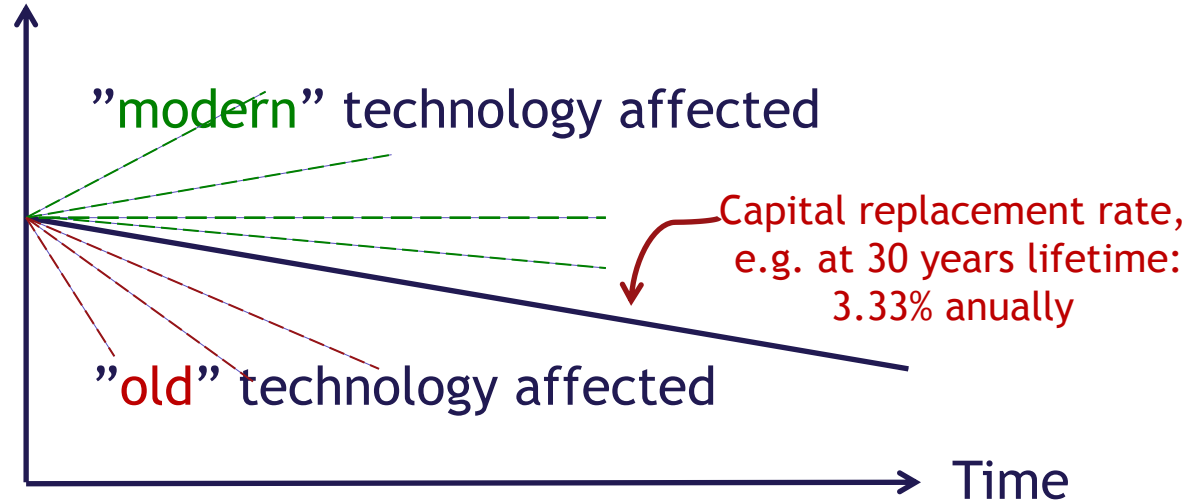
# The linking algorithm

## Identifying marginal, unconstrained suppliers

- i.e., modern, competitive suppliers, when the product demand is generally increasing; Old, uncompetitive suppliers, when the product demand is generally decreasing (ISO 14049 - Clause 6.4) relative to the replacement rate of capital (Weidema 2003).

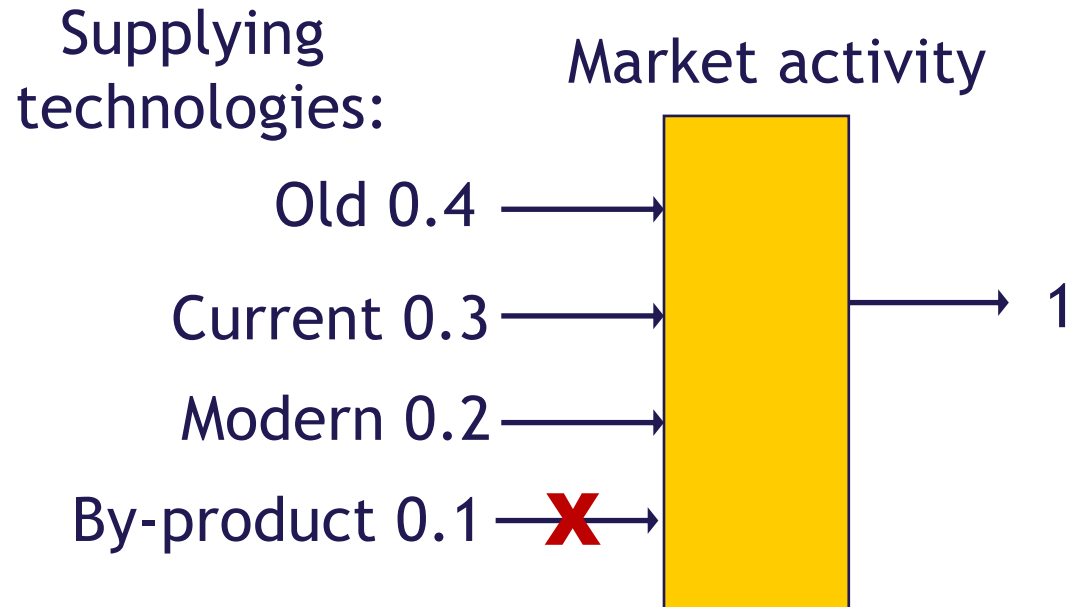
# Borderline between “modern” and “old”

Production volume  
= capacity requirement



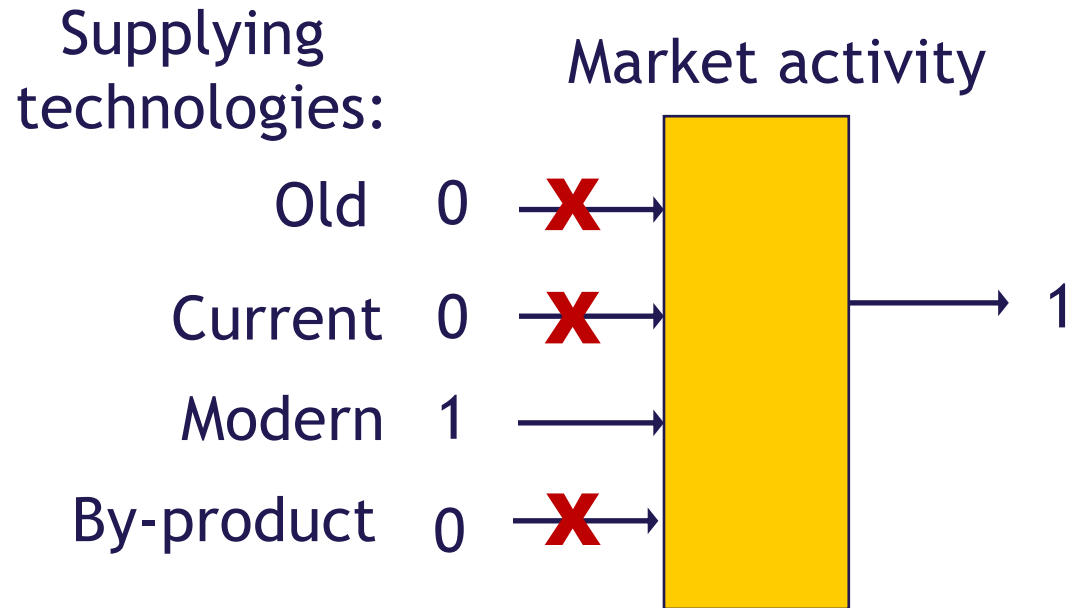
Example:  
Natural gas (30 years lifetime) in  
DK has a trend of -2.3% per year  
→ still a ‘modern’ technology

# The linking algorithm: By-products are always constrained



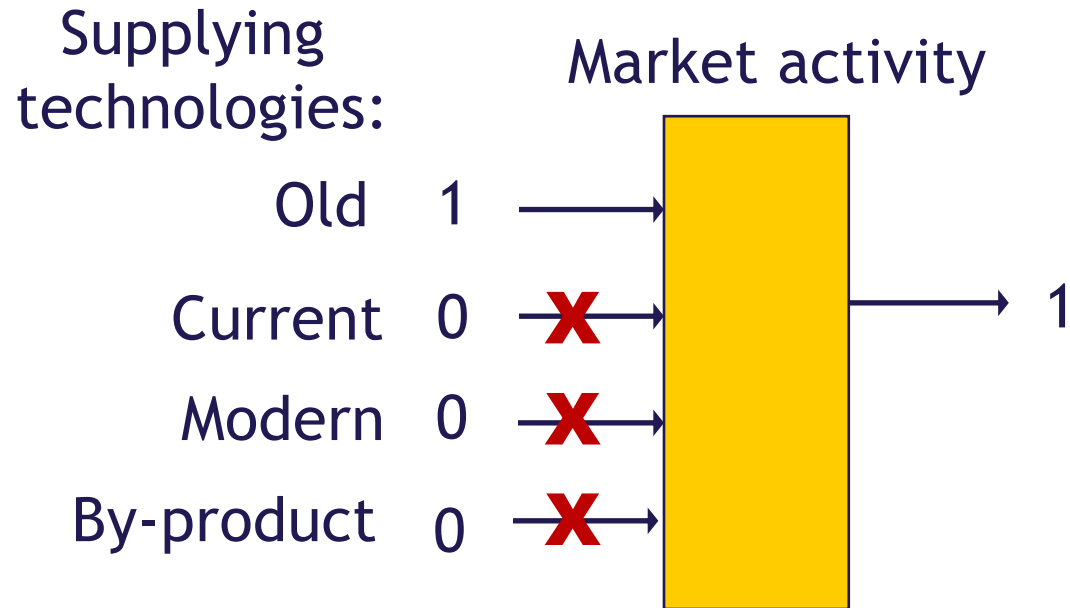
# The linking algorithm:

## Case: Increasing market trend



# The linking algorithm:

Case: Sharply decreasing market trend





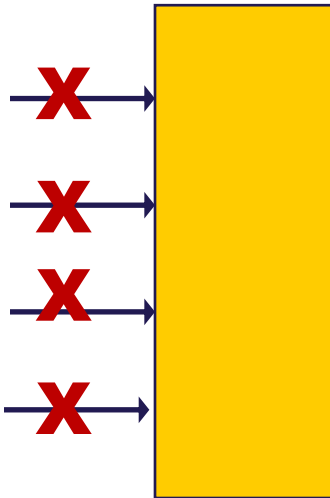
# The linking algorithm:

## Case: **Constrained market**

Supplying  
technologies:

Old 0  
Current 0  
Modern 0  
By-product 0

Market activity



Example:

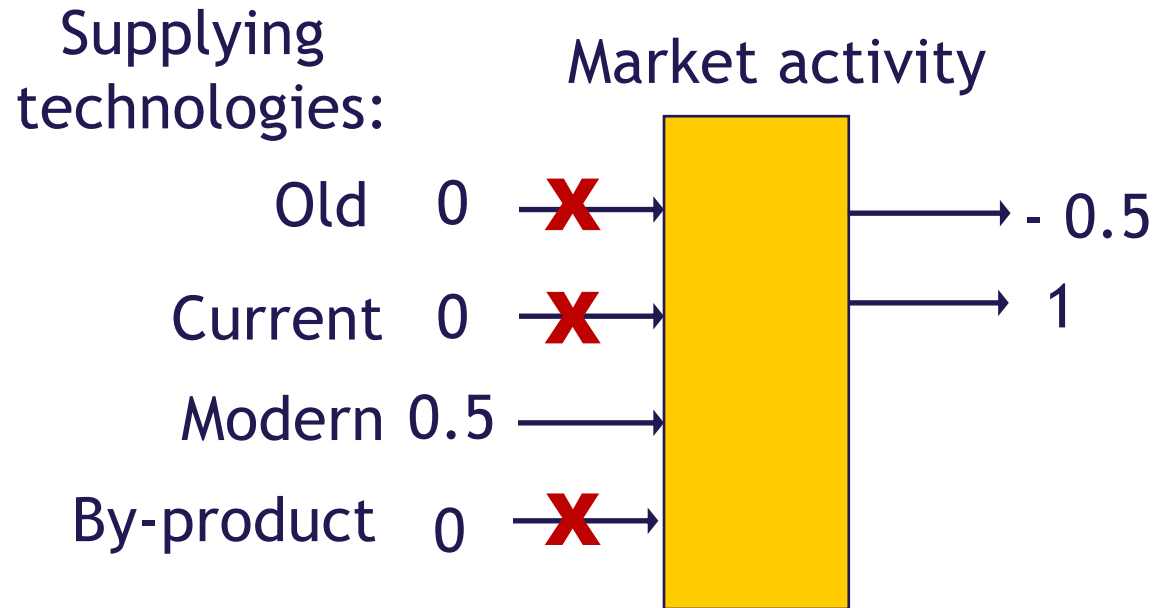
- 1  
- 1 kg NaOH + 1.325 kg soda

1  
1 kg sodium hydroxide (NaOH)



# The linking algorithm:

## Case: **Constrained market**



# The linking algorithm: Composing a consumption mix

How is this implemented in ecoinvent v3?

- **By-product constraints:** Only reference products (determining products) can be unconstrained and thus be part of a consumption mix
- **Technology constraints:** Technology level classification (outdated, old, current, modern, new) of the individual datasets, so the data provider thereby signals whether an activity should be part of the consequential consumption mix, thus making the determination subject to peer review and scientific dialogue
- **Constrained markets** (when there are **no** unconstrained suppliers to a market): Modelled as a reduction in consumption of the marginal consumer

THANKS FOR YOUR ATTENTION