



CIRAIG^{MC}

Centre interuniversitaire de recherche sur le
cycle de vie des produits, procédés et services



DDI8003E – Week 3

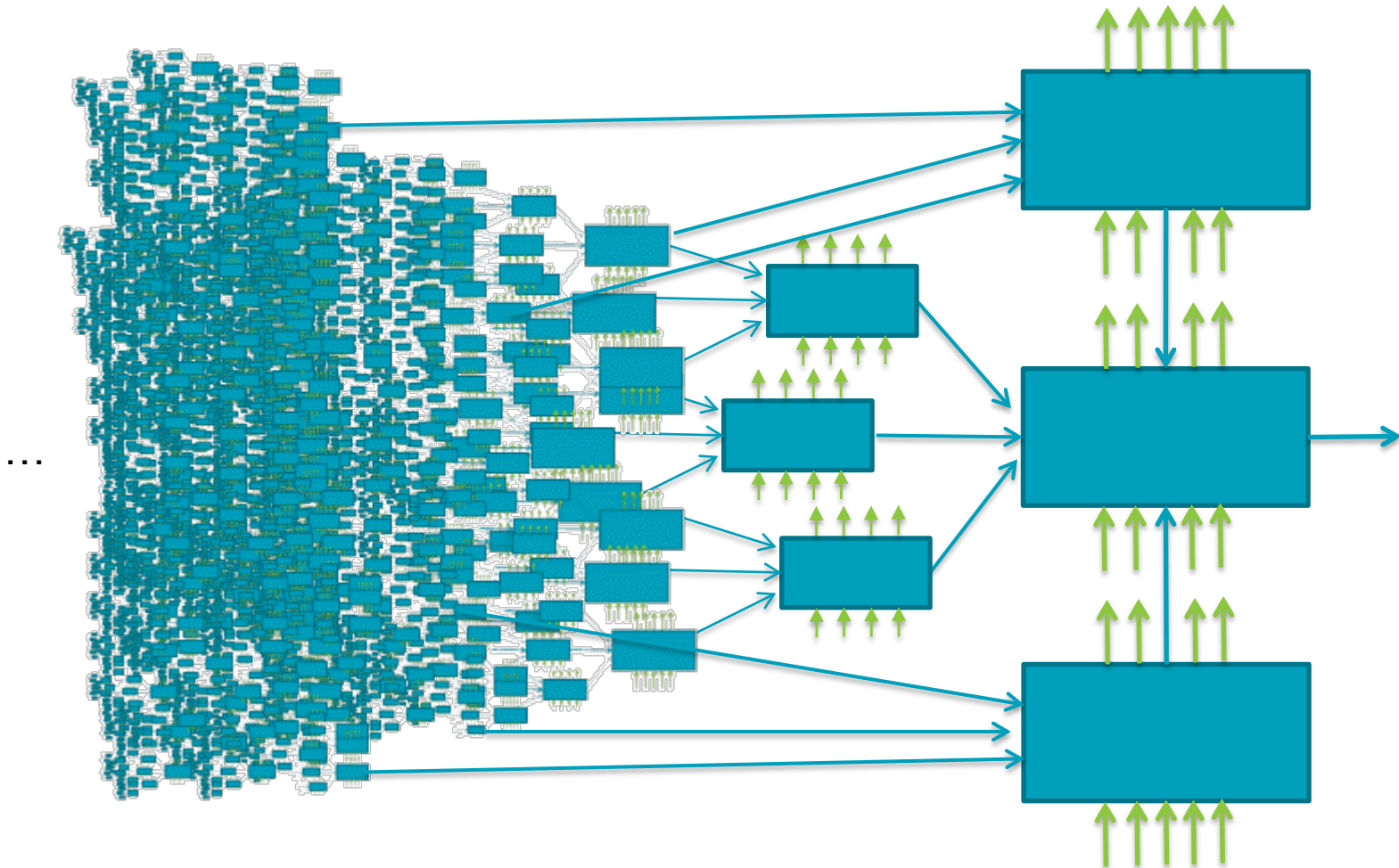
Life Cycle Inventory databases

POLYTECHNIQUE
MONTRÉAL

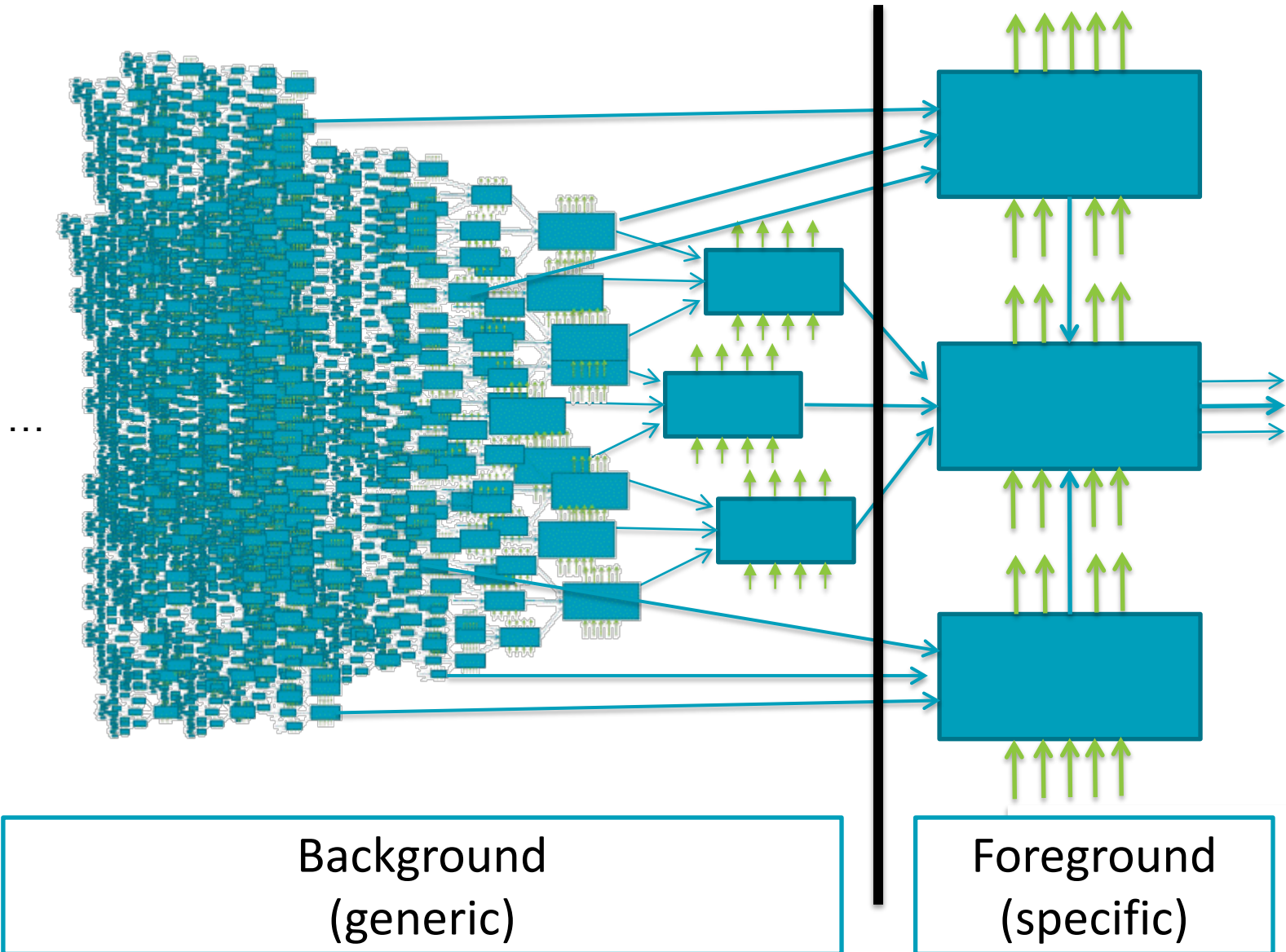
WORLD-CLASS
ENGINEERING



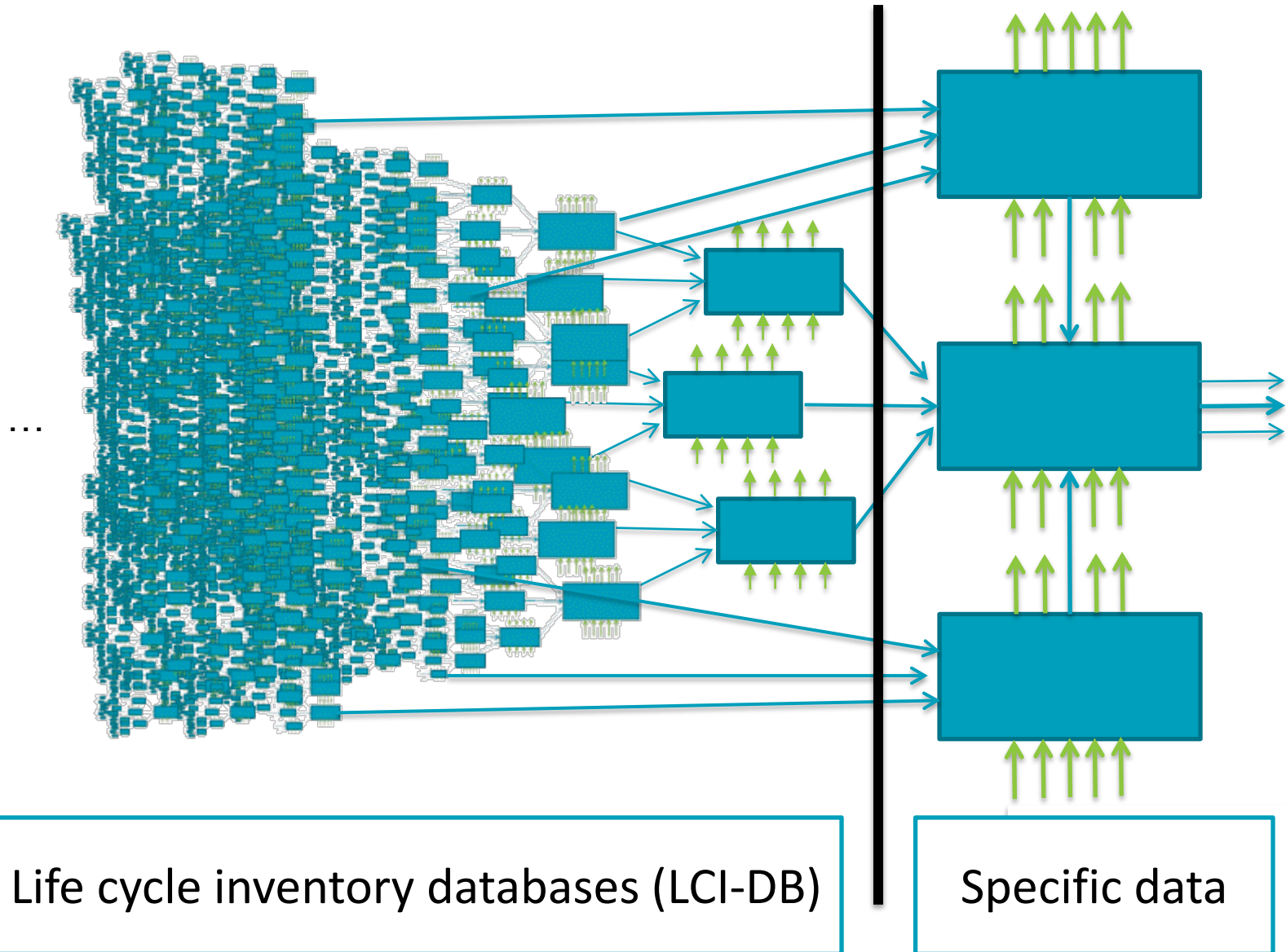
Product system



Types of data used in an LCA

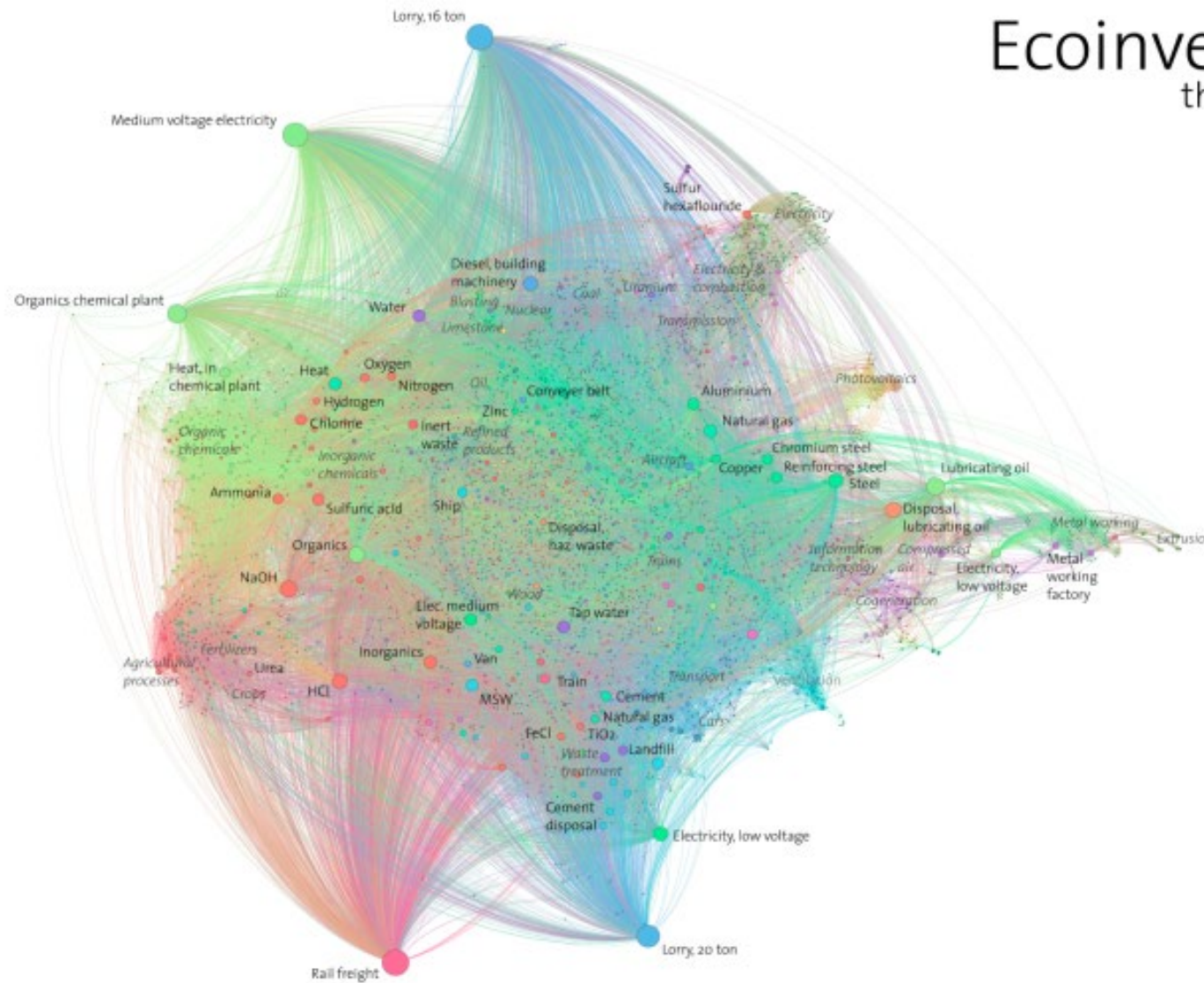


Types of data used in an LCA



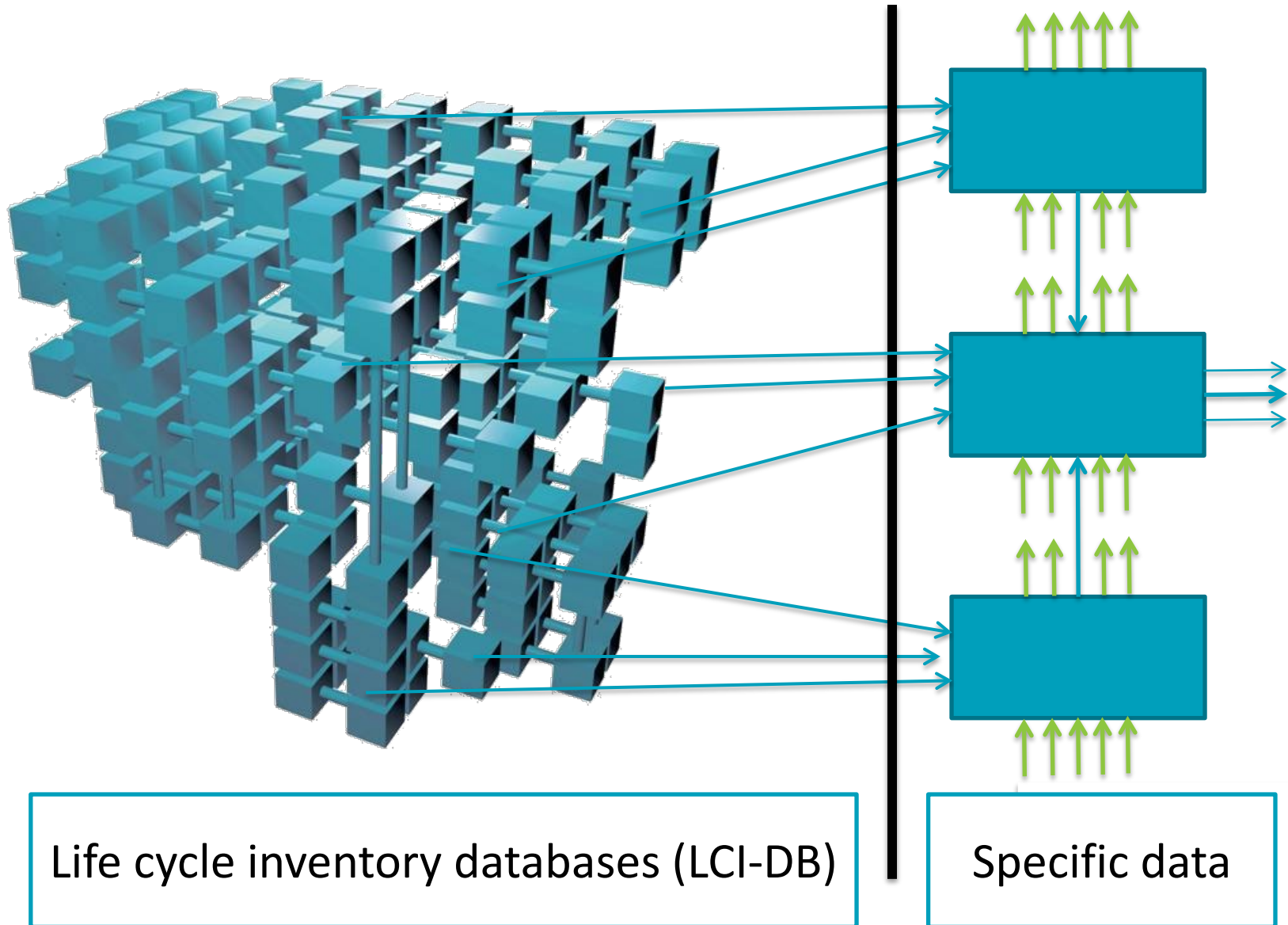
« Real » representation of a LCI-DB

Ecoinvent 2.2
the database

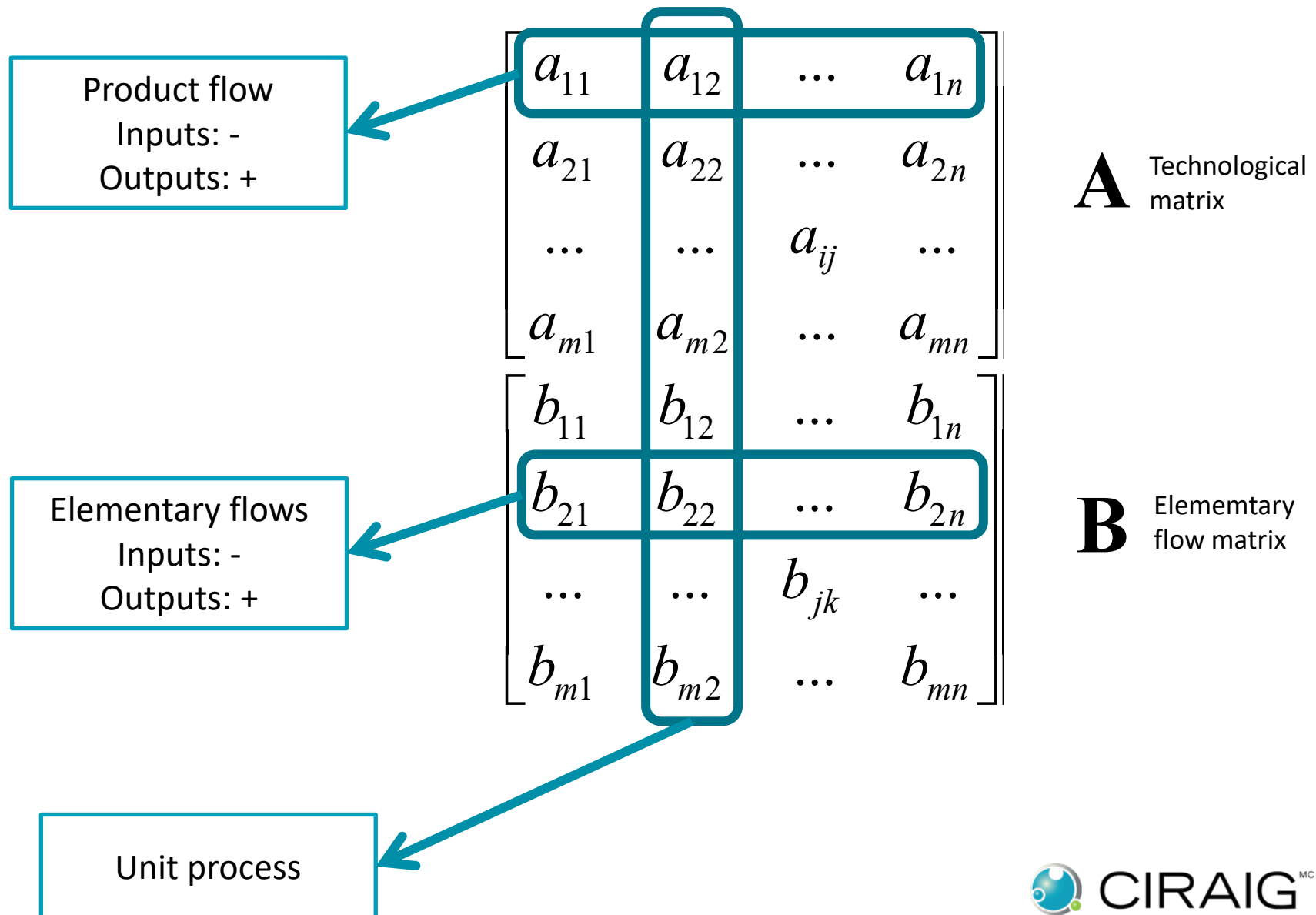


Made by Chris Mutel
using Brightway2
and Gephi

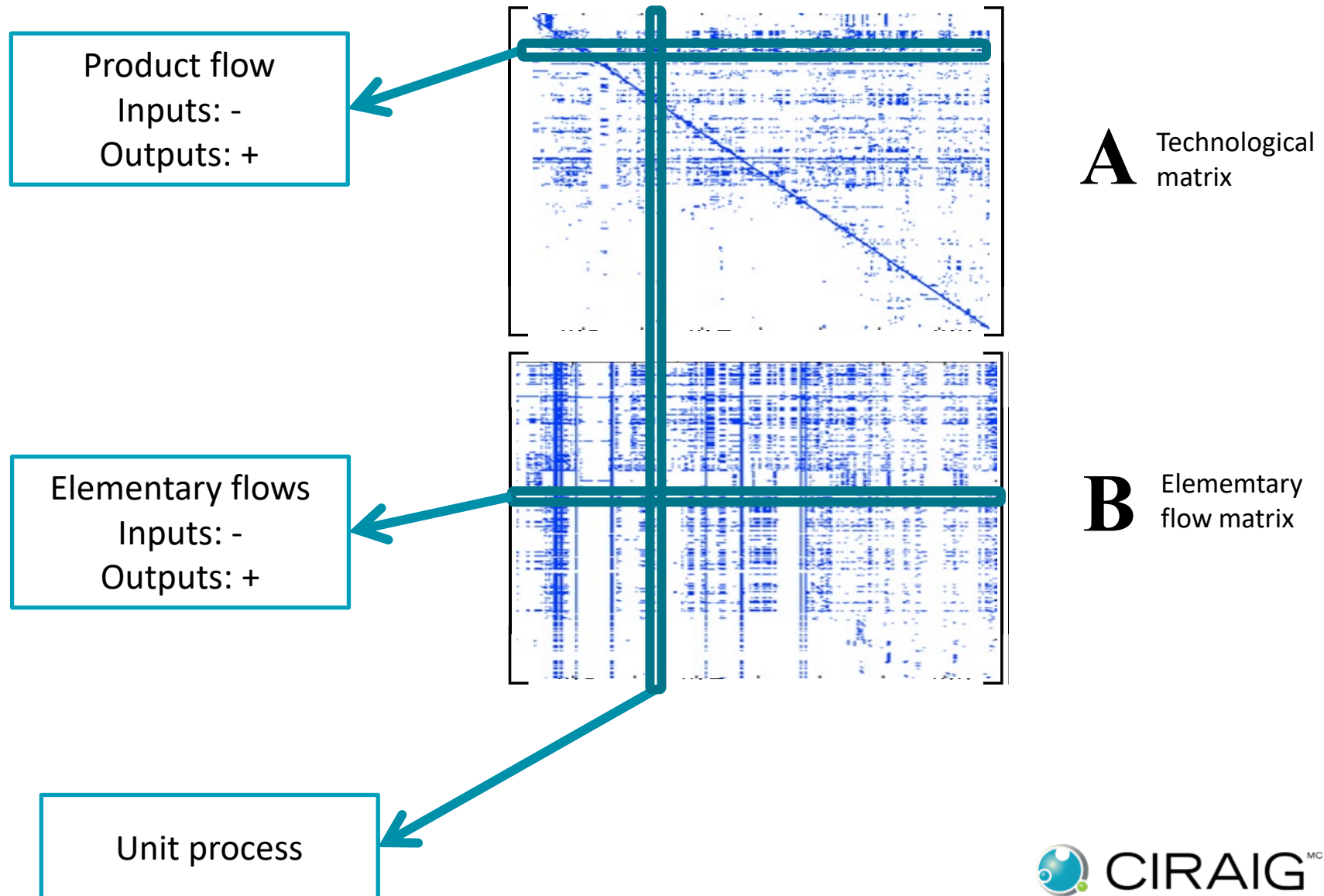
Better representation of a LCI-DB



Reminder – matrix representation



Matrix representation – ecoinvent 2.2



Reminder – matrix representation

$$\mathbf{A}\mathbf{s} = \mathbf{f} \iff \mathbf{s} = \mathbf{A}^{-1}\mathbf{f}$$

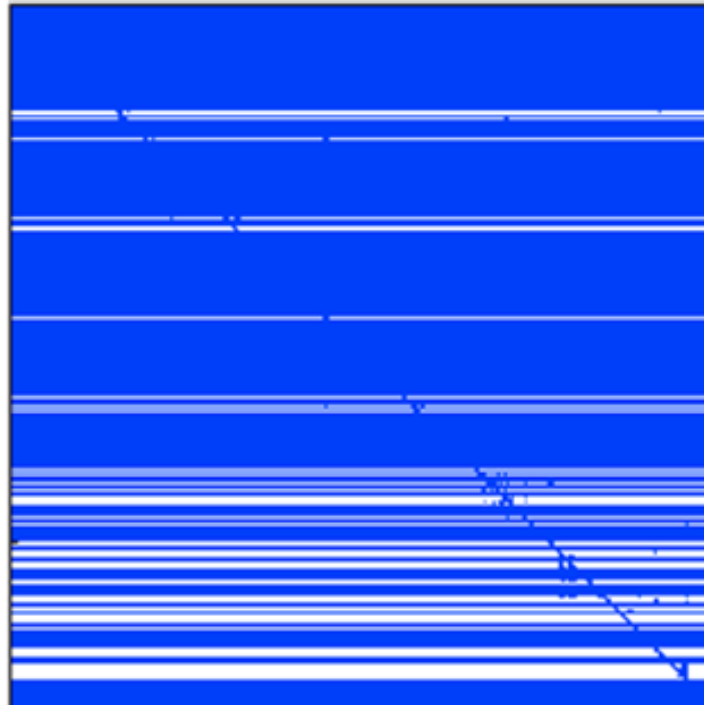
$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & a_{ij} & \dots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} \begin{bmatrix} s_1 \\ s_2 \\ \dots \\ s_n \end{bmatrix} = \begin{bmatrix} f_1 \\ f_2 \\ \dots \\ f_m \end{bmatrix}$$

Scaling factors

Final demand

Matrix representation – ecoinvent 2.2

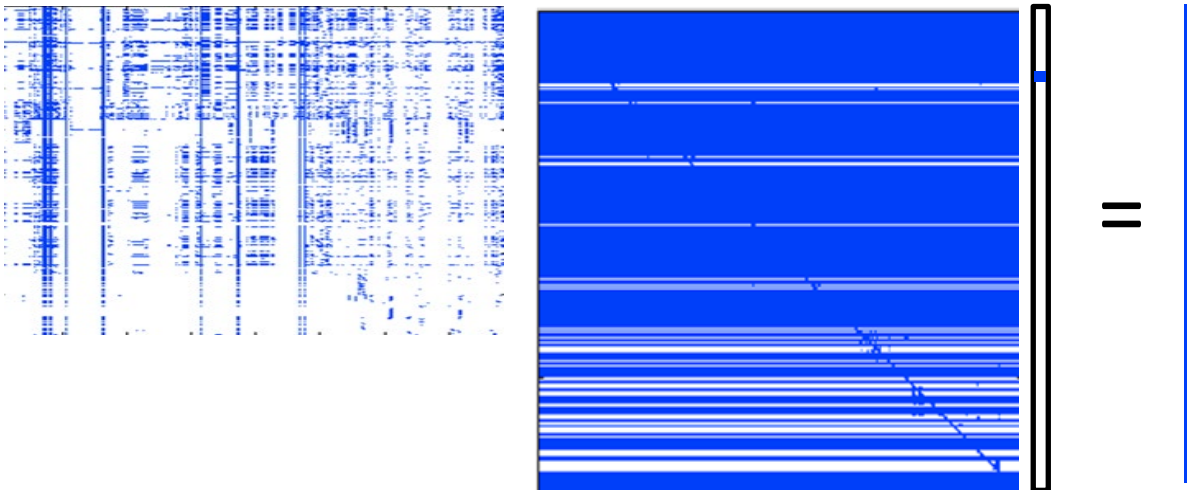
$$\mathbf{A}^{-1}$$



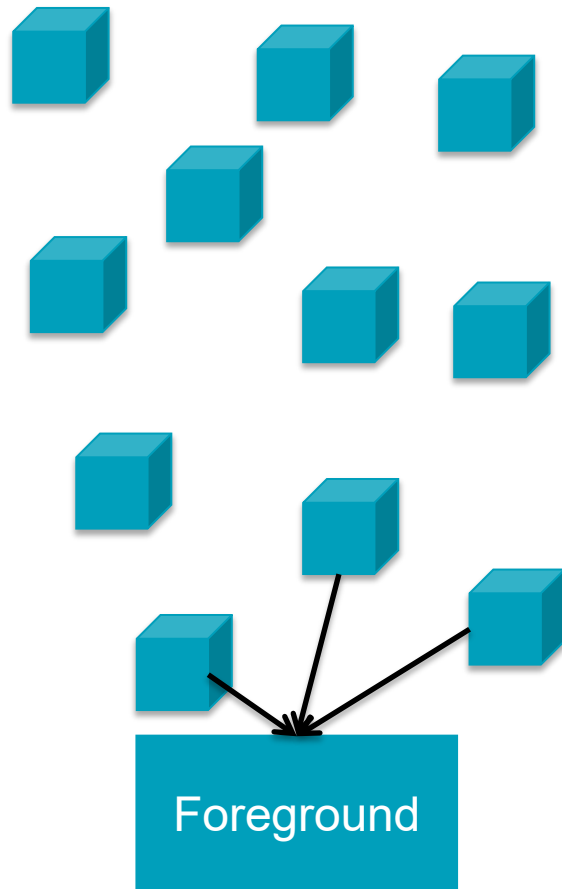
Matrix representation – ecoinvent 2.2

Calculation of the inventory

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

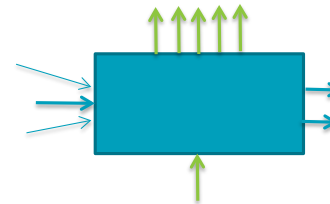


Archetypes of LCI-DBs



“Collection” of unit processes
(ie. U.S. LCI)

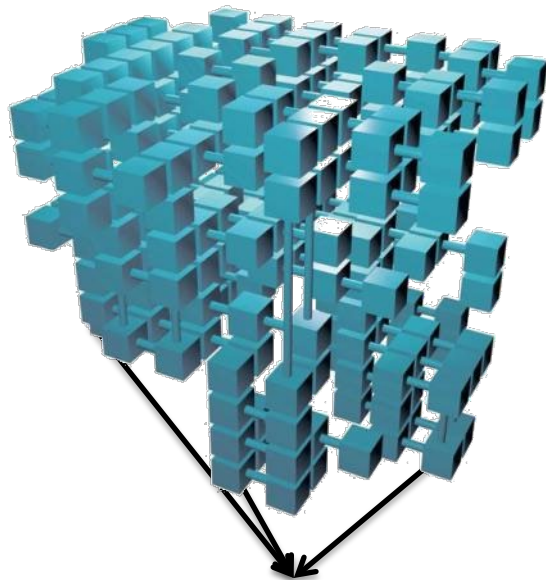
« gate-to-gate » datasets allow to see the modeled activities and to modify the flows if needed



However, the work of linking the unit processes together (theoretically infinite) is done by analysts

Note on U.S. LCI: « linked » version was created in 2008 by a third party and is integrated in different softwares. This version shows that there are many « holes » in the database

Archetypes of LCI-DBs



Foreground

Disaggregated LCI-DB
(e.g. *ecoinvent* version
« *Unit process* »)

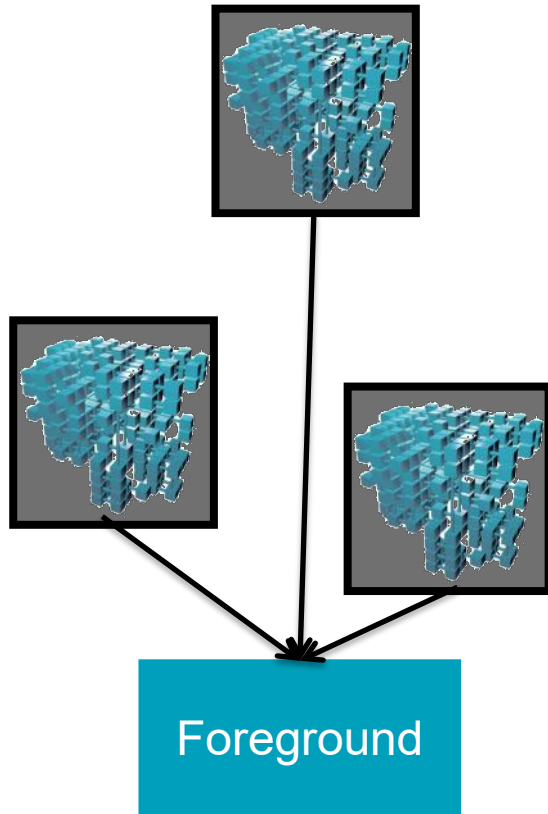
« gate-to-gate » datasets available
(transparent, modifiable)

Links between processes are given – with
a specific approach for modeling systems
(ie. « attributional »)

Links between the processes are
« coded », meaning the life cycle inventory
calculations are done in the software
without intervention from analysts

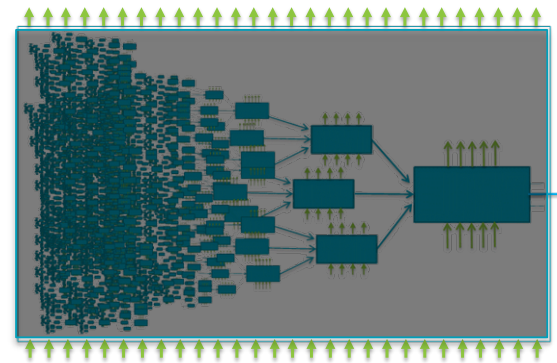
Links are also modifiable

Archetypes of LCI-DBs



Aggregated LCI-DB
(e.g. GaBi « agg », ecoinvent
version « system »)

Pre-calculated « cradle-to-gate » datasets
(hundreds of elementary flows)

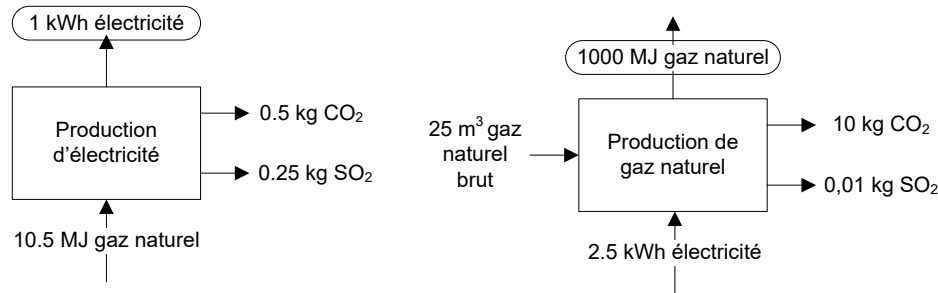


→ Individual gate-to-gate datasets and
links between the processes are not
accessible

Allows for hiding confidential information
Calculation is simpler

Concepts of aggregated data: example of electricity production

From:

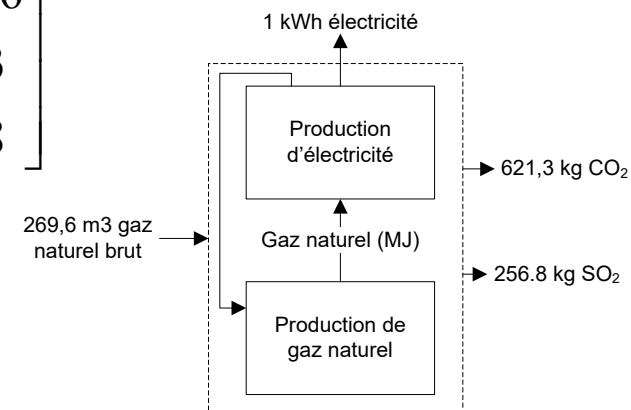


	$p_{\text{élect}}$	p_{GN}
Electricity (kWh)	1	-2,5
Natural gas (MJ)	-10,5	1000
Raw natural gas (m³)	0	-25
CO ₂ (kg)	0,5	10
SO ₂ (kg)	0,25	0,01

A
B

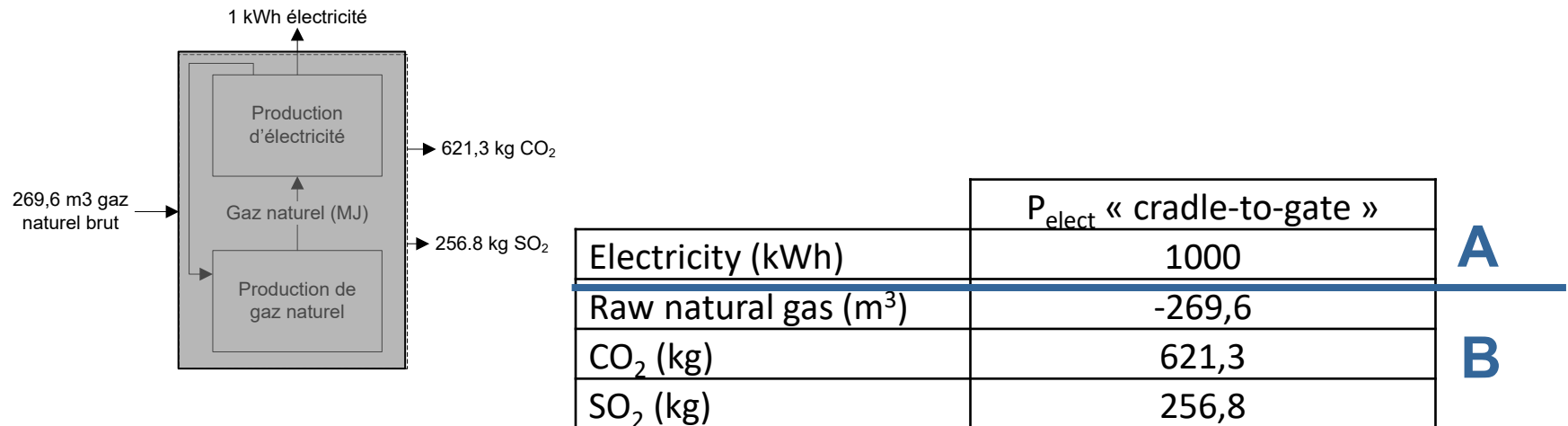
We calculated:

$$\mathbf{g} = \mathbf{BA}^{-1}\mathbf{f} = \begin{bmatrix} 0 & -25 \\ 0,5 & 10 \\ 0,25 & 0,01 \end{bmatrix} \begin{bmatrix} 1.027 & 2.57\text{E} - 03 \\ 1.08\text{E} - 02 & 1.03\text{E} - 03 \end{bmatrix} \begin{bmatrix} 1000 \\ 0 \end{bmatrix} = \begin{bmatrix} -269,6 \\ 621,3 \\ 256,8 \end{bmatrix}$$



Concepts of aggregated data: example of electricity production

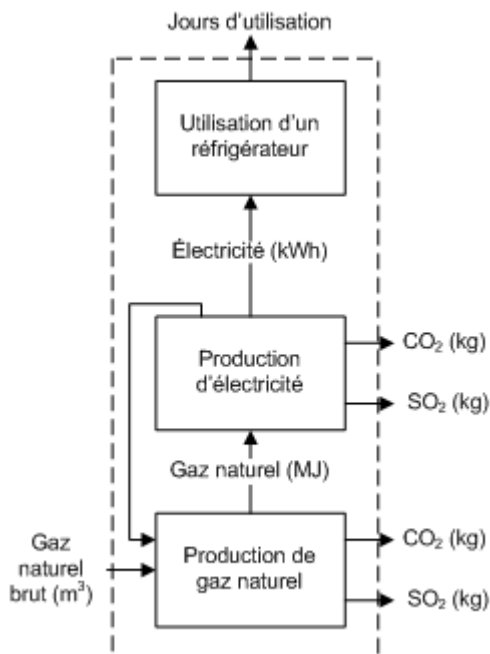
- We could use the inventory result to create a « cradle-to-gate » datum



- Only one economic flow equal to the reference flow
- The emissions are the emissions on the entire life cycle
- The details of what happen inside the system boundary of the datum cradle-to-gate are unknown

Concepts of aggregated data: example of electricity production

- This data can then be used in other LCAs
 - E.g. LCA of a refrigerator**
 - FU: Using refrigerator X for one year
 - Key parameter: 10 kWh/day
 - Two approaches:**
 - 1: Transparent & disaggregated system



	$p_{\text{élect}}$	p_{GN}	p_{refri}
Electricity (kWh)	1	-2,5	-10
Natural gas (MJ)	-10,5	1000	0
Refrigerator use (days)	0	0	1
Raw natural gas (m ³)	0	-25	0
CO ₂ (kg)	0,5	10	0
SO ₂ (kg)	0,25	0,01	0

A

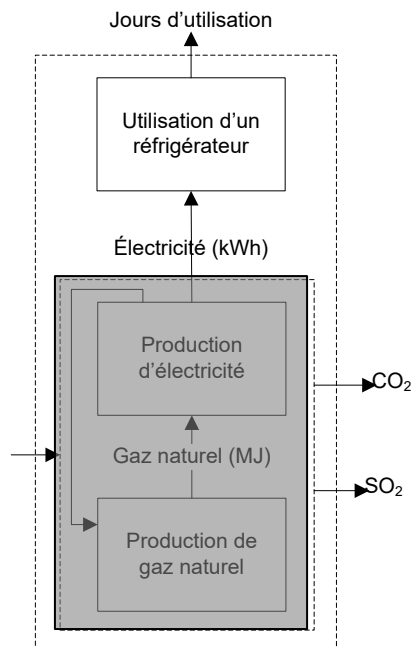
B

Electricity (kWh)	0
Natural gas (MJ)	0
Refrigerator use (days)	365

f

Concepts of aggregated data: example of electricity production

- This data can then be used in other LCAs
 - **E.g. LCA of a refrigerator**
 - FU: Using refrigerator X for one year
 - Key parameter: 10 kWh/day
 - **Two approaches:**
 - 2: System with aggregated data



	p _{élect}	p _{refri}
Electricity (kWh)	1000	-10
Refrigerator use (days)	0	1
Raw natural gas (m ³)	-269,6	0
CO ₂ (kg)	621,3	0
SO ₂ (kg)	256,8	0

A

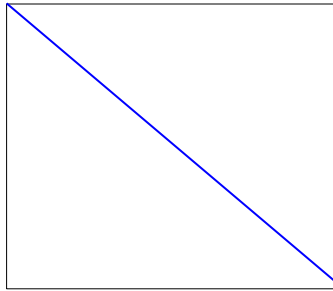
B

Electricity (kWh)	0
Refrigerator use (days)	365

f

LCI-DB matrices completely aggregated

Aggregated LCI-DB

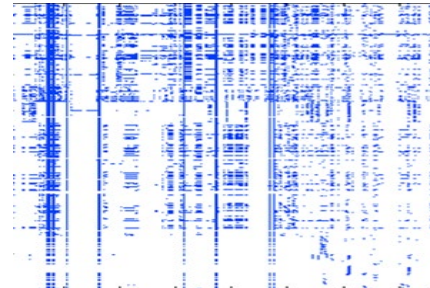
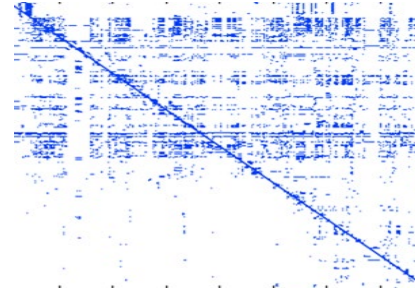


A



B

ecoinvent v2.2 LCI-DB (disaggregated)



Example: aluminium production, primary, ingot (CA-QC) in ecoinvent

Aggregated (system)

[illegible]

Disaggregated (unit process)

Flow	Category	Flow property list	Amount	Formal Uncertainty	Uncertainty (1σ)	ISO 9500
Electricity capacity	F1	F1.Capacity	1546.18	kg	kg-normal	1.7348e-02
Electricity capacity	F2	F2.Capacity	1546.18	kg	kg-normal	1.7348e-02
Energy input	C1	C1.EnergyInput	0.0009	kg	kg-normal	1.0629e-02
Energy input	C2	C2.EnergyInput	0.0009	kg	kg-normal	1.0629e-02
Compressed biogas	C3	C3.CompressedBiogas	0.0004	kg	kg-normal	1.0629e-02
Compressed biogas	C4	C4.CompressedBiogas	0.0004	kg	kg-normal	1.0629e-02
Electricity	E1	E1.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E2	E2.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E3	E3.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E4	E4.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E5	E5.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E6	E6.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E7	E7.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E8	E8.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E9	E9.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E10	E10.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E11	E11.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E12	E12.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E13	E13.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E14	E14.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E15	E15.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E16	E16.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E17	E17.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E18	E18.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E19	E19.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E20	E20.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E21	E21.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E22	E22.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E23	E23.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E24	E24.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E25	E25.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E26	E26.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E27	E27.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E28	E28.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E29	E29.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E30	E30.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E31	E31.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E32	E32.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E33	E33.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E34	E34.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E35	E35.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E36	E36.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E37	E37.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E38	E38.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E39	E39.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E40	E40.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E41	E41.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E42	E42.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E43	E43.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E44	E44.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E45	E45.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E46	E46.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E47	E47.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E48	E48.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E49	E49.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E50	E50.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E51	E51.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E52	E52.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E53	E53.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E54	E54.Electricity	1.0	kg	kg-normal	1.0629e-02
Electricity	E55	E55.Electricity	1.0	kg	kg-normal	1.0629e-02

Intermediary
flows

[illegible]

Elementary flows

Elementary flows

[illegible]

Aggregated and disaggregated data: comparison

	Disaggregated DB	Aggregated DB
Calculation time	☹️	😊
Interpretation	😊	☹️
Adaptability	😊	☹️
Simplicity	☹️	😊
(but the software takes care of it)		
Confidentiality	☹️	😊
(but there are ways to ensure confidentiality of sensitive data)		

In the course: You will mainly use ecoinvent, via openLCA

This database comes in aggregated format (S) and disaggregated format (U)

Databases and openLCA

openLCA Nexus: The sou X

Secure | <https://nexus.openlca.org/databases>

DRIVE-gmail Drive-poly Prog reading list ACV-BIM Capture Reference uncertainty-SA trees Run IO kids bass wwt uk _MOOC blockchain etc

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openLCA Nexus

Your source for LCA data sets.

Databases

- [ecoinvent](#)
- [Agri-footprint](#)
- [exiobase](#)
- [GaBi](#)
- [ARVI](#)
- [Agribalyse](#)
- [soca](#)
- [EuGeos' 15804-IA](#)
- [NEEDS](#)
- [PSILCA](#)
- [ESU World Food](#)
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- [openLCA LCIA methods](#)

All

Free databases

For purchase databases



ecoinvent

updated

A leading LCA database by the ecoinvent centre. Ecoinvent 3.4, the fourth update of ecoinvent version 3, includes over a thousand new and updated datasets. The new data covers: updates of the electricity markets for both attributional and consequential system models, partitioning of the electricity sector by state and grid for the country of India, new and updated data for the European supply chains for natural gas, new and updated data for chemical products, and lastly activities for the recycling of PE and PET. We offer a fully valid ecoinvent licence with full access to the ecoinvent website and with databases specifically adapted to openLCA.

[Browse](#)



Agri-footprint

new

Agri-footprint is an life cycle inventory (LCI) database for the agriculture and food sector. It covers data on agricultural products: feed, food and biomass.

For your projects

- We will give you access to ecoinvent v3.6, “cut-off by classification” version in “.zolca” format, directly importable in openLCA
- The ecoinvent v3 database contains thousands of activities, and only a few hundred are specific to Quebec
- You may use data from other databases if needed
- All the details for using ecoinvent will be sent to you via Moodle in the coming days