Wiki on processes and products for Life Cycle Assessment (LCA) Overview

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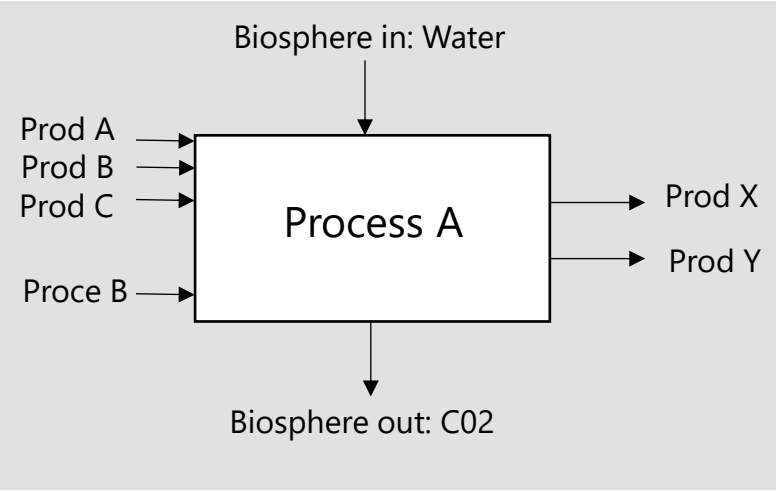
Outline

1. Some challenges in LCA – Initial motivation
2. Working group “GDR DEFI GT2”: ElecImpact database
3. Overview of the project
4. Current vision – two challenges addressed by the wiki
5. Data structure
6. Data import example
7. Tentative parametric approach

Some challenges in LCA – Initial motivation

LCA/Impact results **without transparency on the processes** used (life cycle inventory - LCI) has **limited scientific value**.

- Impact results give **non explainable information**. Cannot be analyzed by experts.
- Given processes, one can compute and explain impact results.
- Used processes seem to be as important as methodology considered (e.g., PCR/PSR).
  - Using same methodology but different databases, one can observe up to x100 difference.
- No peer review for private databases.



However, there exist **many scientific publications in the public domain providing processes** used in the scope of LCA.

- **<u>Proposal</u>**: **Centralize processes in a collaborative « wiki of product and processes ».**
- Focus on « downstream » processes, e.g., BOMs, unlike e.g., ecoinvent which focuses on « upstream » processes.

PCR: Product category rules.
PSR: Product specific rules.
BOM: Bill of materials.

DEFIE cnrs

Groupement De Recherche sur les Dispositifs Electroniques à Faibles Impacts Environnementaux

ElecImpact : Vers une base de données ouverte et collaborative pour l’ACV en électronique

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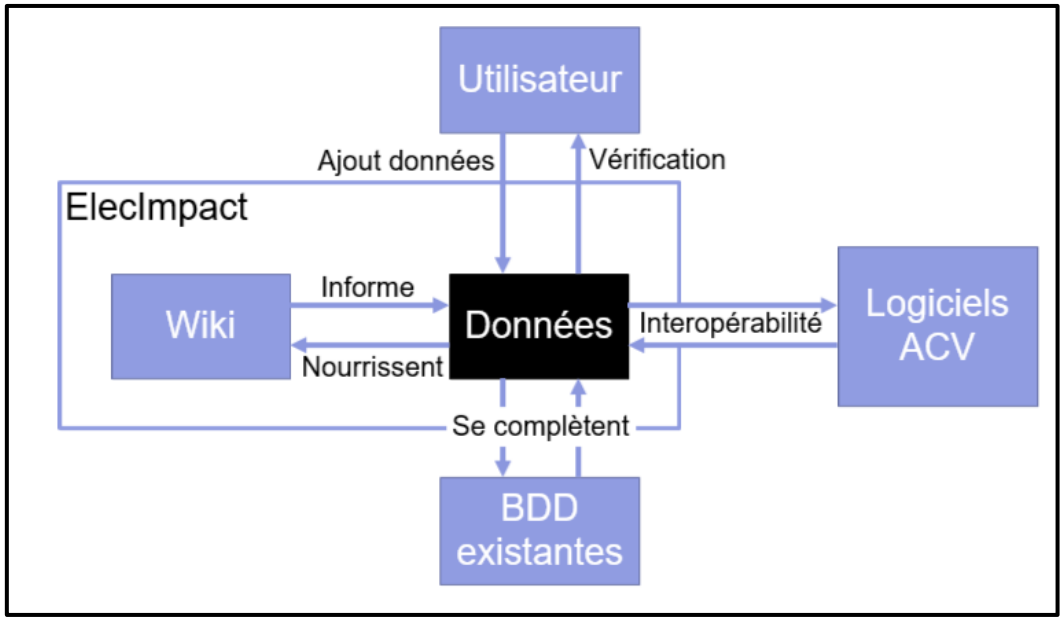
Maxime PERALTA, CEA List
Vincent CORLAY, Mitsubishi Electric R&D
Maxime PELCAT, INSA Rennes, IETR

Nous présentons ici l’un des travaux du GT2 du GDR DEFIE récemment créé : la mise en place d’une spécification pour une base de données collaborative, ainsi que le développement de la base elle-même, ouverte et collaborative, dédiée à l’ACV dans le domaine de l’électronique.

Bases de données pour l’ACV en électronique	GaBi	CODDE	Ecoinvent	NegaOctet	Base Empreinte	ElecImpact
Libre + gratuite	✗	✗	✗	✗	✓	✓
Utilisable hors logiciel propriétaire	✗	✗	✓	✓	✓	✓
Traçabilité des sources	✗	✗	✗	✗	✓	✓
Grande diversité de composants disponibles	✗	✗	✗	✗	✗	✓
Ajout de nouveaux composants (e.g. issus de la recherche)	✗	✗	✗	✗	✗	✓

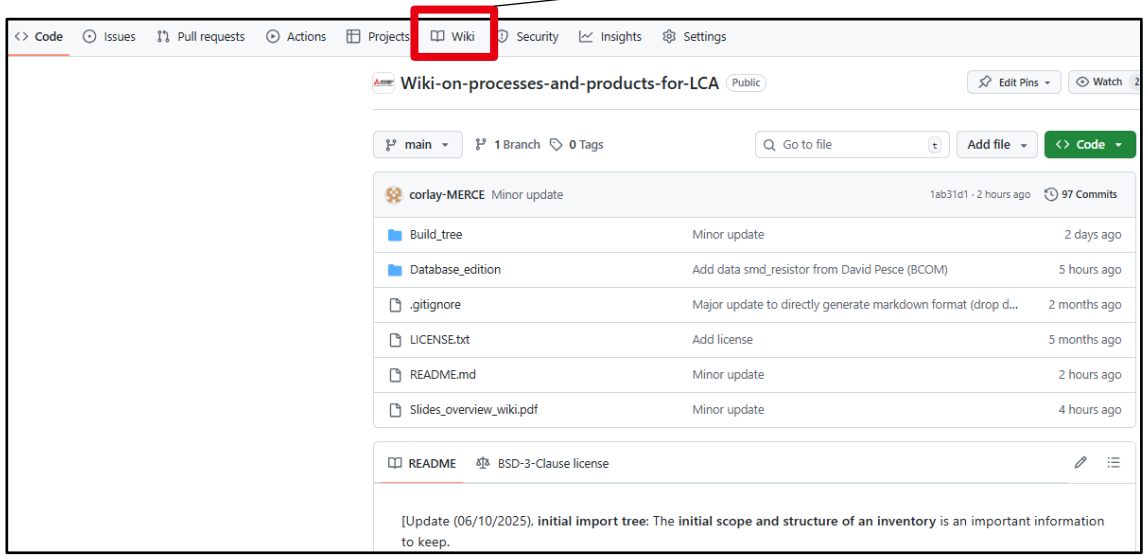


Overview of the project (1)

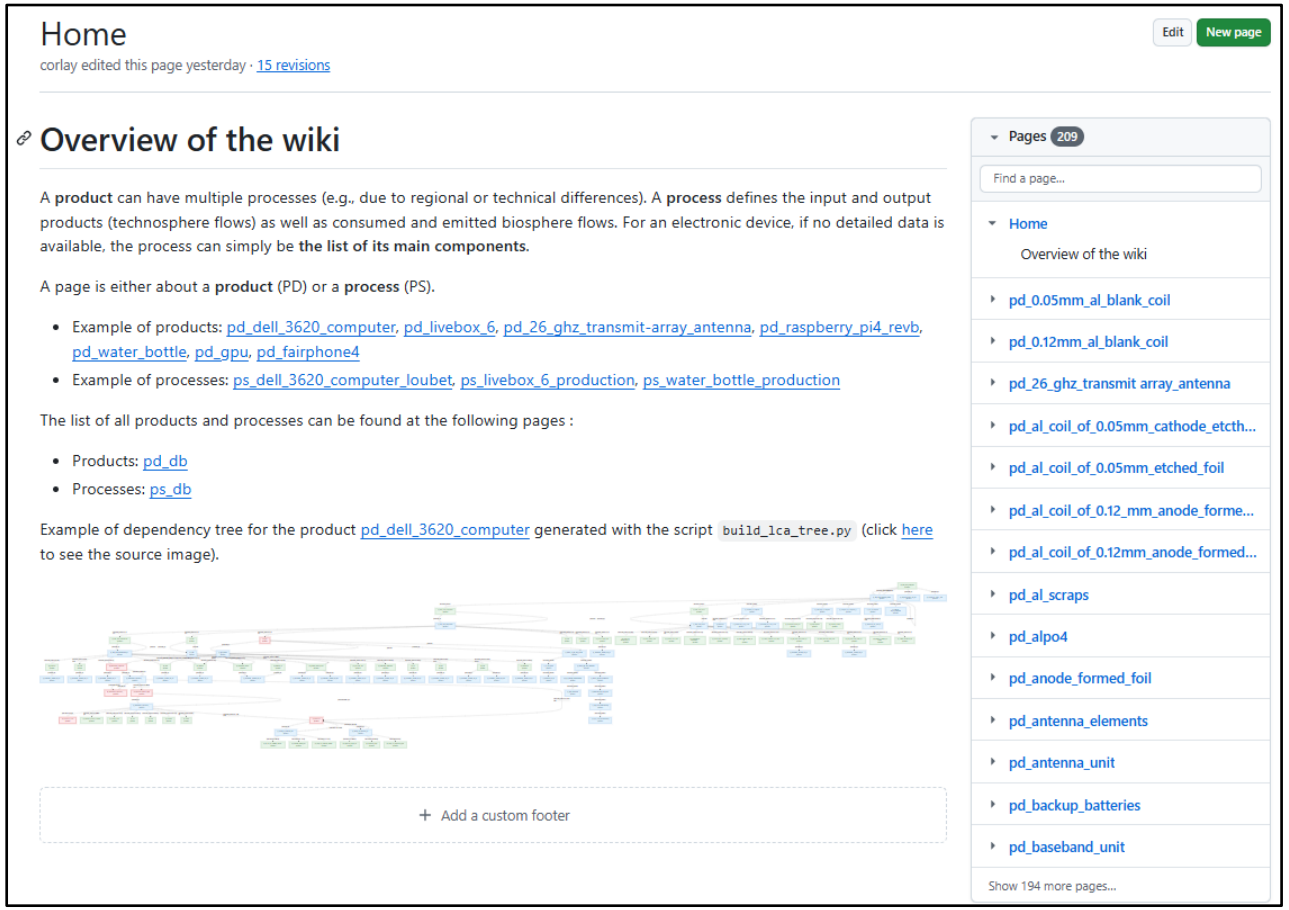
- Project link: **https://github.com/merce-fra/Wiki-on-processes-and-products-for-LCA**
  - Still at prototype stage. Goal is to illustrate approach.
- Project consists of four main parts:
  1. **The Wiki**: to organize processes and products, that can be found in the public domain, to be used for the **Life Cycle Inventory (LCI)** part of a Life Cycle Assessment (LCA) study.
  2. The **import function** for **Brightway-formatted inventory data.**
  3. **Visualization function**: automatically build a **dependency tree** starting from a chosen product or process page, **with identification of alternative process nodes**.
  4. **AI-based Wiki Edition**: AI to assist in the management of the Wiki. It automates tasks such as page generation (for not Brightway-compliant data), inconsistency detection, and product similarity analysis.

Overview of the project (2)

GitHub home page



Wiki home page



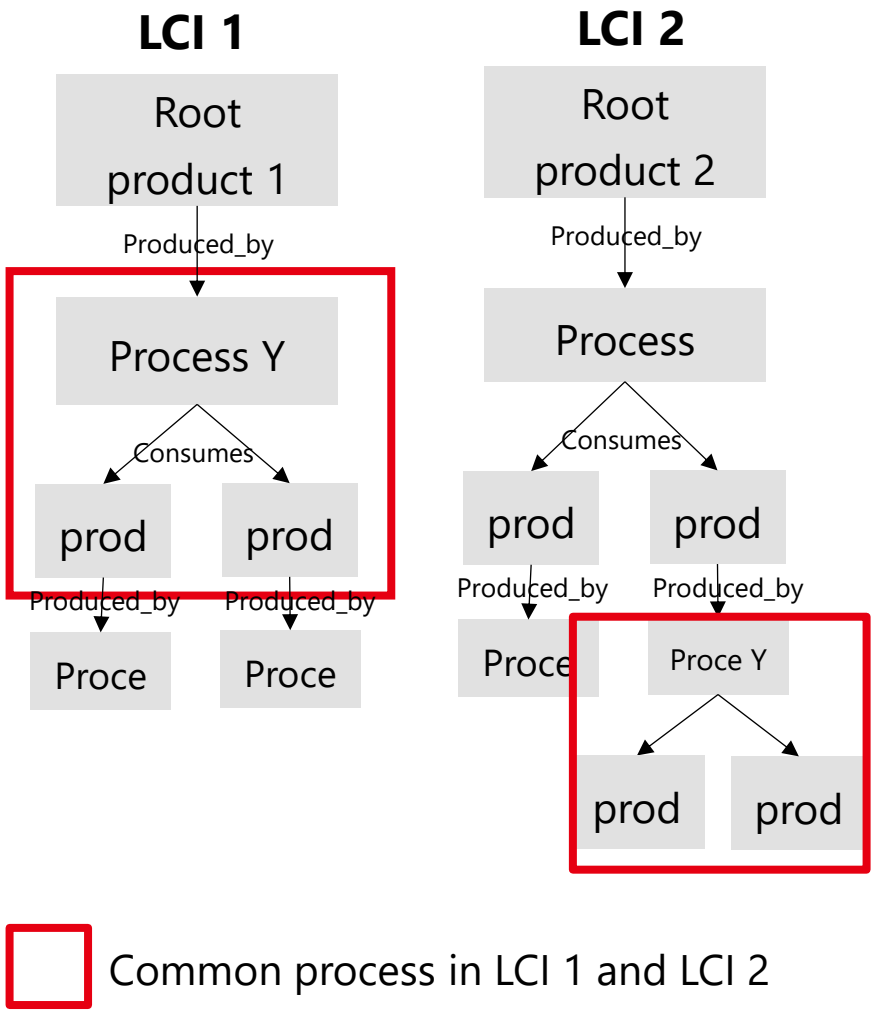
Vision (1)

Currently, performing a LCI includes the following challenges:

1. **Several processes** may exist to produce **the same product** (not only for geographic reasons).
2. **Scientific contributions** are often referenced by the end product, but inventory may include **sub-process data valuable for other studies**.

- This **open** wiki is designed to efficiently list and compare **multiple approaches** for performing the inventory of a product (1). It references data at the **process level** (2).
- Easy to **compare existing options and select the most suitable approach**.

Example where LCI 1 and LCI 2 contain mutually beneficial data
(Point 2 on the left)



Common process in LCI 1 and LCI 2

LCI: Life Cycle Inventory

Vision (2) - Illustrative example

Electrolytic capacitors

- The ecoinvent reference to produce an electrolytic capacitors was originally added when importing the inventory of the Dell computer.
- A second inventory was imported as data from a **research paper** dedicated to this topic. The import script automatically detected that the process produces a product already present in the wiki.
- Visualization script identifies that **two alternative processes now exist** for this node in the tree starting at the Dell computer node. **Red nodes in the graph**.
- This enables researchers studying the Dell computer to easily update their LCA with the alternative process for the electrolytic capacitors and compare the results.
- Link to the tree: raw.githubusercontent.com/wiki/merce-fra/Wiki-on-processes-and-products-for-LCA/out_tree/graph_pd_dell_3620_computer.svg

pd_electrolytic_capacitors

corlay edited this page on Jul 3 · 3 revisions

Product: pd_electrolytic_capacitors

List of processes

- Ecoinvent: market for capacitor_electrolyte_type_<2cm_height | GLO
- ps_electrolytic_capacitors_aging_and_inspection_zhang

pd_gpu

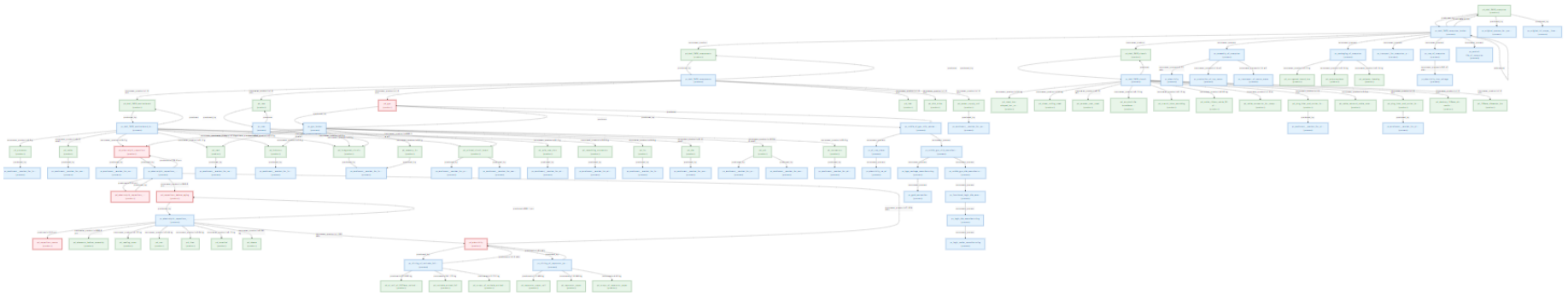
corlay edited this page on Jul 9 · 3 revisions

Product: pd_gpu

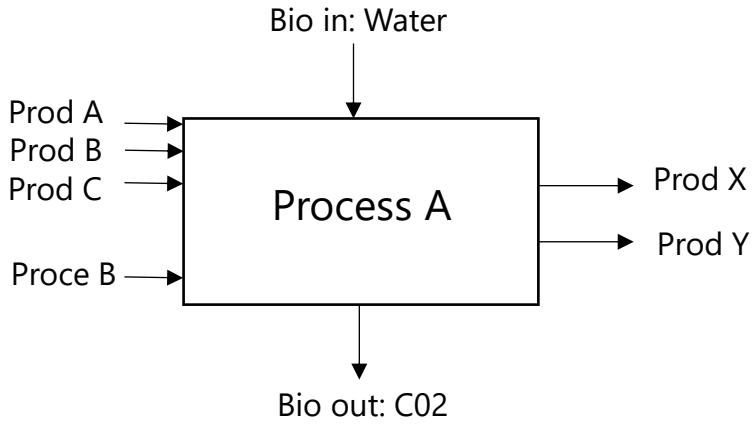
List of processes

- ps_gpu_loubet
- ps_nvidia_ai_gpu_chip_parameter_appa

May be similar to the following products



Data structure (1)- Overview



Product

- One product is always produced by a process.
- Several processes can be proposed for the same product (technical or geographic difference).

Process

- Process may or may not produce a product.
- It is composed of technosphere flows and biosphere flows.
- Technosphere flow:
  - Consumption of products and processes.
- Biosphere flow:
  - Consumption and emission of biosphere elements.
- Original root and process node.

Data structure (2)-Product and process Mardown pages

Blue: clickable

Page of product X:

- Process A
- Process B
  - Original process for product as root node.
  - Original LCI scope
  - Original tree
- Process C
- Process E = Ecoinvent process (non clickable)

Example in the wiki

pd_gpu

corlay edited this page on Jul 9 · 3 revisions

Product: pd_gpu

List of processes

- ps_gpu_loubet
- ps_nvidia_ai_gpu_chip_parameter_appa

Page of process A:

- Technosphere flow:
  - Production
    - Product X
    - Product Y
  - Consumption
    - Product A
      - Quantity
    - Product B
    - Product C
    - Process B
- Biosphere Flow:
  - Emission
    - CO2
  - Consumption
    - water
- Original root product and process nodes
  - Product: XXX
  - Process: XXX
- Information:

  Publi ref…

Example in the wiki

Process: ps_gpu_loubet

Characteristics

- Added by: Vincent Corlay (v.corlay@fr.merce.mee.com)

Technosphere Flow

Production

- pd_gpu - Quantity: None unit

Consumption

Product:

- pd_electrolytic_capacitors - Quantity: 5.2 g - Amount: 4
- pd_smd - Quantity: 22.2 g - Amount: 258 - Database: No
- pd_inductors - Quantity: 3.8 g - Amount: 2 - Database: N
- pd_ics - Quantity: 10.0 g - Amount: 24 - Database: Not s
- pd_memory_ics - Quantity: 8.0 g - Amount: 4 - Database
- pd_die - Quantity: 81.0 mm2 - Amount: 1 - Database: No
- pd_pcb - Quantity: 10336.0 mm2 - Amount: 1 - Databas
- pd_connectors - Quantity: 20.0 g - Amount: 3 - Database
- pd_integrated_circuits - Quantity: 8.0 g - Amount: 1 - Da

Note: this example does not include parametric approach

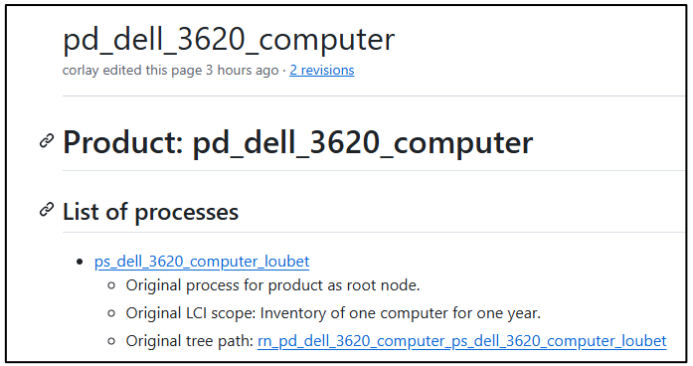
Data structure (3)- Original scope and structure of inventory

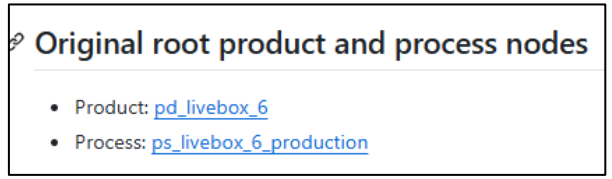
The **original scope and structure of an inventory** is an important information to keep.

- For instance, the quantity used in a sub-process are often established with respect to the root product LCI scope.
- New processes may be added under an existing product ➔ lose track of original path in tree.

Page structure (see pd_smd_thin_resistor, pd_livebox_6, Dell computer for examples):

- When importing an inventory, the **LCI scope shoud be specified**.
- The root process of a root product is **clearly indicated**.
- This LCI scope is added under the **original process of the root product of the inventory**.
- The **original tree path is computed and added under the original process of the root product of the inventory (link to rn_ file)**.
- **A link** to the original root product and process nodes is added in **each child process page**.



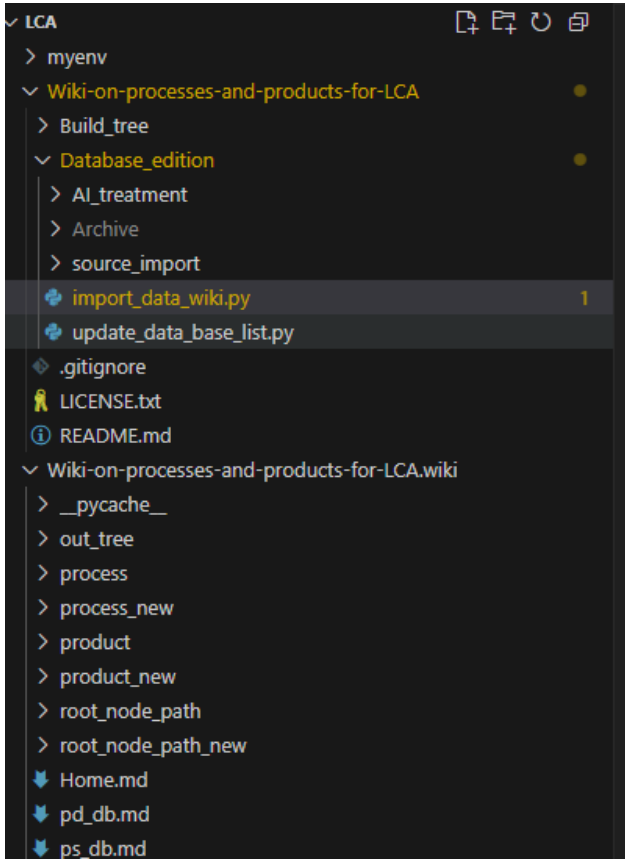


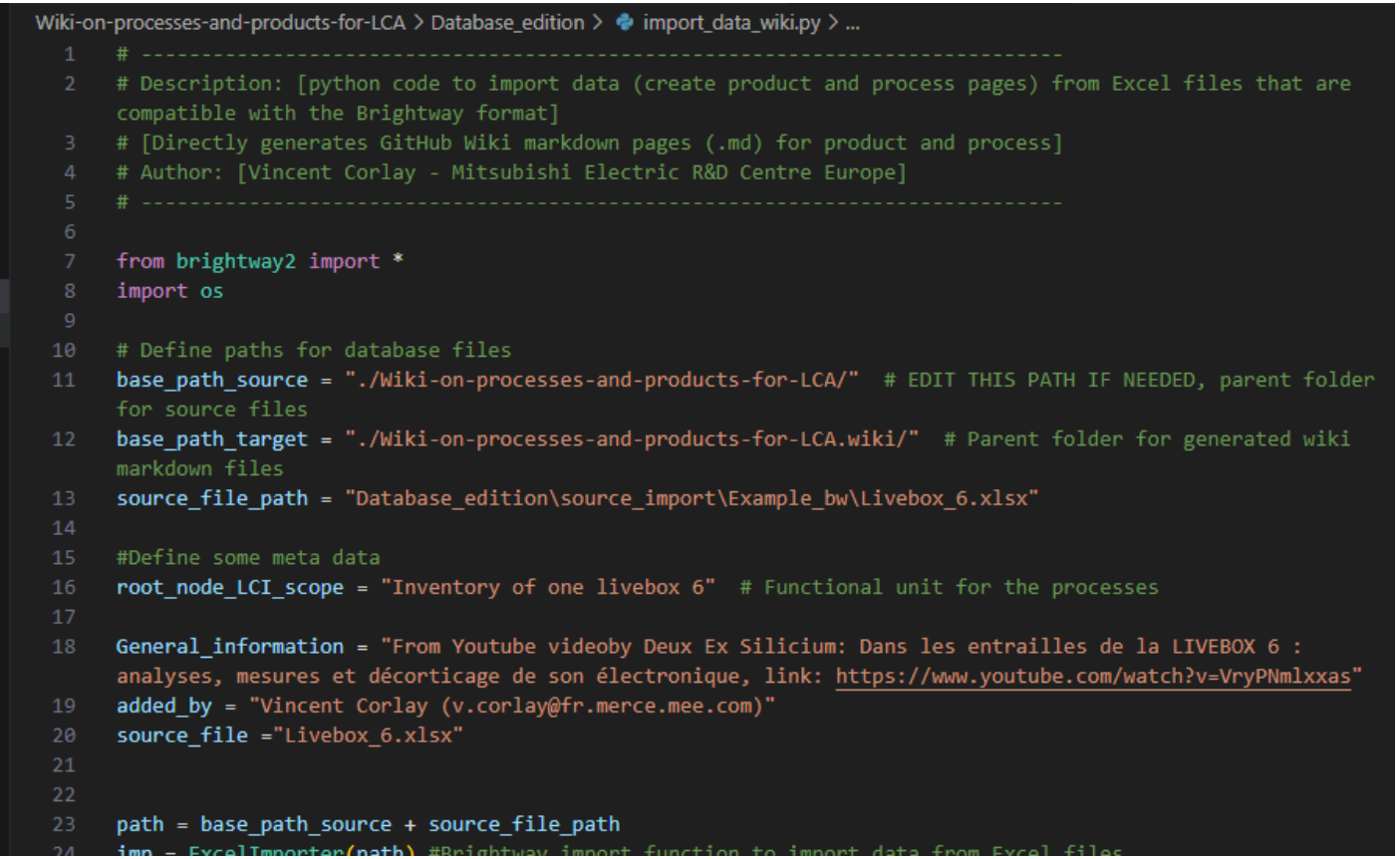
LCI: Life Cycle Inventory

Data import example

GitHub Project
with code to import/edit pages

Wiki Project
Mardown pages located in process & product folders. New pages created in process_new & product_new folders.





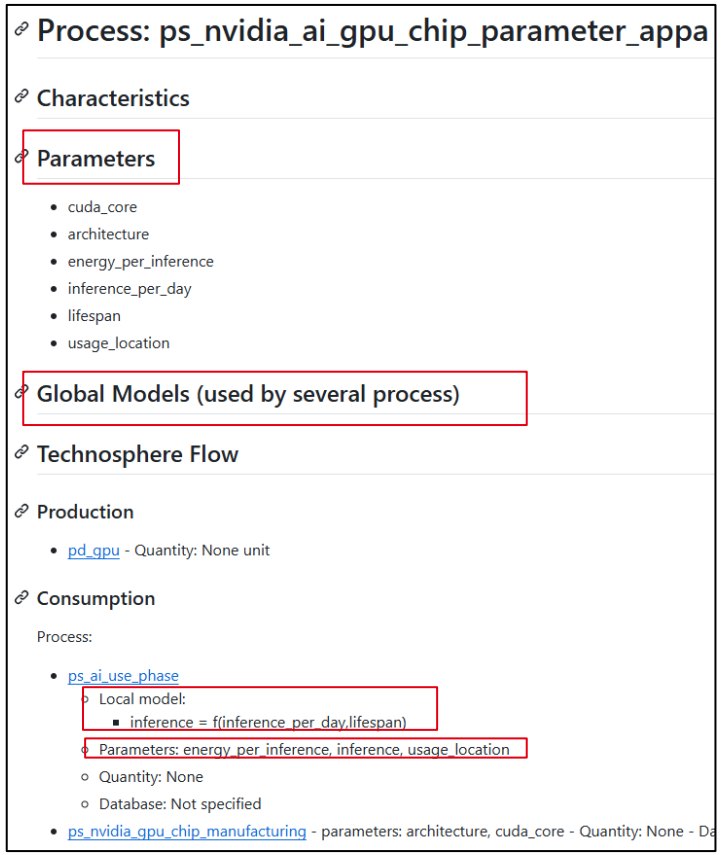
Tentative parametric approach

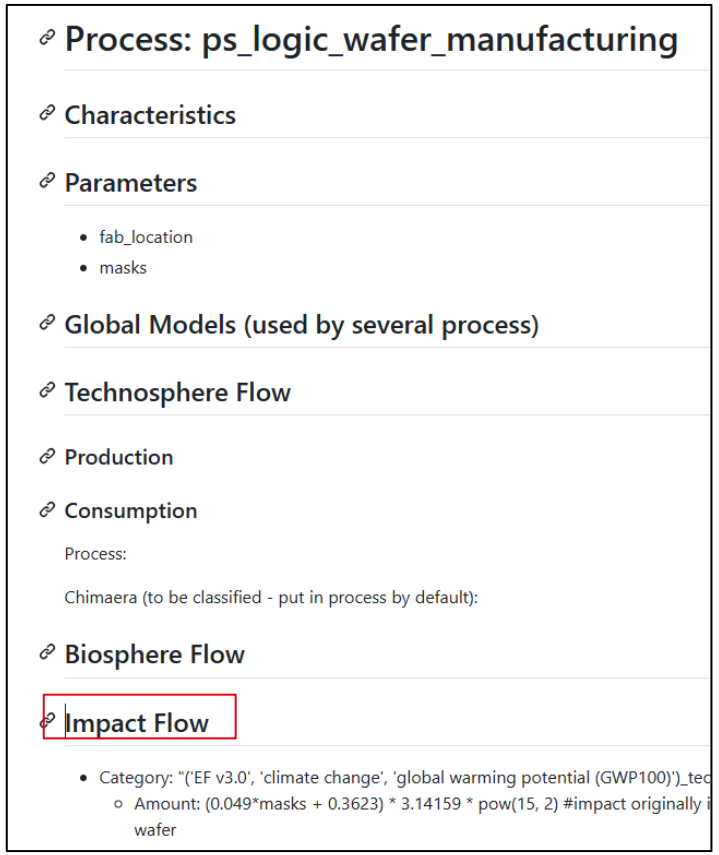
The example of **Appa's parametric GPU model** has been added to the wiki to help identify necessary adaptations.

This process is now listed under the GPU product page of the wiki.

In the Appa GPU process branch, the wiki page structure updated as follow to handle the parametric model.

- New "**Parameters**" **section**: List of the input parameter names.
- New "**parameters**" **field**: Added to the metadata following a process name in the "Consumption" section.
- **Models** (based on Appa's "Parameter Matching"):
  - If a model is used by a single process, it is added as a local model under that process.
  - If a model is used by multiple processes, consider creating a Global Model section to avoid duplication.
- New "**Impact Flow**" section: Allows for impact formulas based on parameters (e.g., see logic_wafer).





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