

# System models

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**ecoinvent**

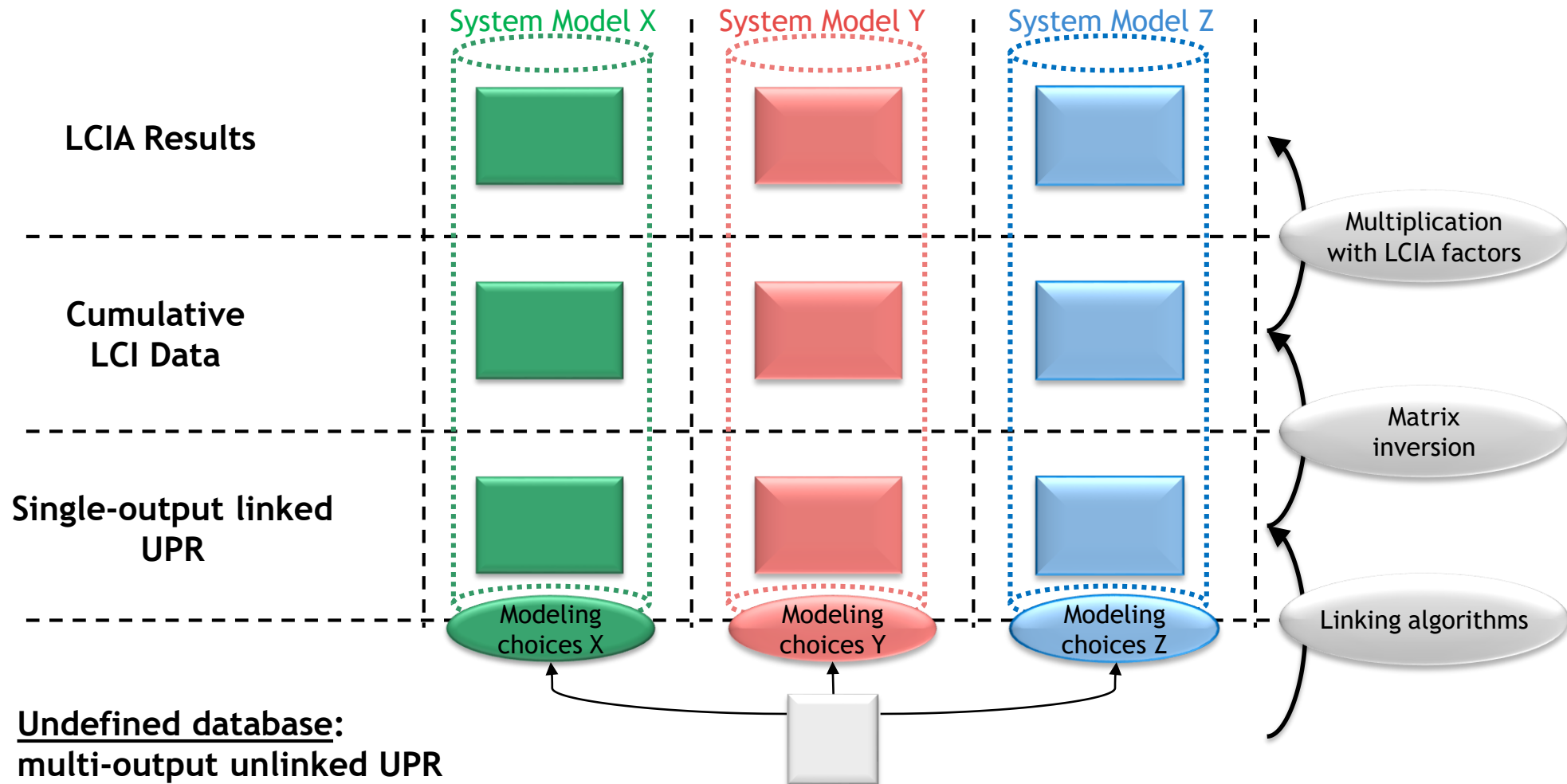
# ecoinvent database accesible in different versions



- ecoinvent v3 is published in different versions:
- the Undefined database, that allows checking the unallocated results and the balanced inventories.
- We give users full flexibility to match the modeling choices of the background database with the goal and scope of their studies, by offering different system models (for now, 3):
  - ↓ attributional, APOS
  - ↓ attributional, cut-off by classification
  - ↓ substitution, consequential, long term

- The ecoinvent database is based in Unit Processes, that describe each process from gate to gate.
- Those Unit Process are created and maintained in a form where they represent the reality: they have several co-products (if appropriated) and list entries of inputs, detailing or not the suppliers of those products: this is the Undefined database.
- You can use this version of the database to check the modeling of each activity, the choices taken, the mass, carbon and water balances (only accessible in ecoQuery).
- This version is used to build the other versions of the database, using for that different algorithms, that reflect different modelling options.

# Same undefined database, different results



# Discriminating between system models



- ecoinvent does not provide recommendations on when to use one system model or another, we consider only the user knows the constraints of his/her study.
- The user can choose between 2 systems with partitioning, and one using substitution, depending on the goal and scope of the study.
- As user, be consistent and do a conscious choice of the system model: don't use «consequential» if you want to do allocation, for example.

# Discriminating between system models



- If you prefer to continue working in the same lines that v2 did, use the cut-off system model. This is the one we advise for beginners as well.
- APOS vs cut-off show only insignificant differences in results, except in the case of waste treatment and recycling products. It might then be of added value to assess results with both systems and discuss the difference in those contexts.

# Two important differences between System Models



- The big differences among the 3 system model modeling choices:
  - ↓ (i) the way by-product are handled; and the burdens for waste treatment are considered
  - ↓ (ii) the way consumption mixes are supplied

# Two important differences between System Models: by-products

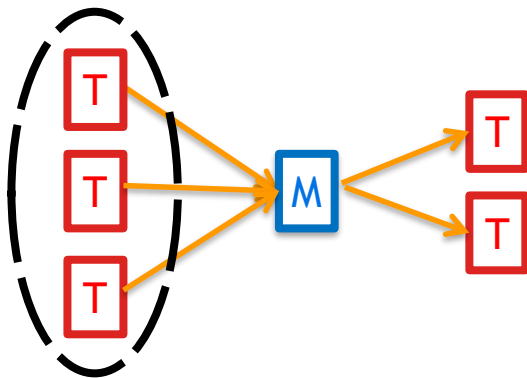


- How to deal with by-products
  - ↓ Allocation (partitioning)
    - Allocation, cut-off by classification
    - Allocation, APOS
  - ↓ Substitution
    - Substitution, consequential, long-term

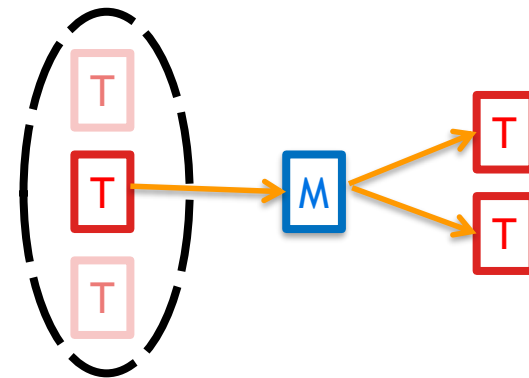


# Two important differences between System Models: suppliers

- All suppliers feed the consumption mix
  - ↓ Allocation, cut-off by classification
  - ↓ Allocation, APOS
- Only the suppliers that can adapt to changes supply the consumption mix (marginal or unconstrained suppliers)
  - ↓ Substitution, consequential, long-term

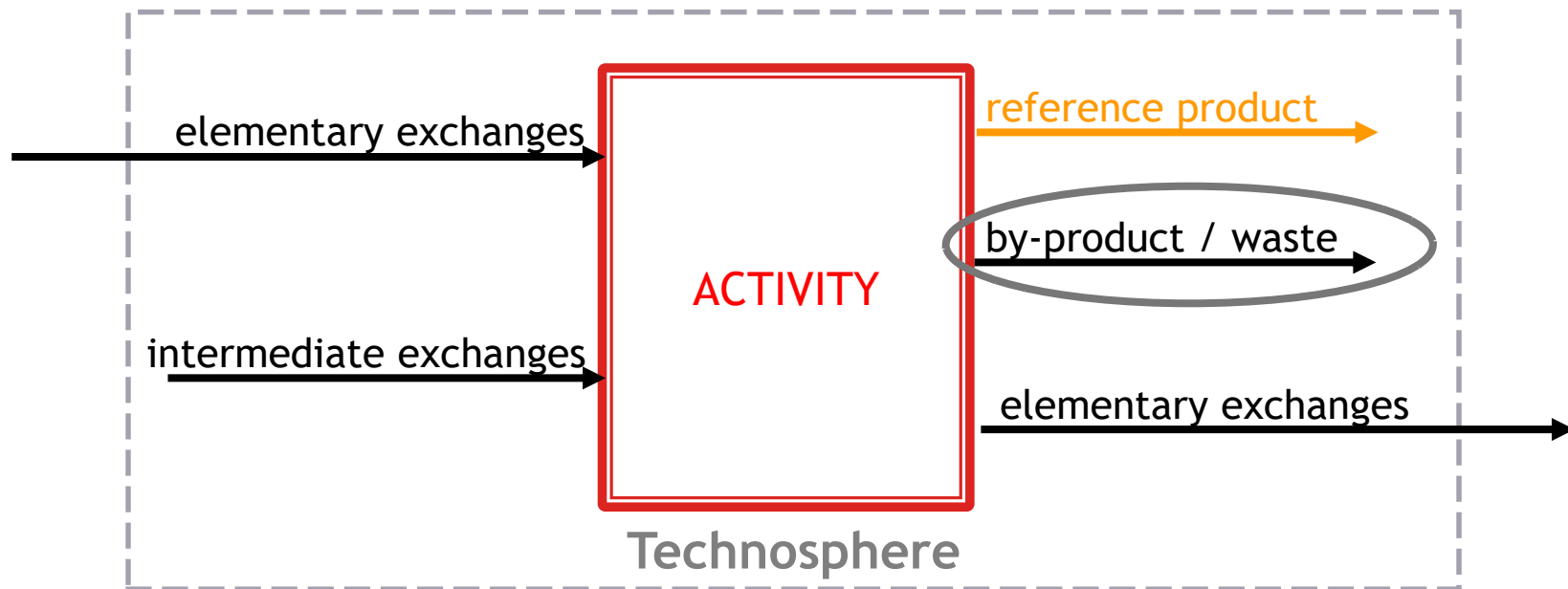


The market composition is different in the attributional or consequential approach.

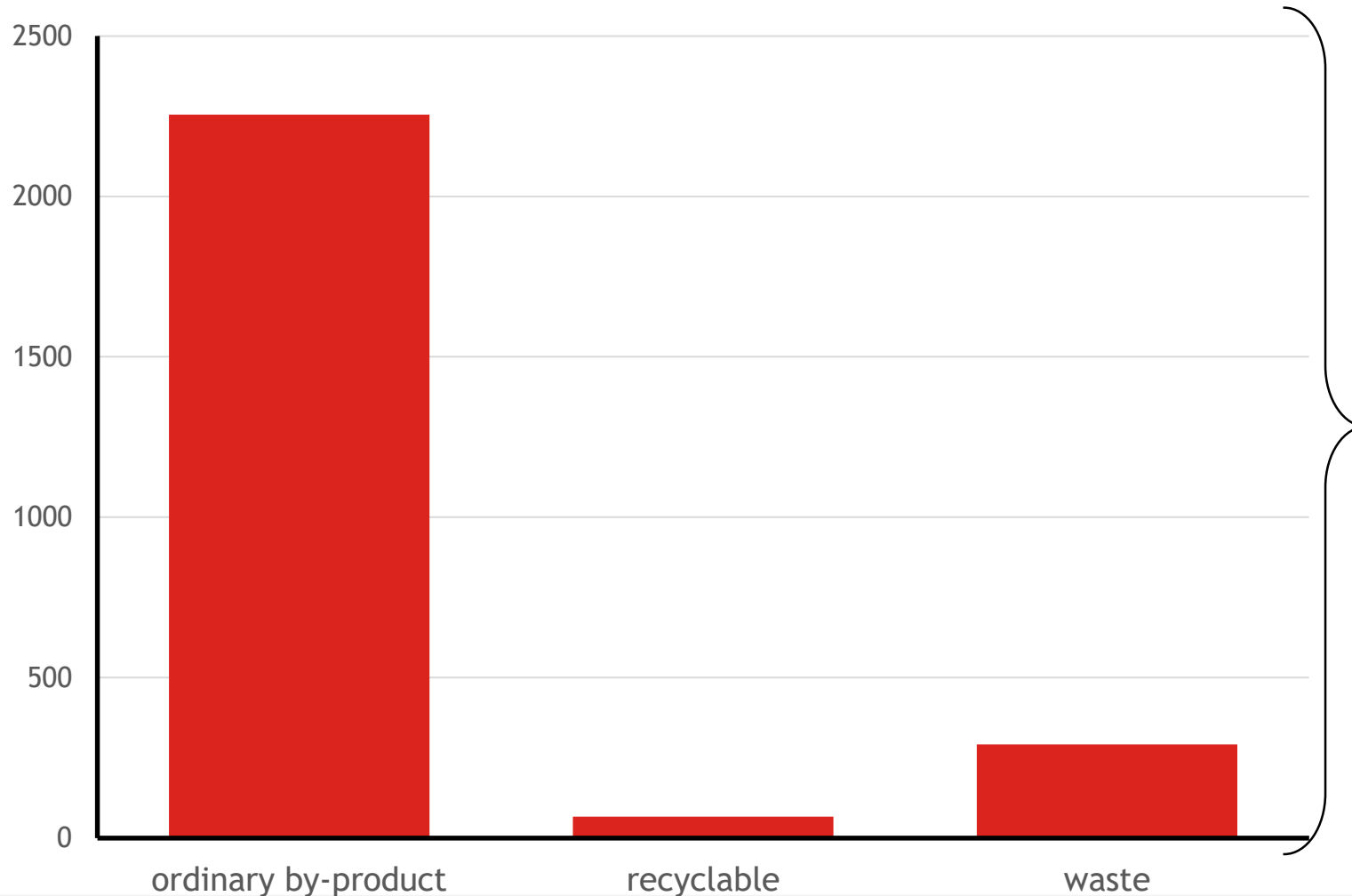


# «Allocation, cut-off by classification» SM

- No cut-off within activity in v3
- All co-products are considered in the activities (completeness)

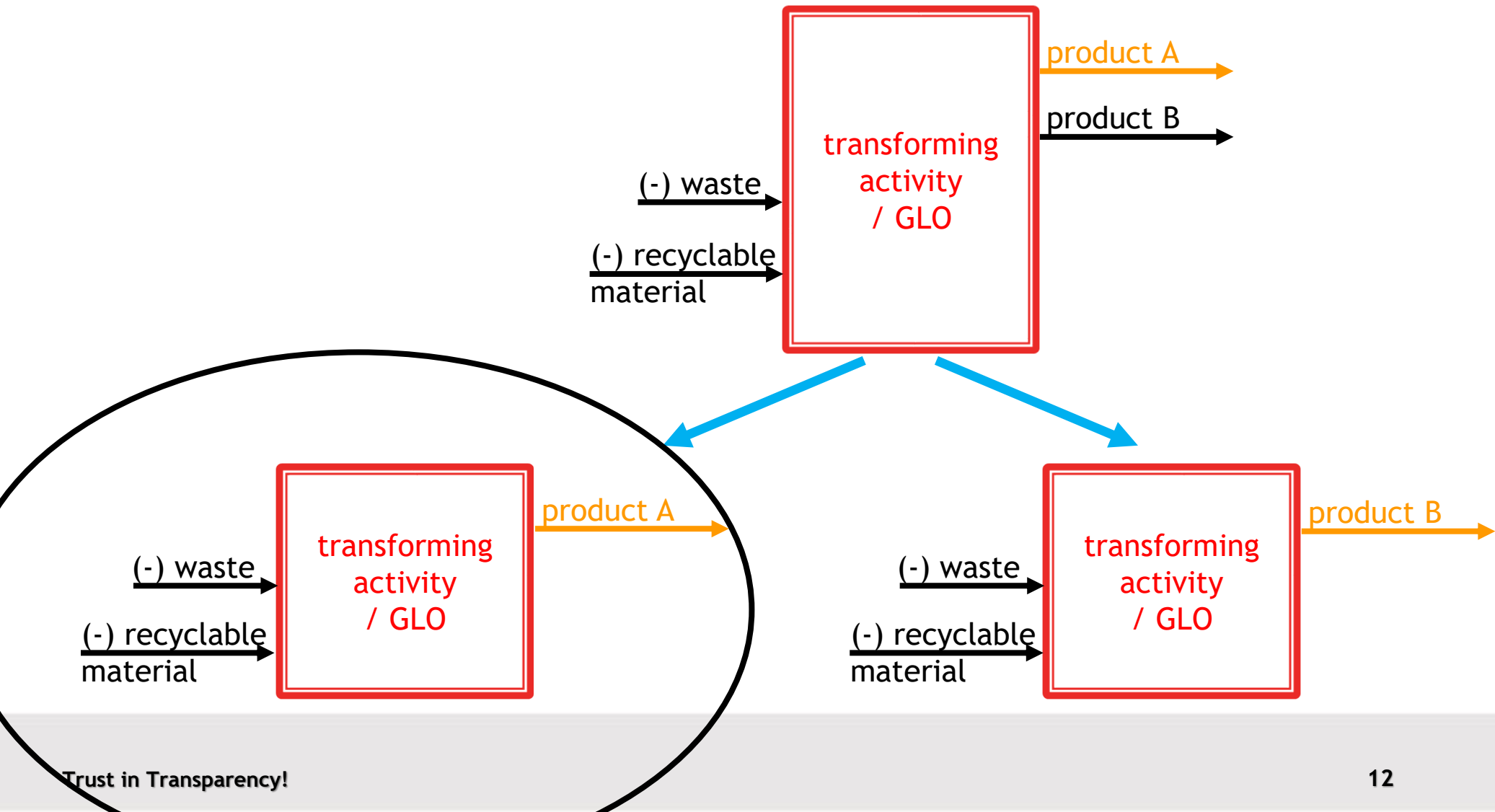


# «Allocation, cut-off by classification» SM

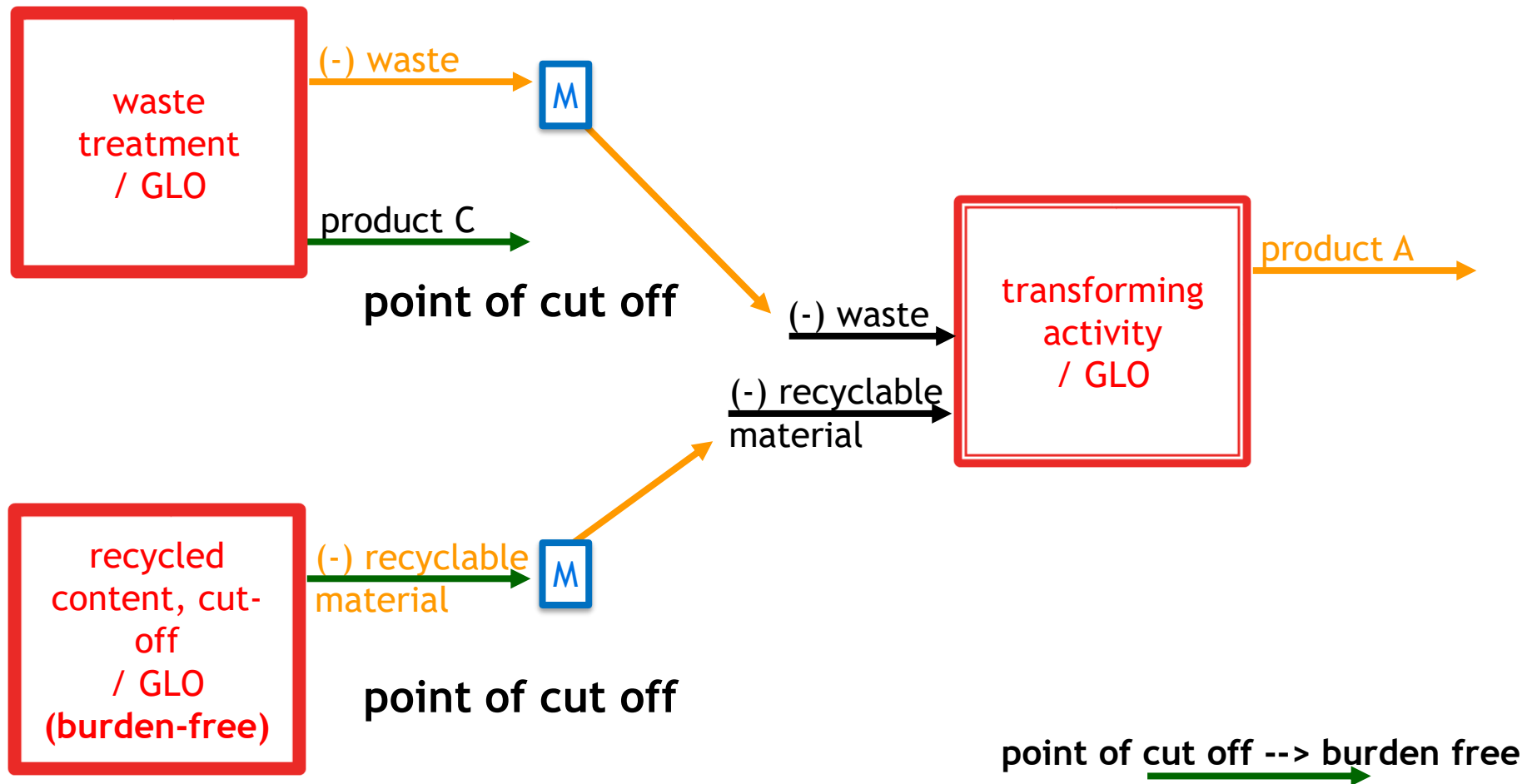


This product-level classification determines how the by-product is allocated in the cut-off System Model

# «Allocation, cut-off by classification» SM



# «Allocation, cut-off by classification» SM



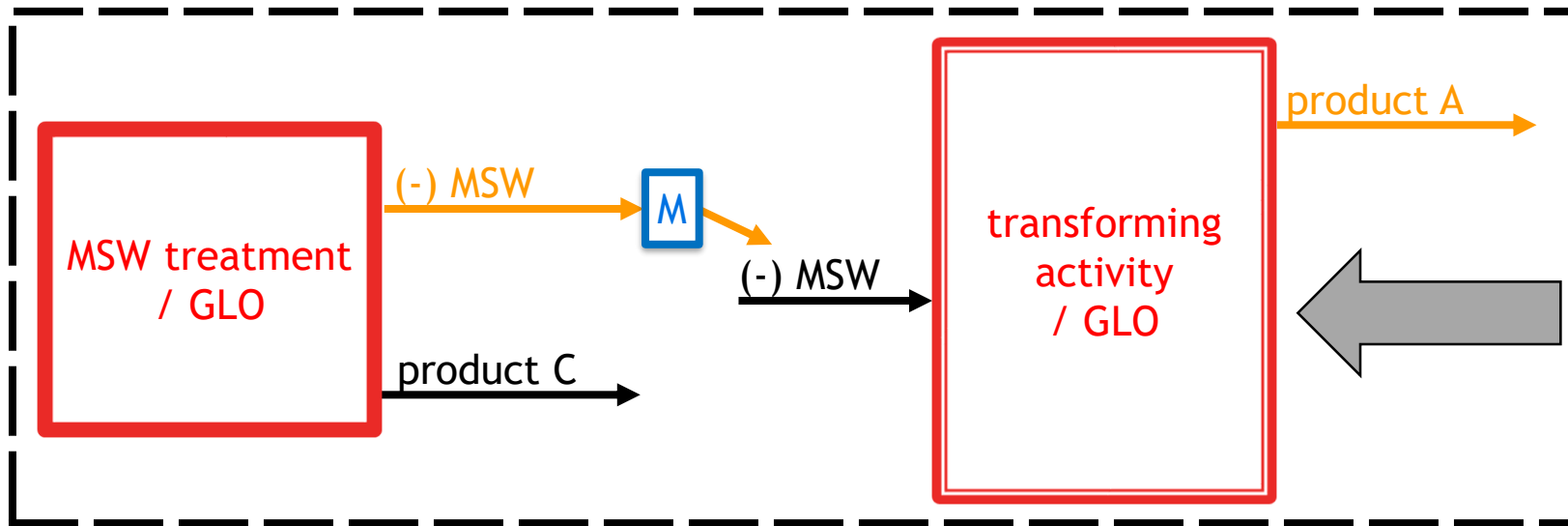
# Understanding results in cut off

- Understand the activity of your interest: what is the main product, what are the by-products.
- Check the classification of the by-products, to understand how they are allocated: in the activity overview file ([www.ecoinvent.org/support](http://www.ecoinvent.org/support)) or in ecoQuery
- classification: allocatable, waste, recyclable material
  - ↓ allocatable: the activity is partitioned between main product (allocatable) and this by-products
  - ↓ waste: the allocated product gets the burdens of treating them
  - ↓ recyclable materials: provided burden-free by a specially tagged activity.

# «Allocation, APOS» SM



- Allocation happens at the point of substitution (small system expansion)
- No distinction between waste or recyclable material, but between products that need further treatment to be commercially valuable (non-MFT) and products that don't (MFT).

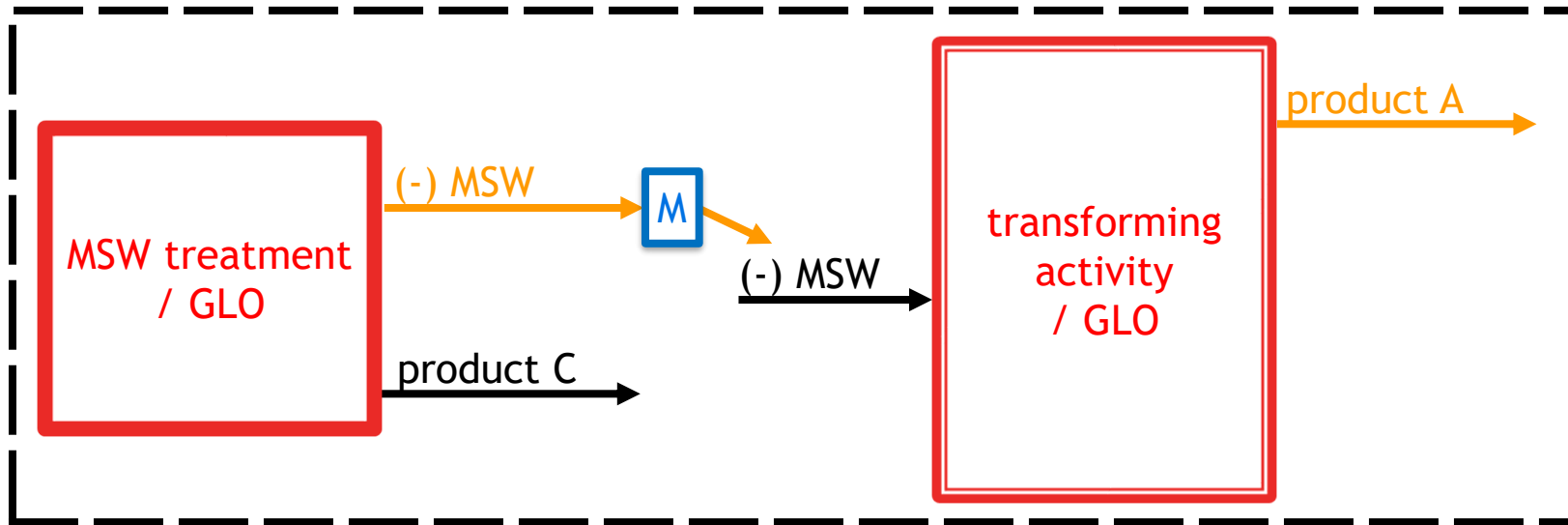


Allocation happens at the point of substitution:

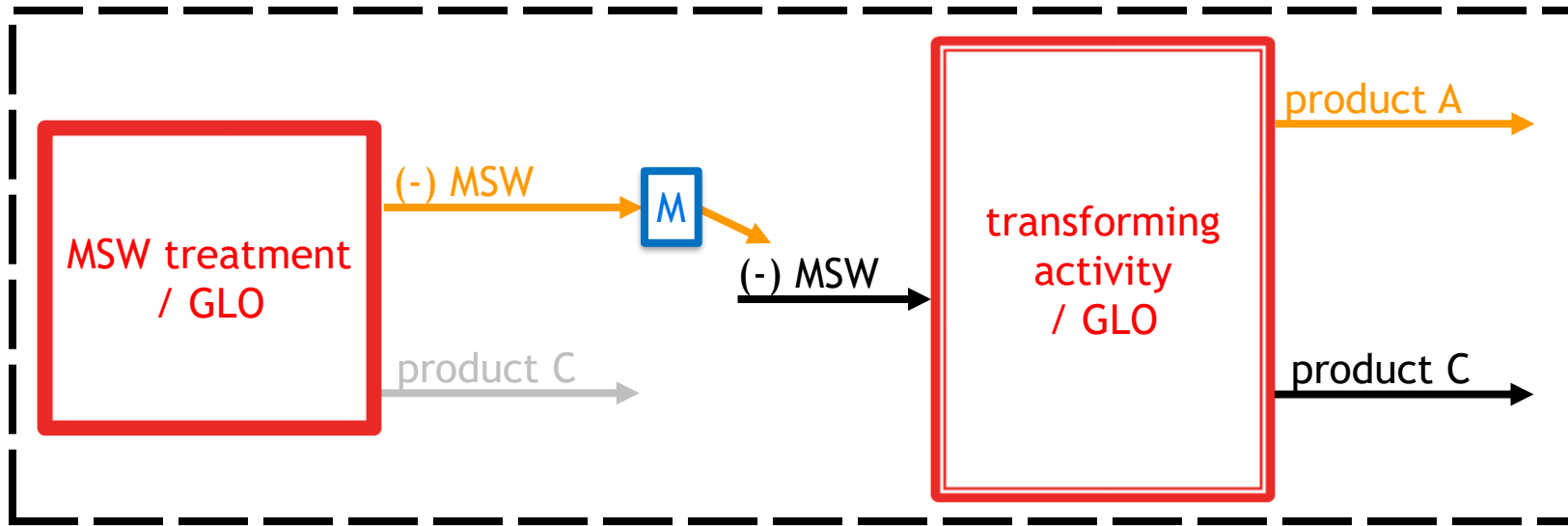
the point where the first «commercially valuable» product appears in the supply chain.



# «Allocation, APOS» SM



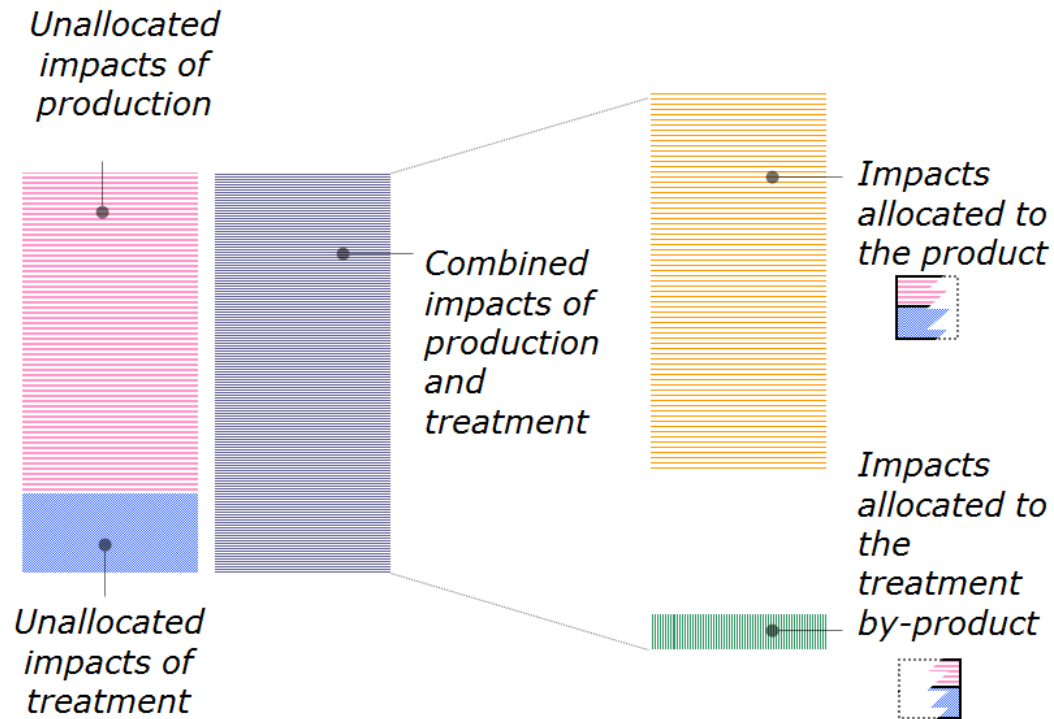
# «Allocation, APOS» SM





# «Allocation, APOS» SM

## Allocation at the point of substitution in ecoinvent v3



Graph: G. Doka

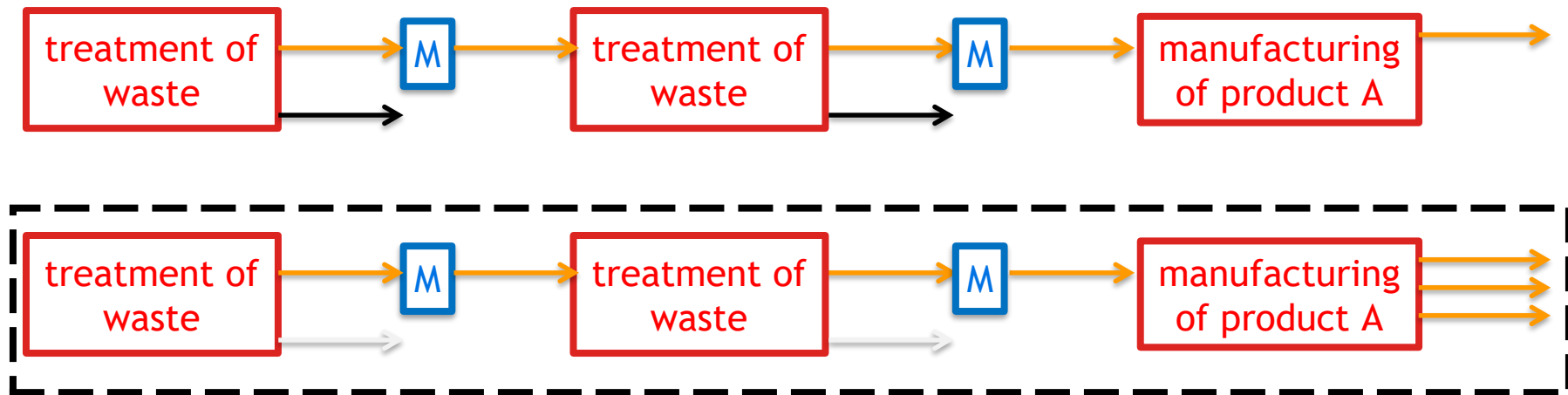
- The impacts of the activity that generates the waste to be treated, and the impacts of the activity of treating the waste are together shared between all commercial products produced in the value chain.
- The value chain can contain a treatment chain, and potentially several commercial by-products.

# Understanding results in APOS

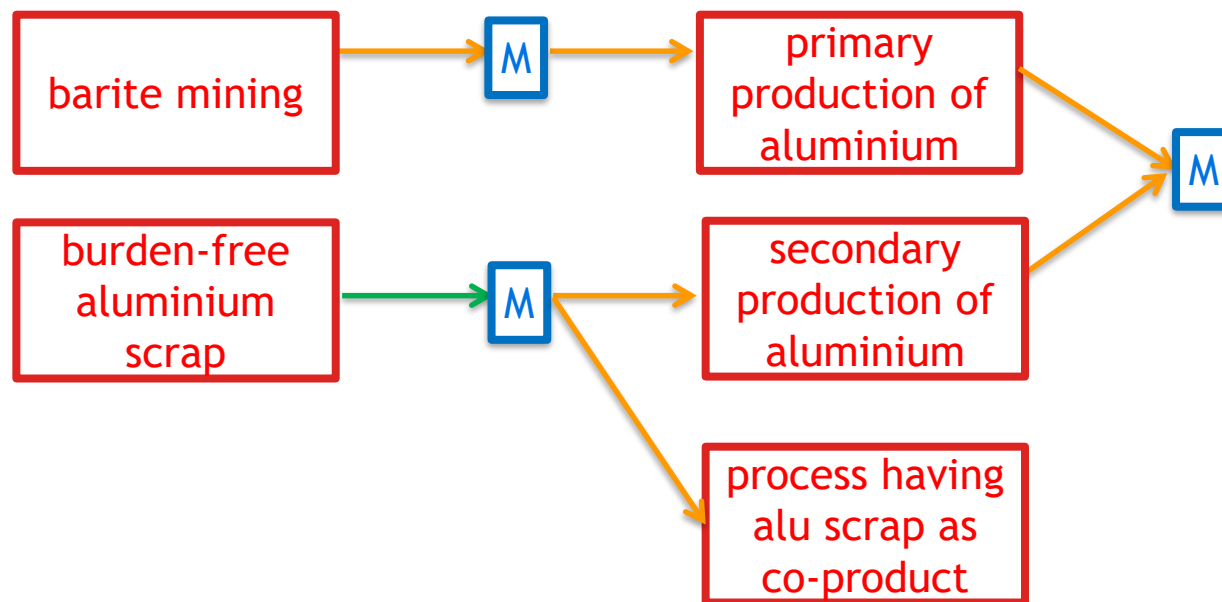
- Understand the activity of your interest: what is the main product, what are the by-products.
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# Understanding results in APOS

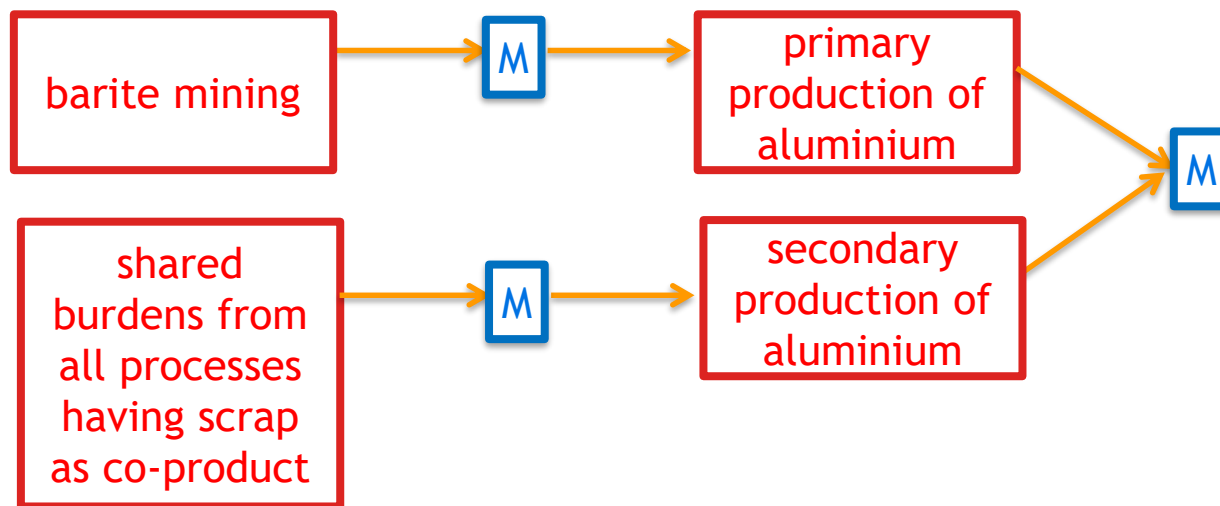
- classification: MFT, non-MFT
  - ↓ non-MFT: the activity is partitioned between the main product (another non-MFT) and this kind of by-products
  - ↓ MFT: any non-MFT product produced when treating MFT gets allocated in the activity where the point of substitution is



- The cut-off model separates primary and secondary use stages.
- The use of secondary materials is incentivized, but there is no credit for useful products in waste treatments.



- In APOS waste producers are incentivized to assess recycling and reuse possibilities due to the partial allocation of impacts to useful treatment products.
- Use of secondary materials is not incentivized per se.





- The cut-off model separates primary and secondary use stages. The approach incentivizes the use of secondary materials, but it does not incentivize waste producers to maximize reuse of waste materials (no benefits are given for any useful treatment products).
- In APOS waste producers are incentivized to assess recycling and reuse possibilities due to the partial allocation of impacts to useful treatment products.
- APOS can therefore be used in studies where the question of waste disposal method is a topic, or as a counterpoint to the cut-off model in a sensitivity analysis.

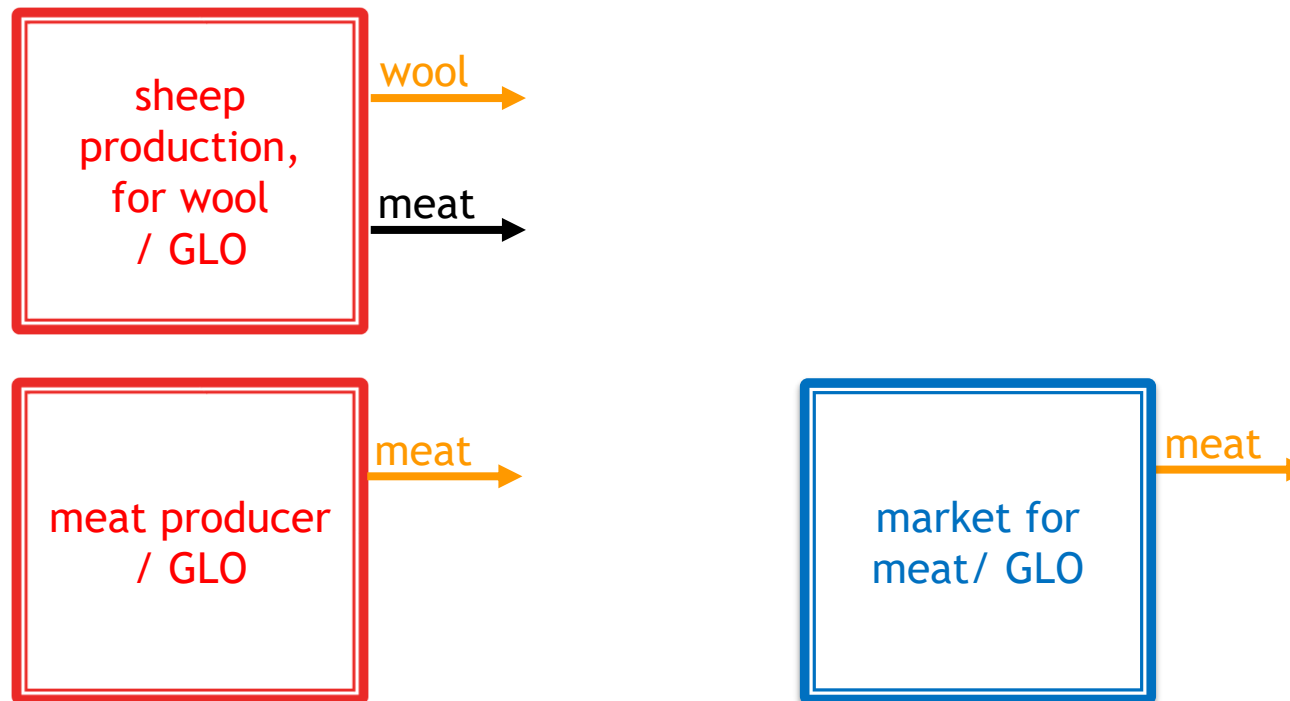
# «Substitution, consequential, long-term» SM



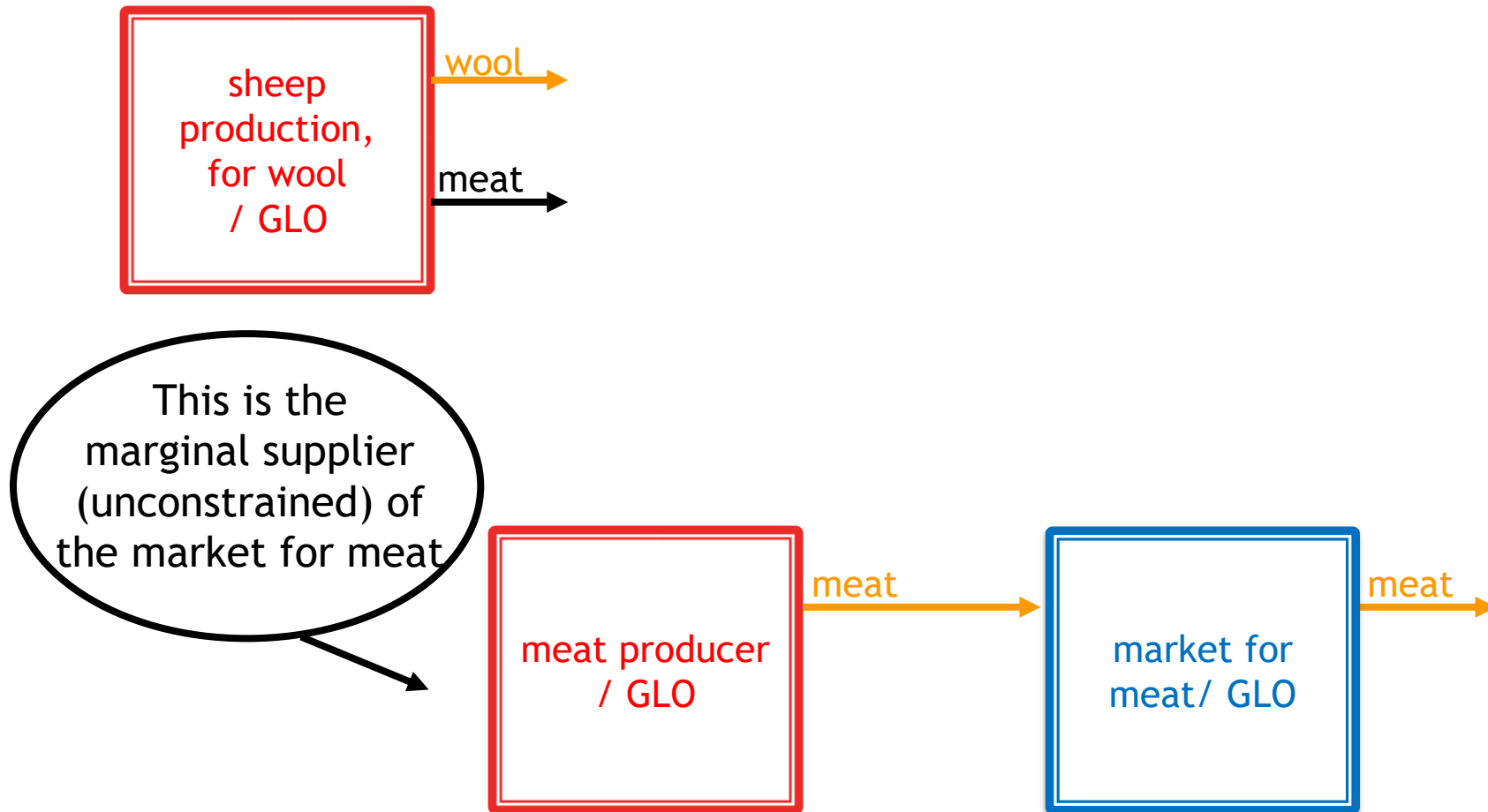
- In the «Substitution, consequential, long-term» System Model:
  - ↓ substitution is used to resolve multi-functionality
  - ↓ In the consequential model, only unconstrained suppliers (those who can respond to changes in demand by adapting their production) are taken into account.
  - ↓ A reference product for an activity is always burdened with the full impacts of all inputs and emissions, but is credited with benefits for any by-products it produces that can substitute other productions

# «Substitution, consequential, long-term» SM

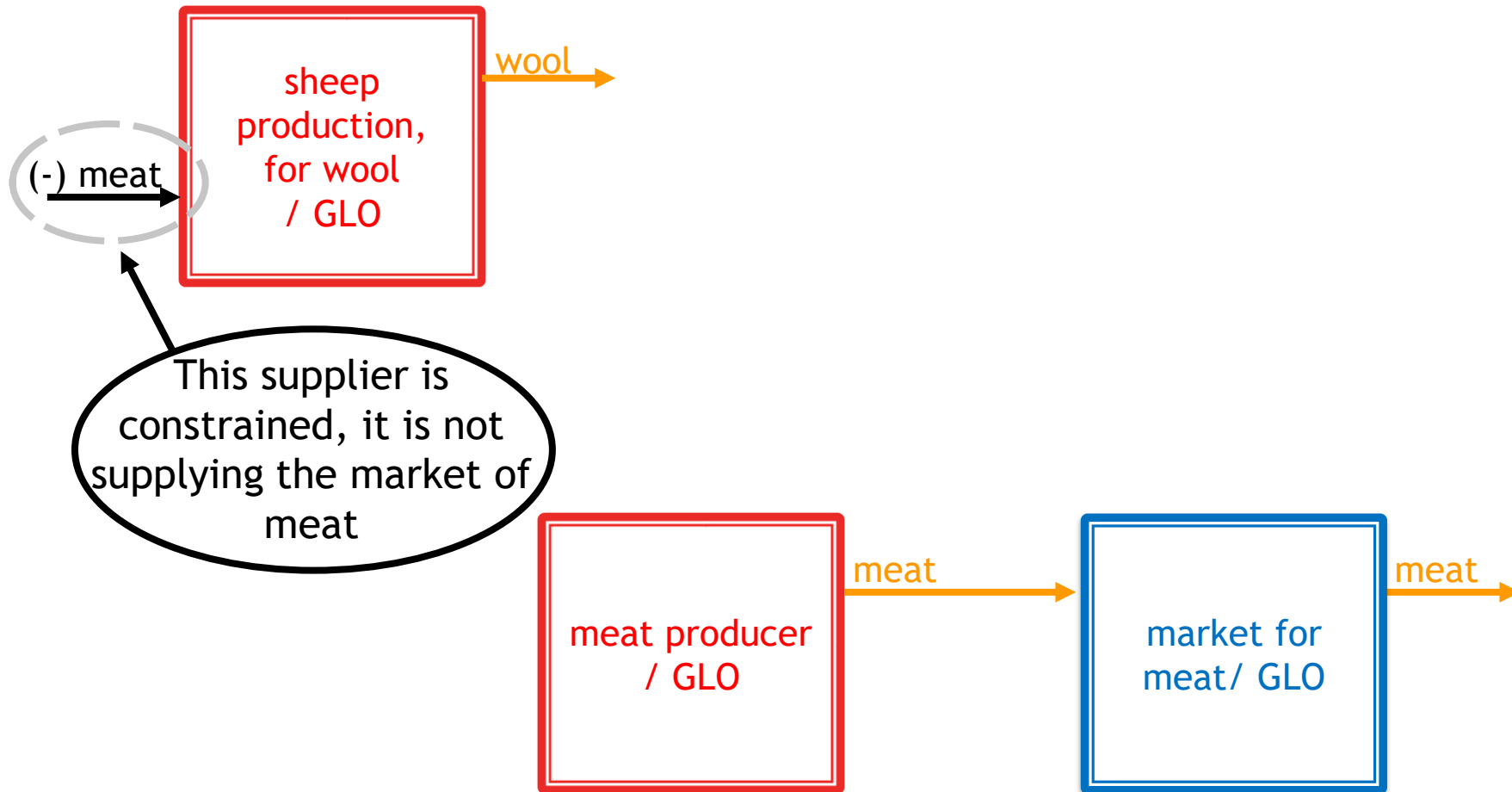
- In the «Substitution, consequential, long-term» System Model:
  - ↓ by-products are treated by substitution



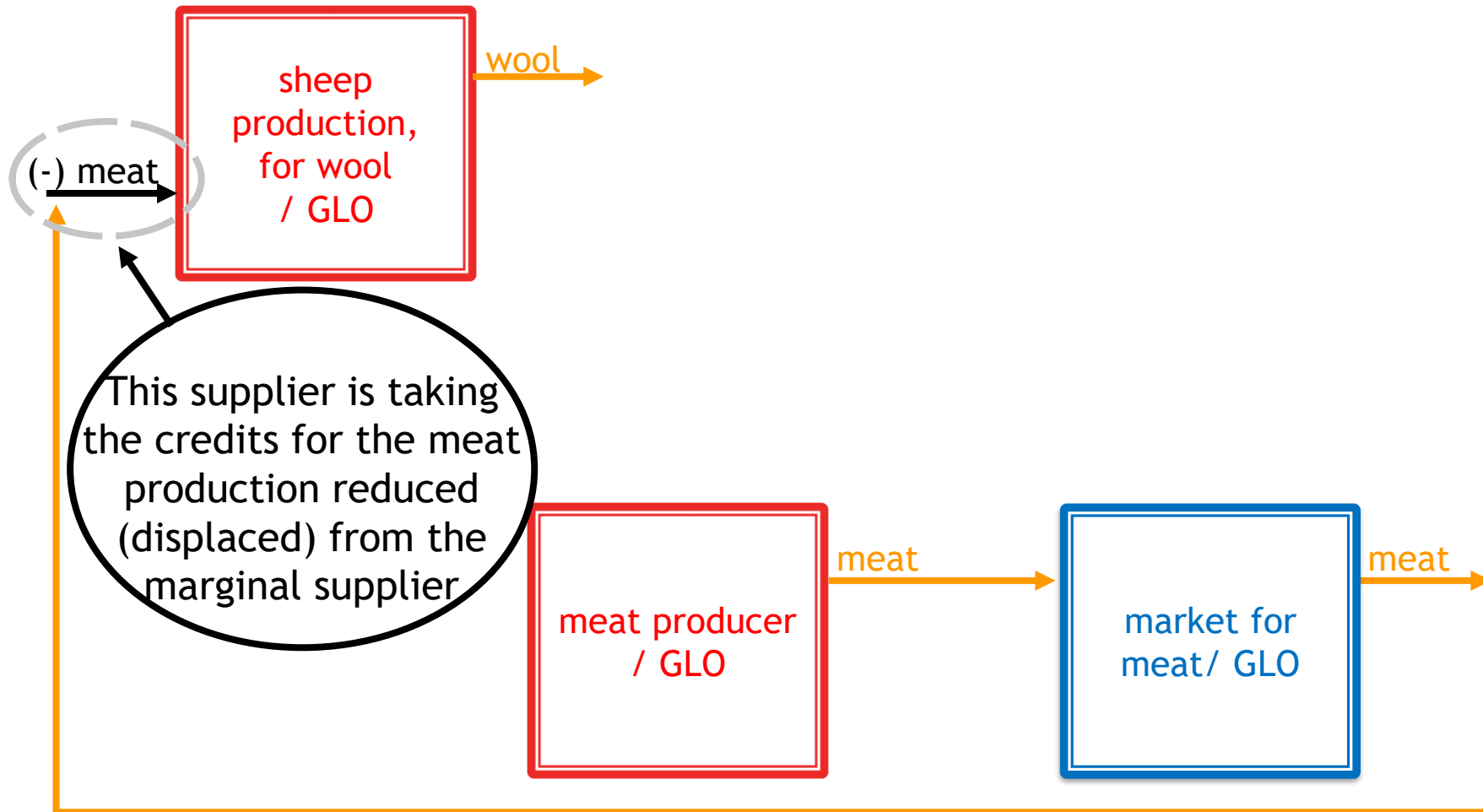
# «Substitution, consequential, long-term» SM



# «Substitution, consequential, long-term» SM



# «Substitution, consequential, long-term» SM



# Constrained by-products: constrained markets



- Constrained markets occur for by-products that cannot be substituted using alternative production routes, but still have a demand without following further treatment (they are commercially valuable).
- Substitution applies then by reducing the use of this product elsewhere, in the called “marginal consumption activity”, which is the one capable of changing to an alternative mean of production.

# Understanding results in consequential



- Understand the activity of your interest: what is the main product, what are the by-products.
- In consequential, you will only see the activity producing the main product; the by-products will be inputs to that (negative).
- Activities are then burdened for the production of the main product but credited with benefits for any by-products it produces that can substitute other productions.
- In constrained markets, the marginal consumer is shifted to be able to supply the market (to model the shift in production means).



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# Questions?

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