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

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Determining product (definition)

- Product of an activity for which a change in demand will affect the production volume of the activity

  (called “reference product” in ecoinvent terminology)

Weidema B P (2003). *Market information in life cycle assessment*. Copenhagen: Danish Environmental Protection Agency. (Environmental Project no. 863) https://lca-net.com/p/1078

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Combined and joint production

- Combined production: Amounts of co-products can be varied independently → All products are determining, and the unit process can be subdivided according to physical causalities

  Example: Petroleum refinery
- Joint production: Amounts of co-products cannot be varied independently (i.e., proportions are fixed)

  → The determining product(s) must be identified depending on the existence of alternative production routes (see next slides)

  Example: Soy oil and meat

Milk and meat: Combined or joint?
Production optimised for one output → not variable

Determining and dependent products

- Co-production can be varied independently ⇒ Combined production

Joint production:

- Only one joint product without alternative production route: This product is the determining product ⇒ Type 1 situation
- All joint products have alternative production routes: Only one of these co-products is determining. Data on marginal productions costs, revenues, and normalised market trends used to identify the determining product ⇒ Type 2 situation
- More than one joint product has no alternative production route: All of these will be determining products ⇒ Type 3 situation
- Together, type 1, 2 and 3 cover all possible situations

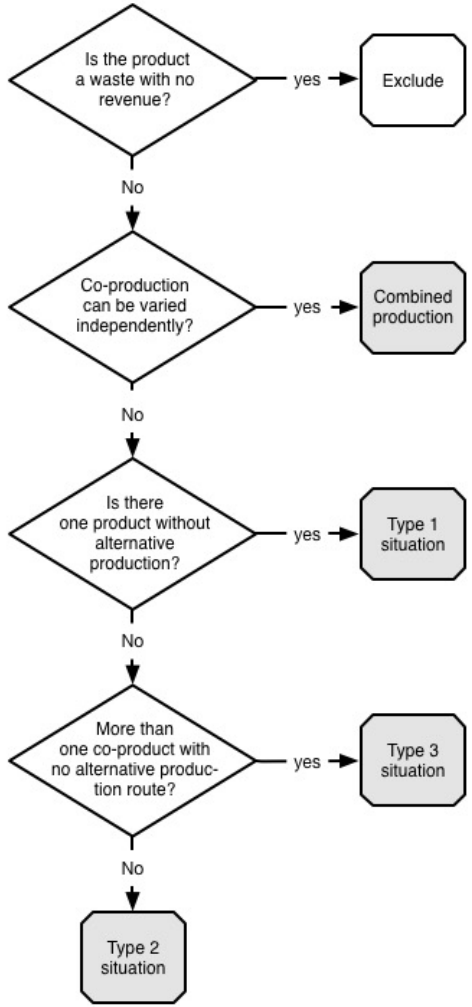


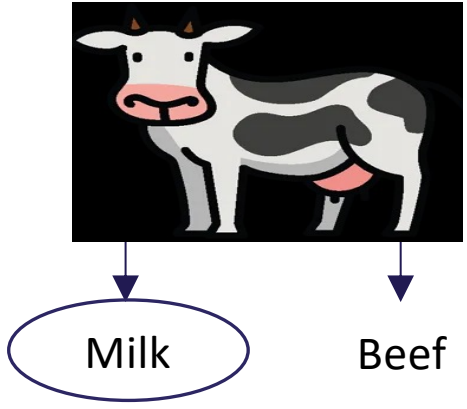
Figure: Decision tree to identify the various situations of determining and dependent products depending on the existence of alternative production routes for the co-products.

https://consequential-lca.org/clca/determining-or-dependent-co-products/

Type 1 situation

- only one joint product without alternative production route

- Products without alternative production routes are typically determining products
- simply because this is only way to produce the product



Must alone provide sufficient revenue to change the production volume

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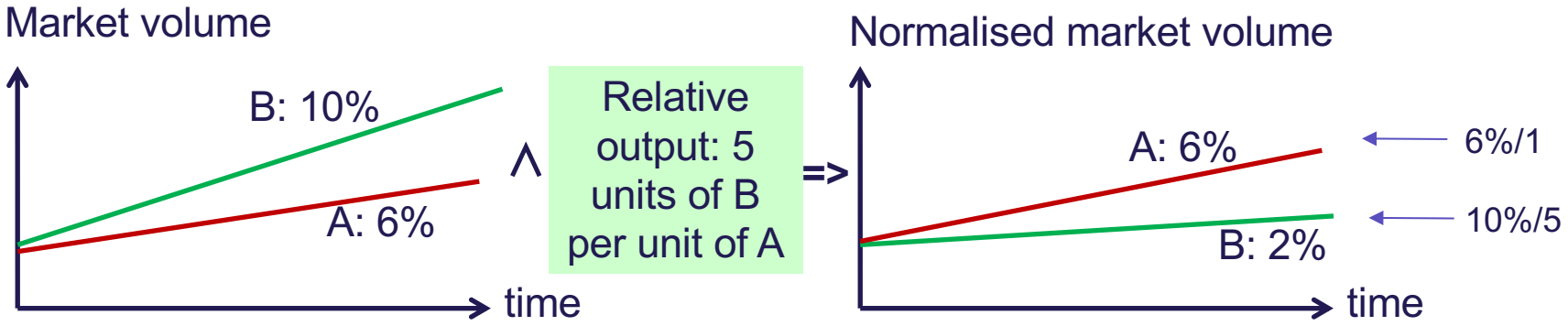
Type 2 situation

- all joint products have alternative production routes

- The determining product is the limiting factor for changing the production
- It shall, either alone or as part of a combination of joint products:
  1) Provide an economic revenue that exceeds the marginal cost of changing the production volume
  2) Have a larger normalised market trend than any other joint product or combination of products that fulfil 1)



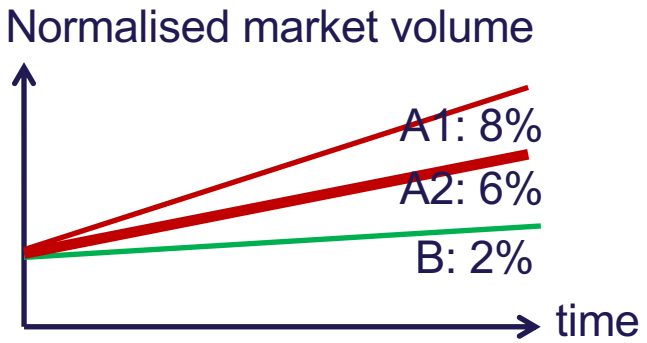
NOTE: The market volumes are for the generic markets, not for the specific joint production, for which the outputs by definition cannot vary independently

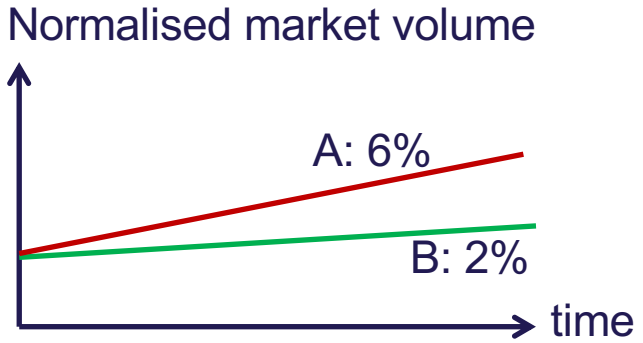
Type 2 situation

- all joint products have alternative production routes

When the demand for one of the co-products increase faster than that of the other:

- the co-product (combination) with *highest* normalised trend in demand will determine the output, when its revenue is adequate for the co-producing activity to change
- when the revenue from more co-products are required for the co-producing activity to change, the co-product with *lowest* normalised trend in demand will impose a constraint on the ones in higher demand

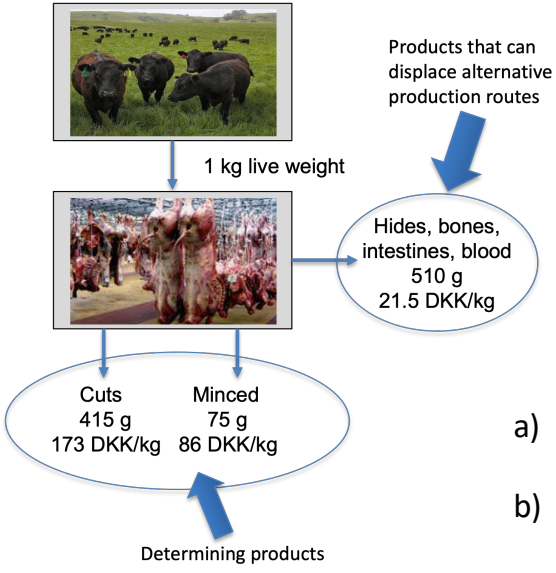


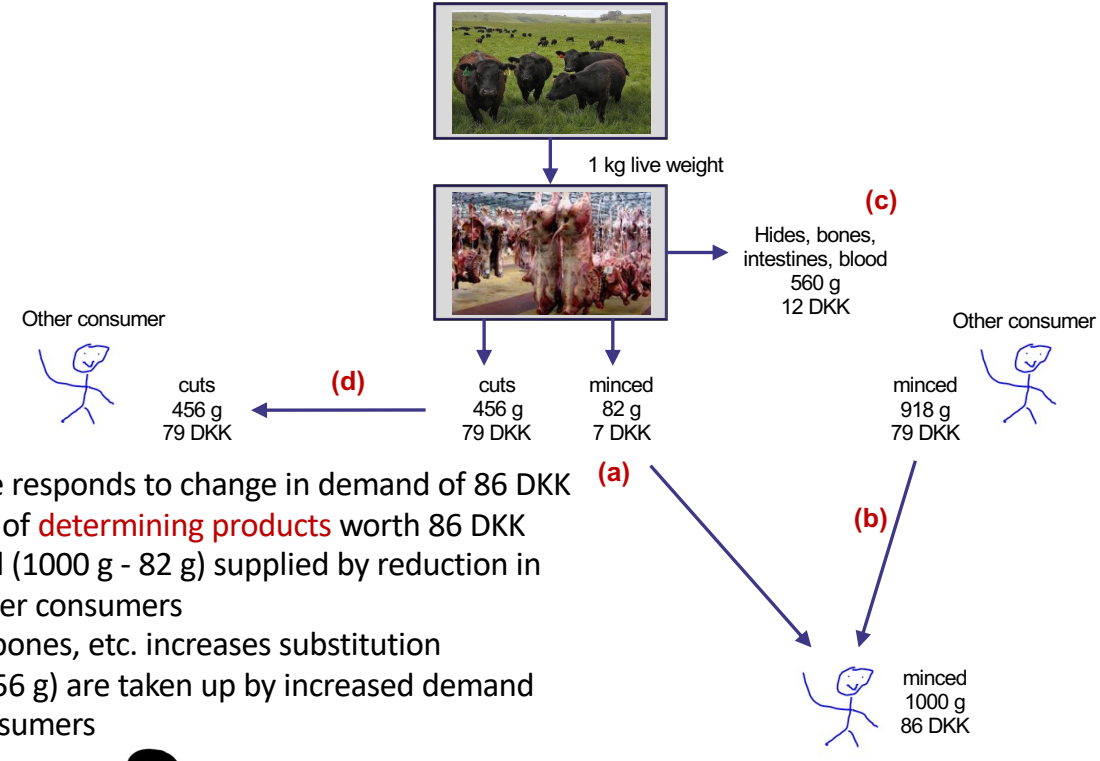


Type 3 situation

- more than one joint product have no alternative production route

- Example: Slaughterhouse





a) Slaughterhouse responds to change in demand of 86 DKK with an output of determining products worth 86 DKK
b) Missing minced (1000 g - 82 g) supplied by reduction in demand by other consumers
c) Surplus hides, bones, etc. increases substitution
d) Surplus cuts (456 g) are taken up by increased demand from other consumers

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