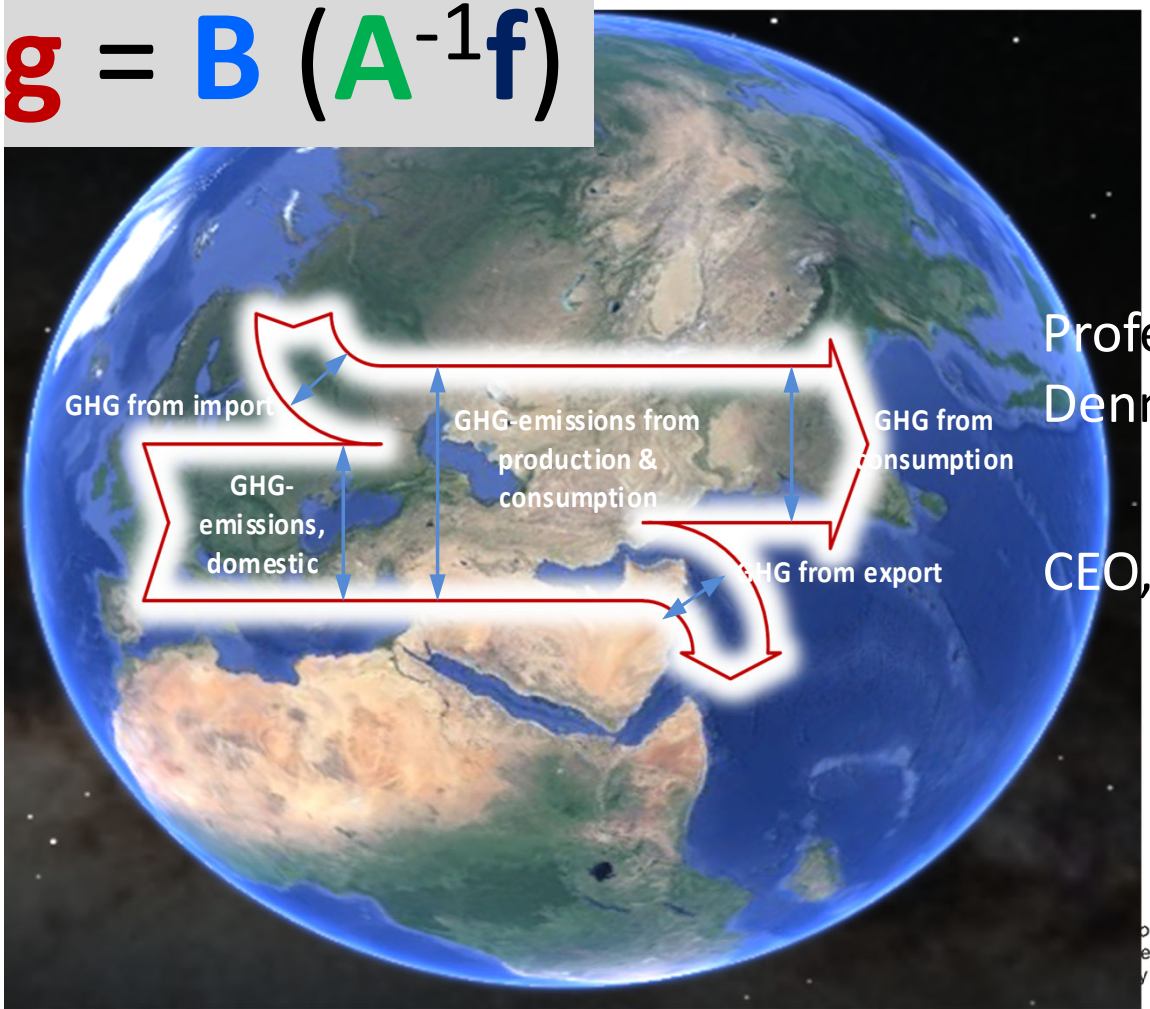
Input-output modelling

Hybrid LCA, Tiered and embedded analysis

$$g = B\,(A^{-1}f)$$



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DCEA | THE DANISH CENTRE FOR ENVIRONMENTAL ASSESSMENT

CEO, 2.-0 LCA consultants

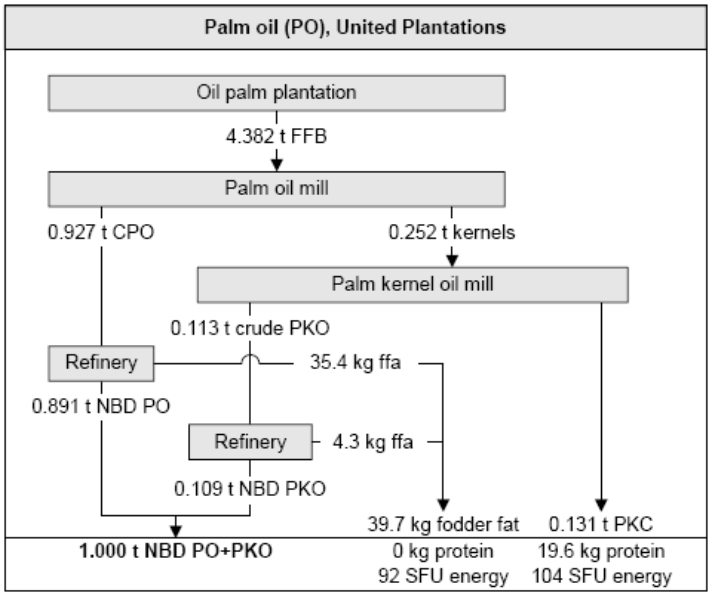
Updated: 26th April 2022

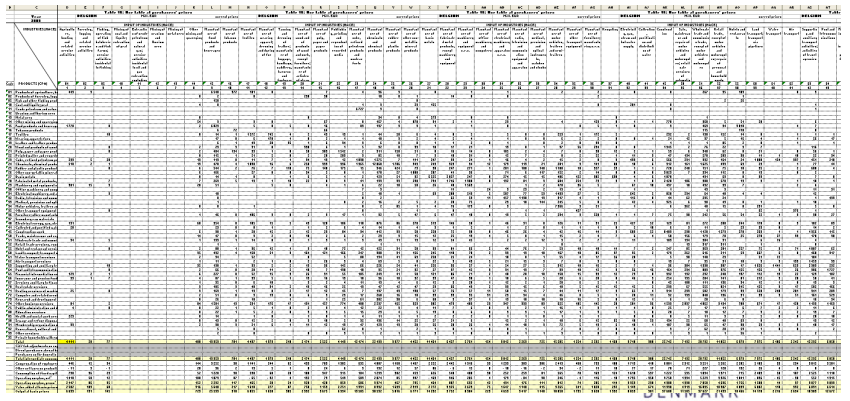
Agenda

- Differences and similarities between IO and process databases
- Hybrid LCA: tiered and embedded analysis

Process LCA versus IO-LCA

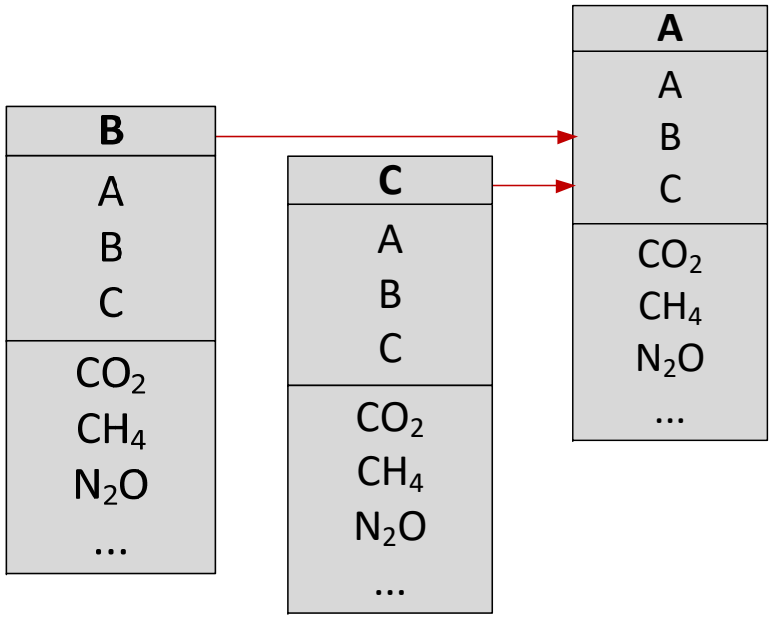
- So far: IO-LCA = process-LCA
- What is the difference?
  - IO-LCA: **Z**
  - Process-LCA: **A**
- How do we derive **A** in process LCA?
  - Follow physical flows in process-diagram
  - Bottom-up approach
- How do we derive **Z** in IO-LCA?
  - Using information provided by statistical agencies: National accounts (supply and use tables)
  - Top-down approach
- Difference = the way **A** and **Z** are derived



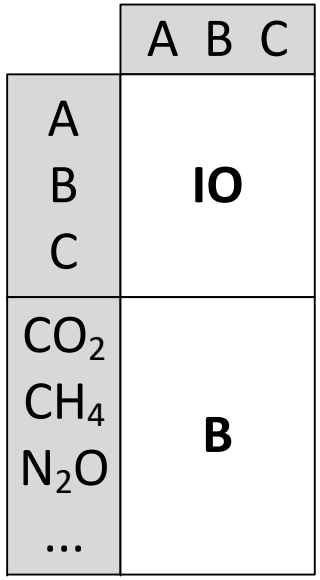


Process LCA and Input-Output LCA

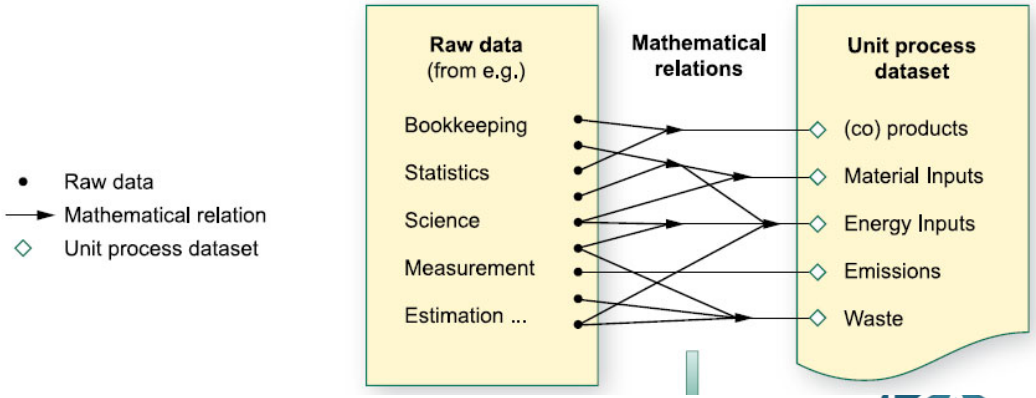
Unit process datasets



IO datasets



Creation of process datasets



Creation of IO datasets

National economic accounts

Products		Industry			
	Unit	Agriculture & food	Materials & machinery	Energy and water	Services
Agriculture & food	MEUR	0.12	0.05	0.01	0.00
Materials & machinery	MEUR	0.18	0.21	0.21	0.07
Energy and water	MEUR	0.02	0.01	0.06	0.01
Services	MEUR	0.17	0.10	0.14	0.29
Value added					
Operating surplus, compensation of employees, taxes	MEUR	0.40	0.38	0.52	0.60
Total inputs to industries	**MEUR**	**0.88**	**0.75**	**0.94**	**0.97**

National emission inventories

H^2O	Kg	0.00	0.00	0.00	0.00
CH^4	Kg	0.03	0.00	0.00	0.00
CO^2 (fossil)	Kg	0.30	0.14	2.08	0.12
emissions	Unit				

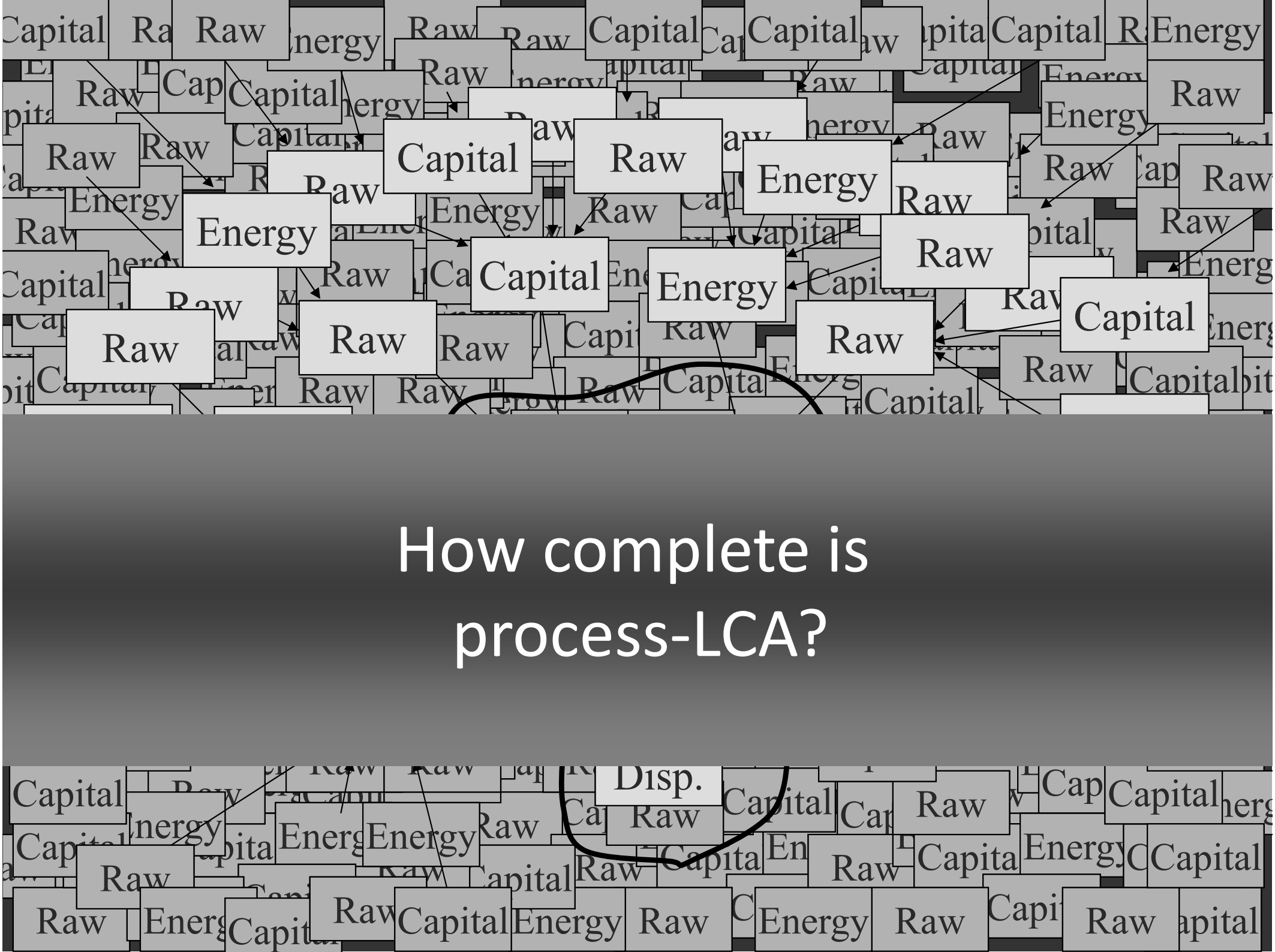
Process LCA versus IO-LCA – Data sources

- Process data (bottom-up)
  - Book keeping
  - Statistics
  - Science
  - Mass balances
  - Measurements
  - Estimations

Detail

- Input-Output data (top-down)
  - National economic accounts
  - National emission inventories

Completeness


How complete is process-LCA?

Process LCA versus IO-LCA

- IO-LCA: No cut-off
- Automatical inclusion of 'hard to quantify' inputs:
  - Accounting, marketing, use of postal services, banking services
  - Business travelling
  - Office machinery, printing paper, pencils, furniture etc.
  - Capital goods (buildings, machinery)
- 'Hard to find' data can easily be derived using top-down, e.g.
  - Household electricity for refrigiators and dishwashers per kg food
  - Fertiliser consumption per ha for all different crops in all countries

Process LCA versus IO-LCA – Results

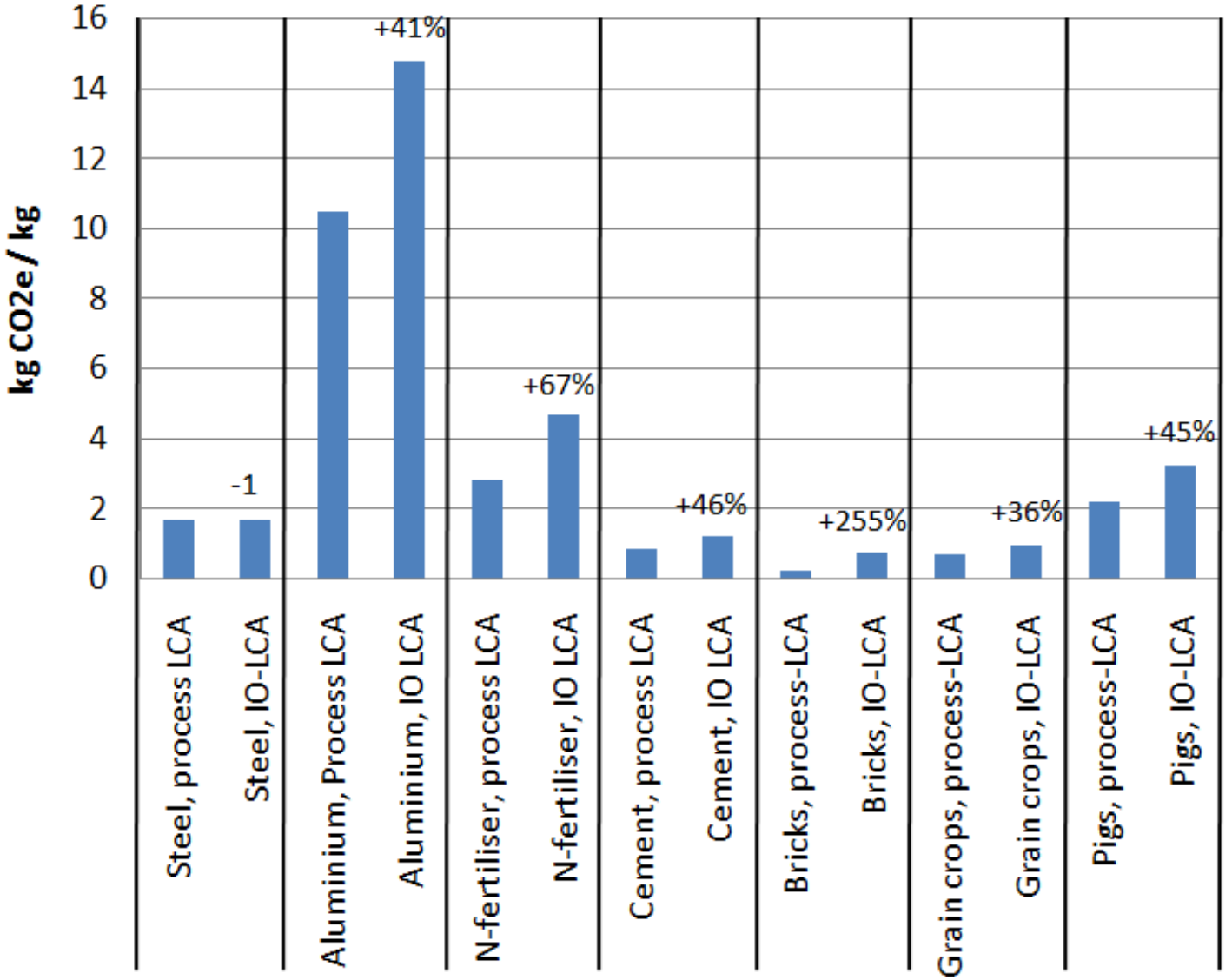
Process-data:

Ecoinvent and LCAfood

IO-data:

Swedish IO-table

(FORWAST project)



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IO versus process LCA database

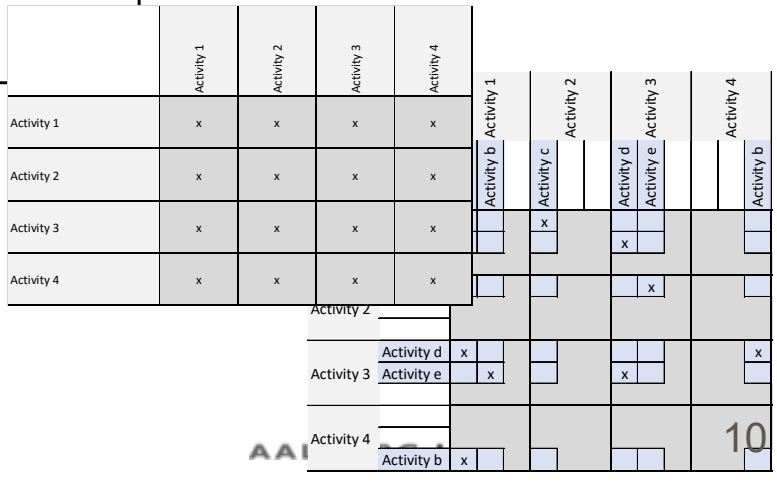
	Activity 1	Activity 2	Activity 3	Activity 4
Activity 1	x	x	x	x
Activity 2	x	x	x	x
Activity 3	x	x	x	x
Activity 4	x	x	x	x

- Process-LCA = subset of IO-LCA
- Process-LCA more detailed than IO-LCA
- Process-LCA: arbitrary cut-off

		Activity 1		Activity 2		Activity 3		Activity 4	
		Activity a	Activity b	Activity c		Activity d	Activity e		Activity b
Activity 1	Activity a			x					
	Activity b	x				x			
Activity 2	Activity c						x		
Activity 3	Activity d	x							x
	Activity e		x			x			
Activity 4									
	Activity b	x							

IO versus process LCA database

	IO	Process
High level of detail	No	Yes
All activities/products	Yes	No
Product balance	Yes	No
Activity balance (econ, mass, energy)	Yes	No
Systematic cut-off	Yes	No
World trade	Yes	No
Consistent emission inventories	Yes	No
Facilitating analysis of total consumption, trade and average industries	Yes	No

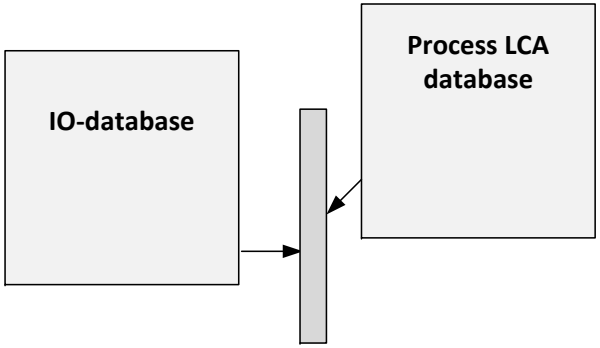


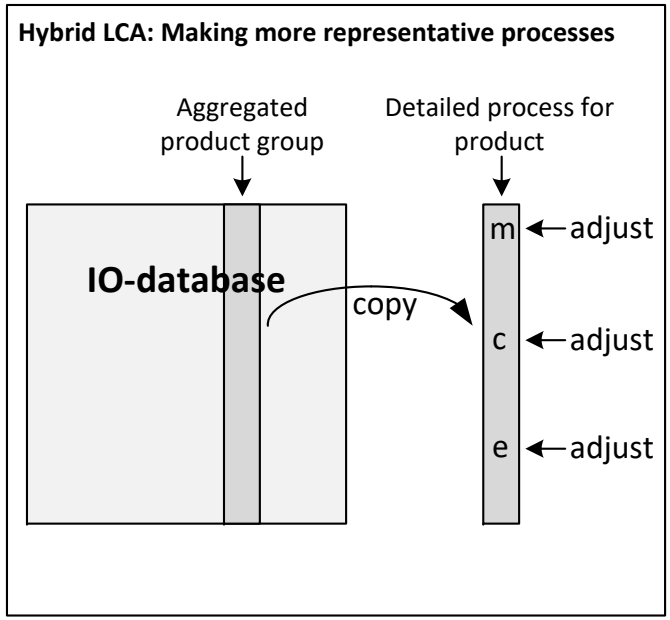
Agenda

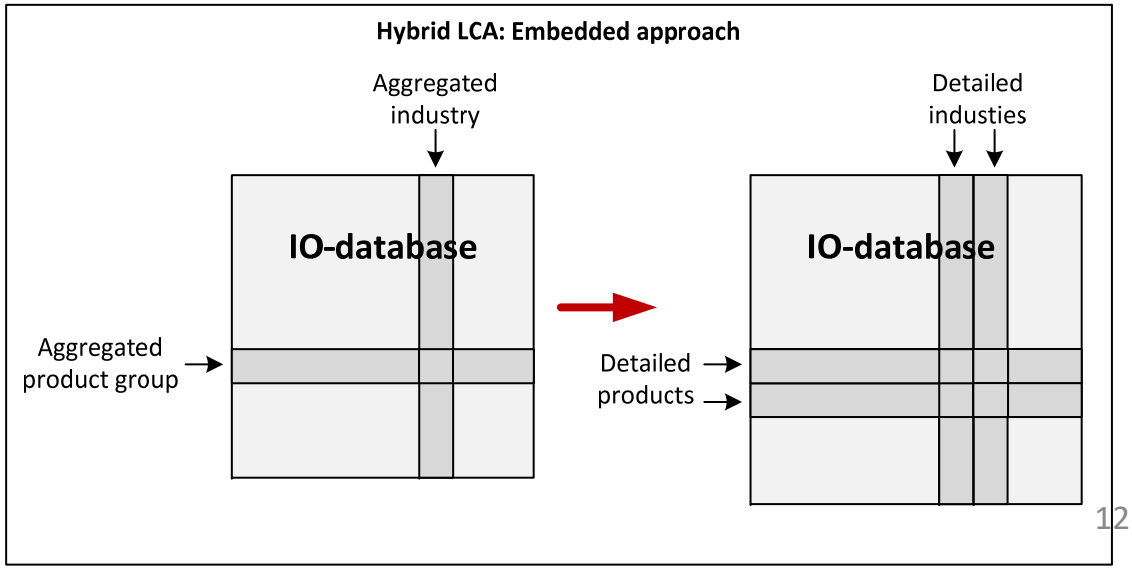
- Differences and similarities between IO and process databases
- Hybrid LCA: tiered and embedded analysis

What is hybrid LCA?

- Many meanings
  1. Tiered (inconsistent): Combine IO-data with process data, e.g. Exiobase and ecoinvent.
  2. Tiered (consistent) Use external data to make more representative version of a certain IO-process.
  3. Embedded: Embedding external data in integrated detailing of products and industries.

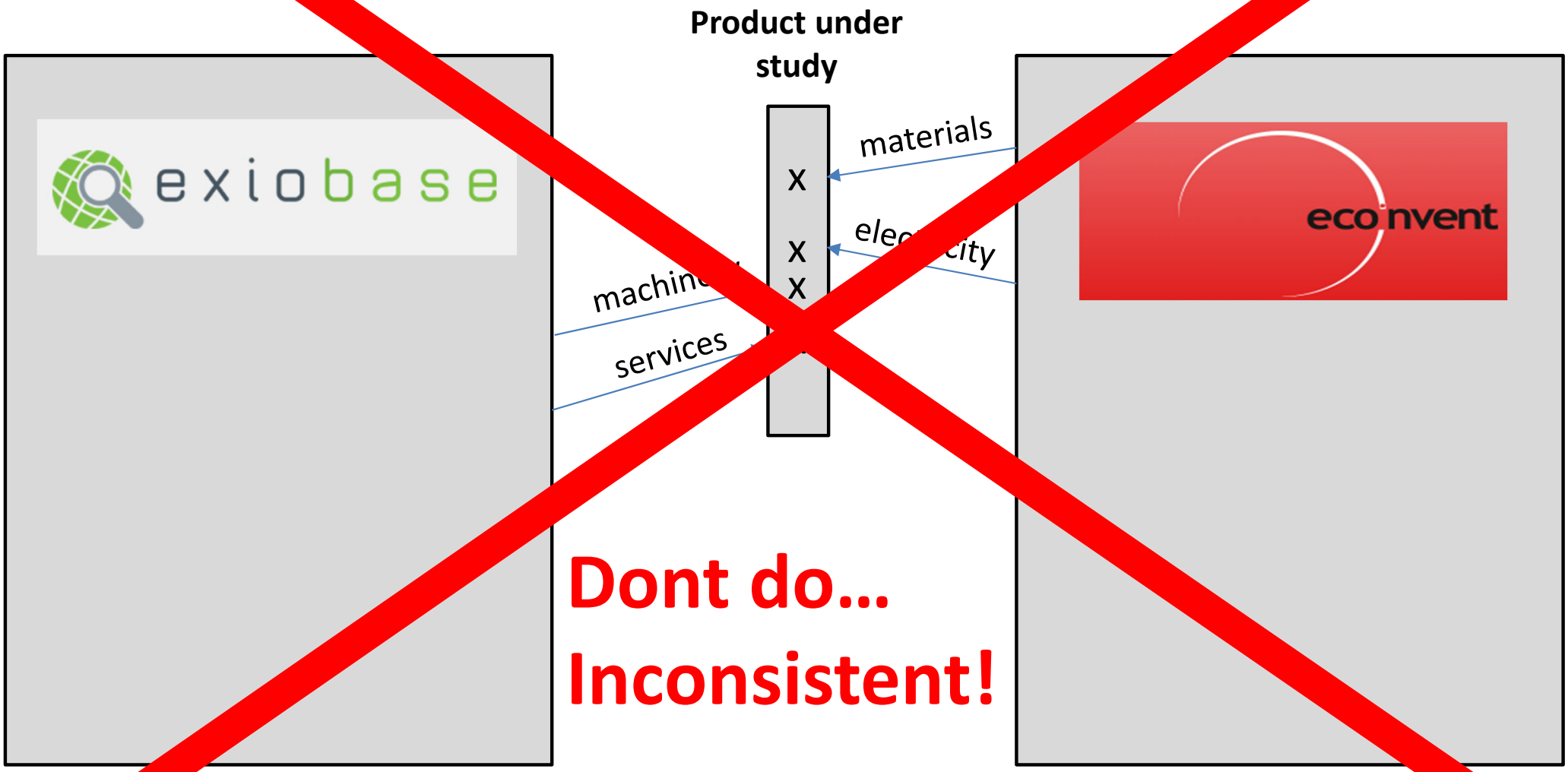






Hybrid LCA

- Tiered (inconsistent) approach: mixing different databases

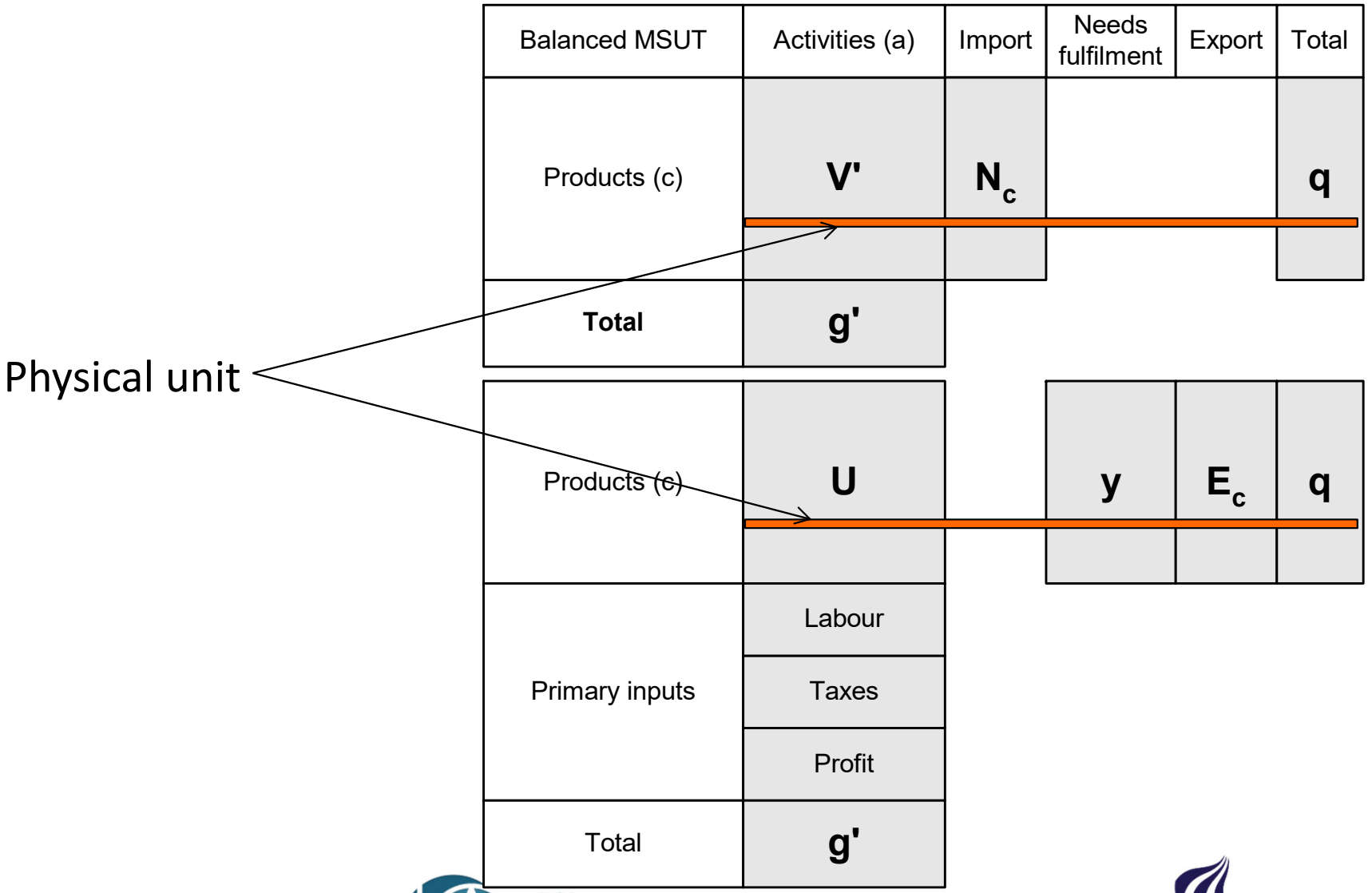


Hybrid – even more meanings/variations…

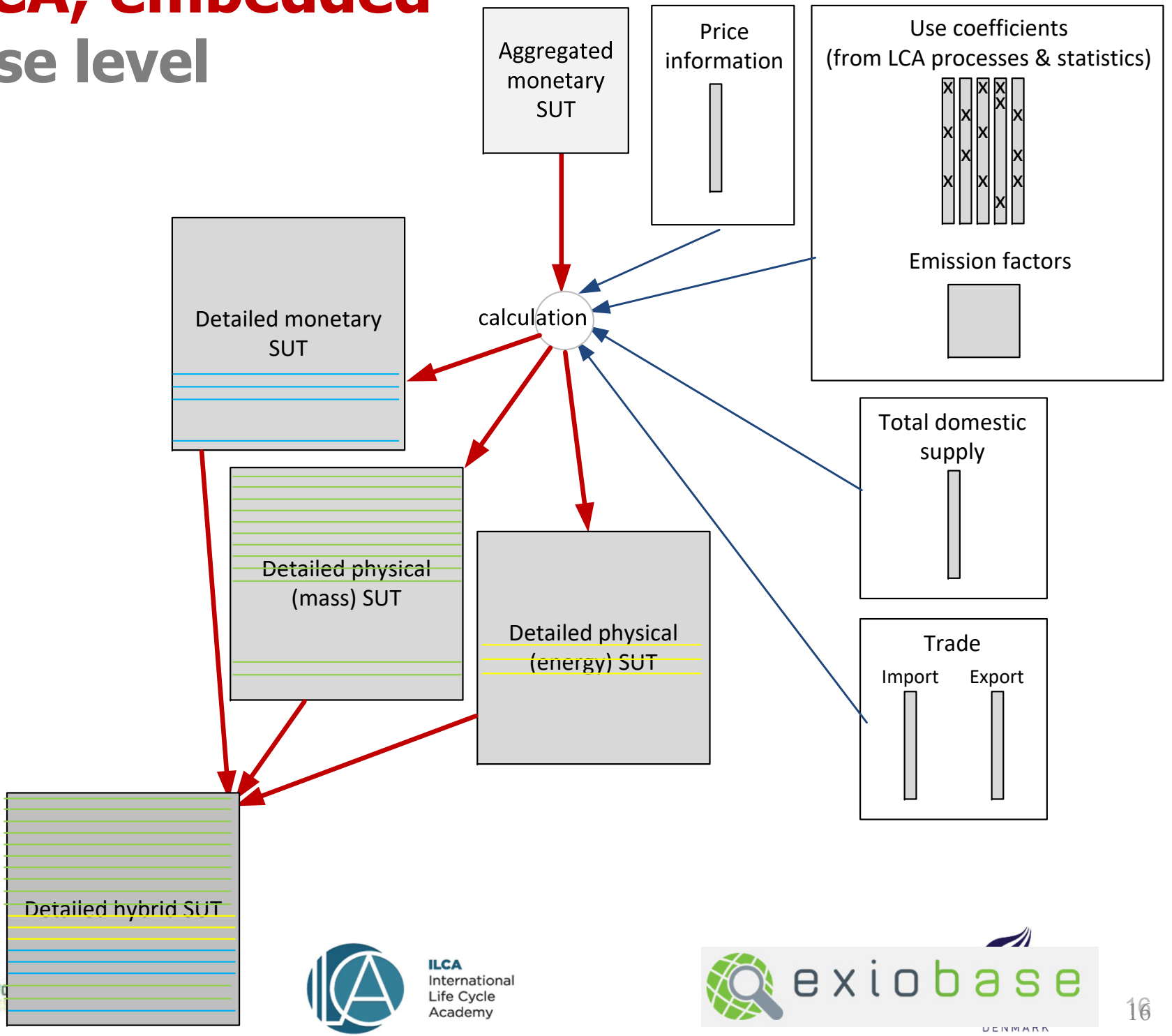
- Hybrid database
  - Monetary units – but detailed via engineering data
  - Hybrid units
  - Process LCI database embedded in SUT
  - IO-database detailed using process data – activity and product level (fully embedded)
  - IO-database detailed using process data – only activity level (satellite)
- Hybrid LCA data sets
  - Embedded approach
  - Tiered approach

Hybrid unit Supply-Use Tables (HSUT)

- Units are changed in selected rows of V' and U

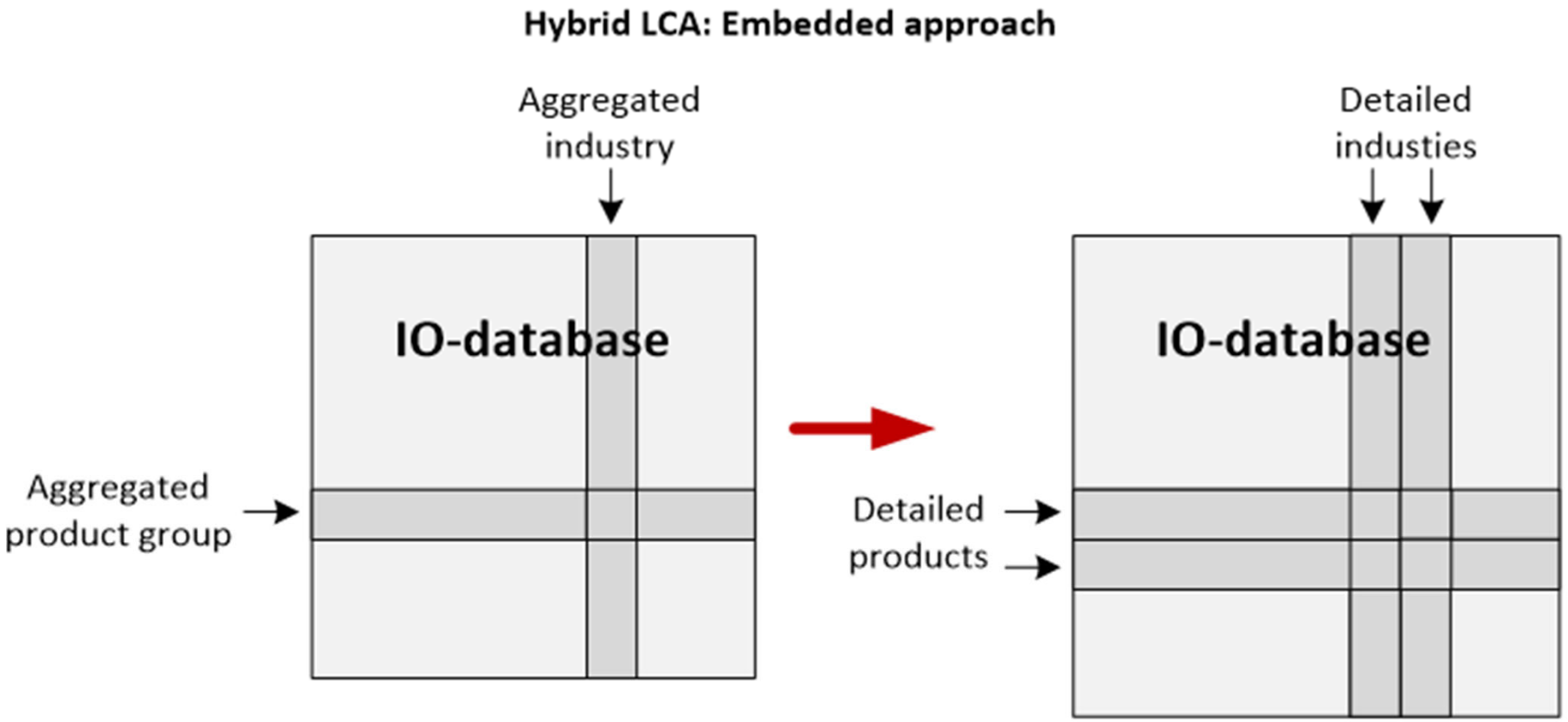


Hybrid LCA; embedded
- Database level



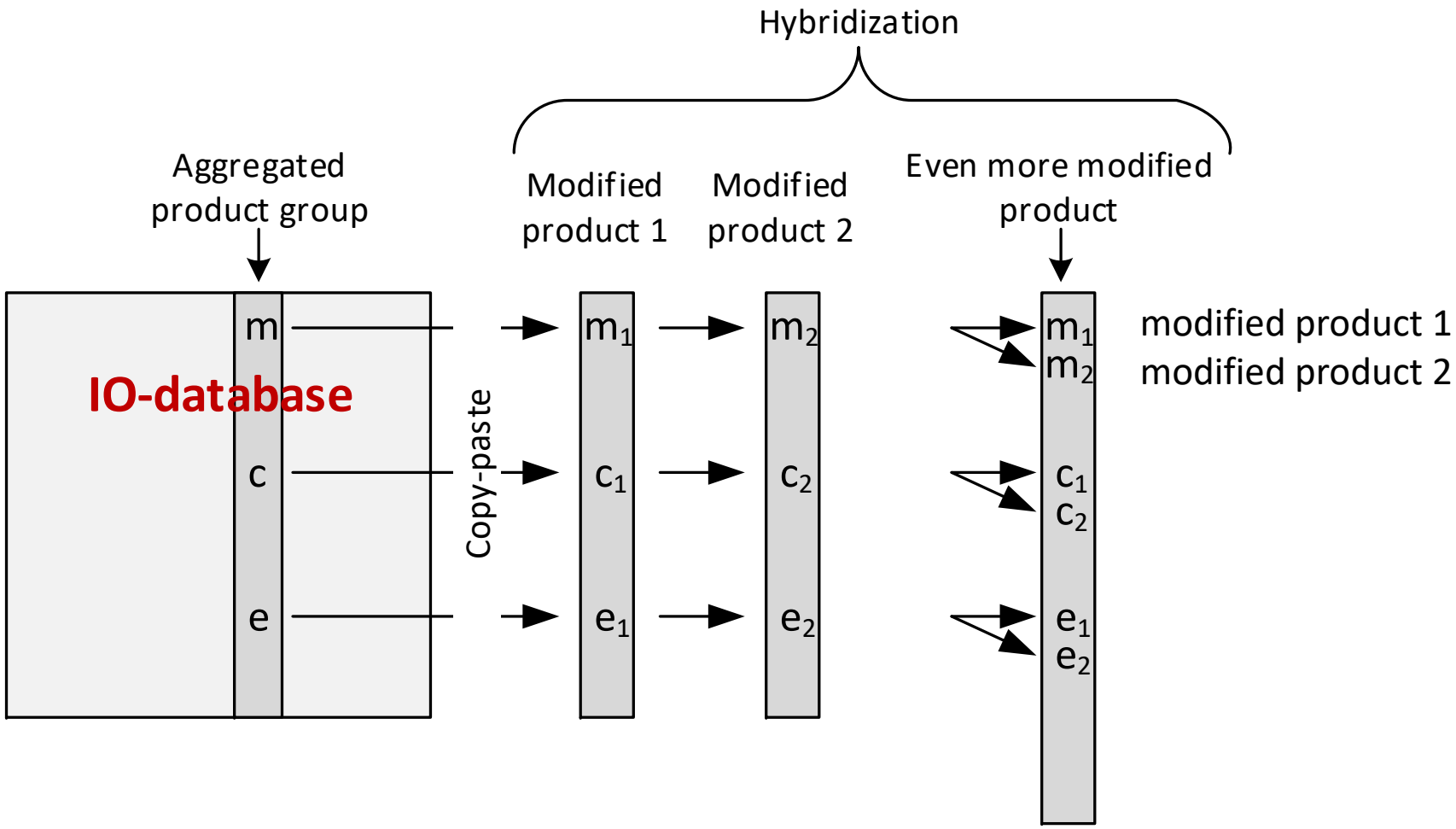
Hybrid LCA; embedded

- Database level disaggregation



Hybrid LCA; tiered (consistent) approach

- Activity level detailing: Making a satellite



m, c, e: aggregated material (m), chemical (c) and energy (e) inputs in IO-database which are detailed to better represent specific inputs.

… if you want to know more

- The International Life Cycle Academy (https://ilca.es/)
- Consequential LCA (https://consequential-lca.org/)