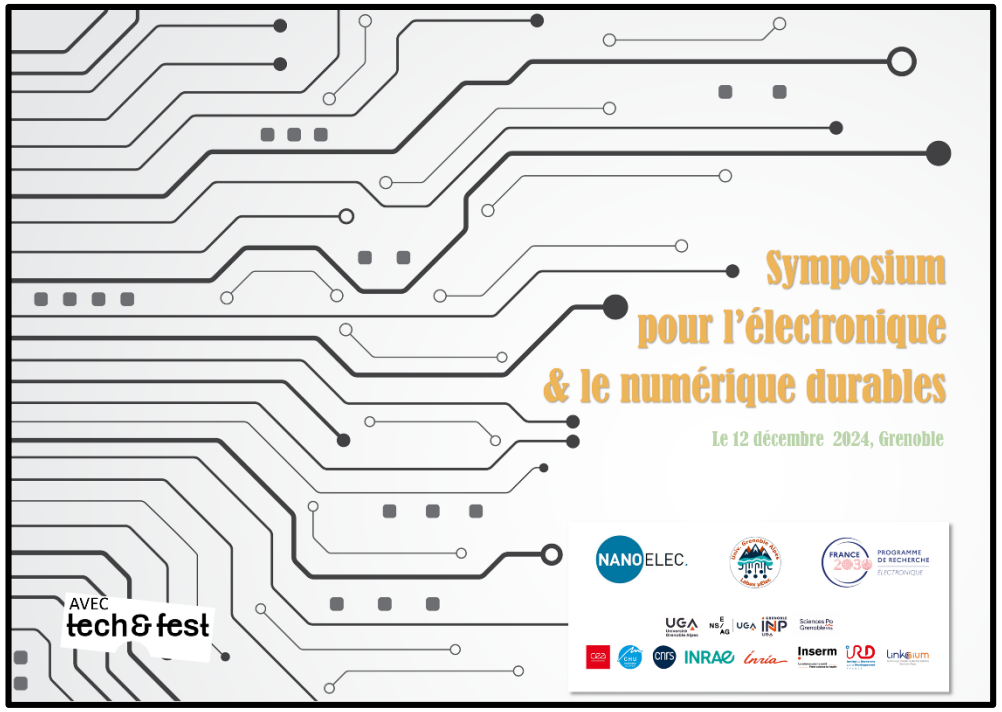


Symposium “Electronique & numérique durables“

Extension of the Life Cycle Analysis method to an R&D environment, based on the study of a prototype use case.

29/11/2024

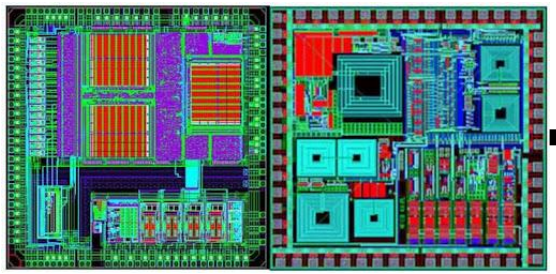
Makan (Thibault) HALTER

CEA LIST

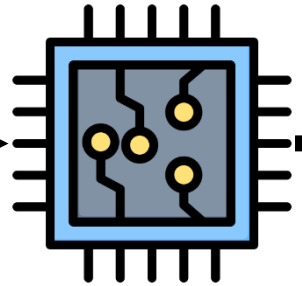
Introduction

Analogy : Ingrated Circuit (IC) and building

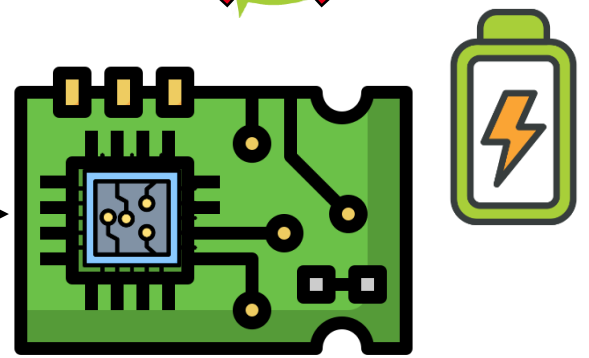
Ecodesign
(**L**ife **C**ycle **A**nalysis)



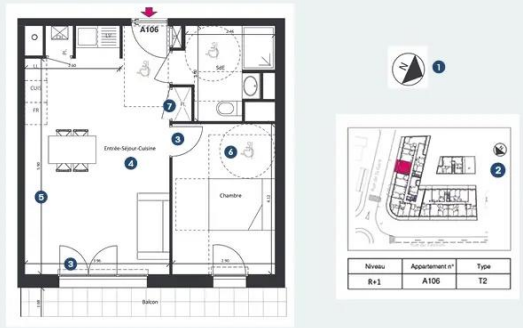
IC Layout



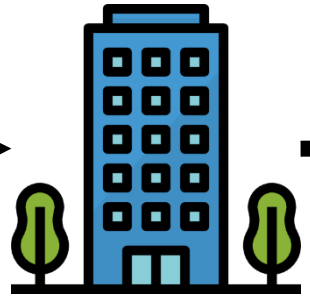
Integrated Circuit [IC]



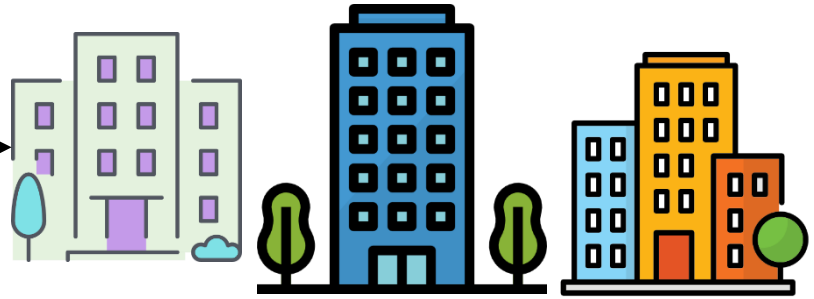
Integration to a specific environment
(PCB + capacitors + unknown ICs + battery + captors…)



Architect building plan



Building



Integration to a specific environment
(Neighborhood)

Icon artists :
Zlatko Najdenovski
Monkik
Rasama studio
Uniconlabs
Surang
Candy design

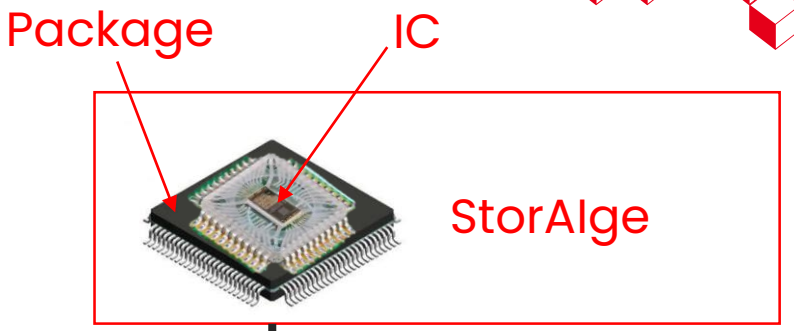
Introduction

Objectives :

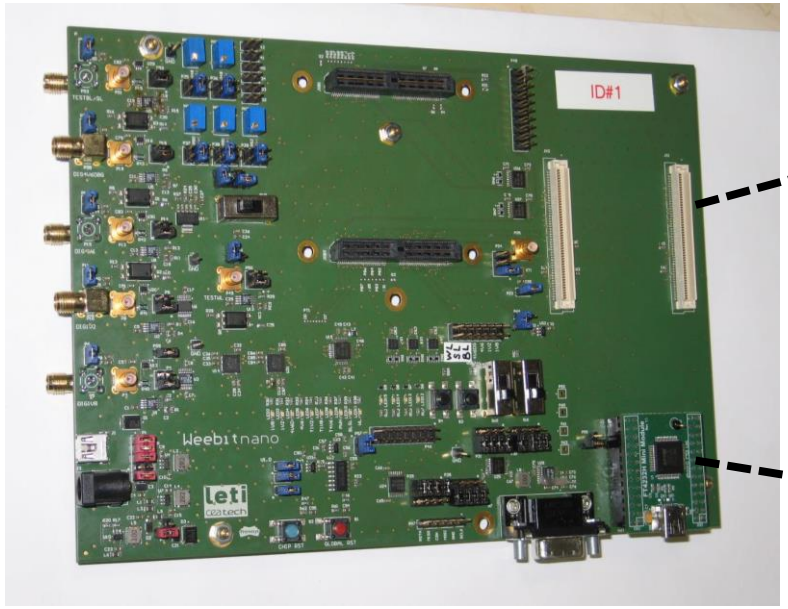
- Define **relevant hypothesis & assumptions** that allow to make **systematic numeric LCA from design**

1st steps :

- Exploration work from a usecase : StorAige project (CEA LIST)
  - **Prototype testversion** [Extraction & Manufacturing only]



Maha & al.
"Storage Class Memory with Computing RowBuffer: A Design Space Exploration", 2021



Motherboard

Daughterboard

FTDI Module

Running a LCA from an electronic design

Datas from design

Bill of material (BoM)
>200 components
(ICs, capacitors, resistors, connectors…)

How to build Life Cycle Inventory from design ?

Case 1 :
Non-exhaustive LCA database
Example : Capacitor

Case 2 :
Lack of precision in BoM and industrial datasheets
Example : unknown ICs

LCA software

EIME

Database [Secondary data]

CODDE
Negaoctet

Methodology

EF 3.0

LCA Hypothesis

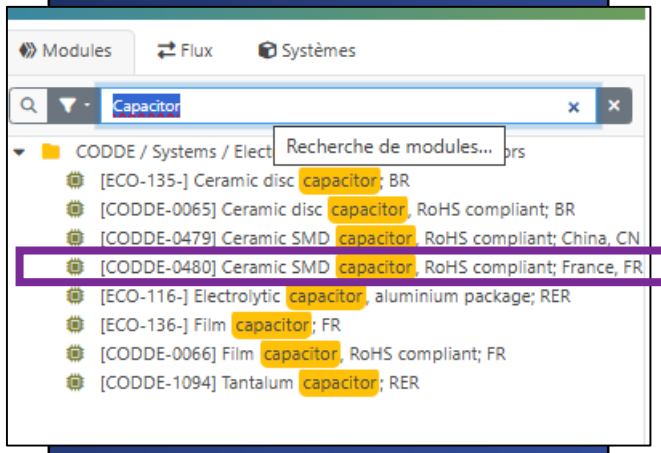
Case 1 : Non-exhaustive LCA database – **Example of Capacitors**

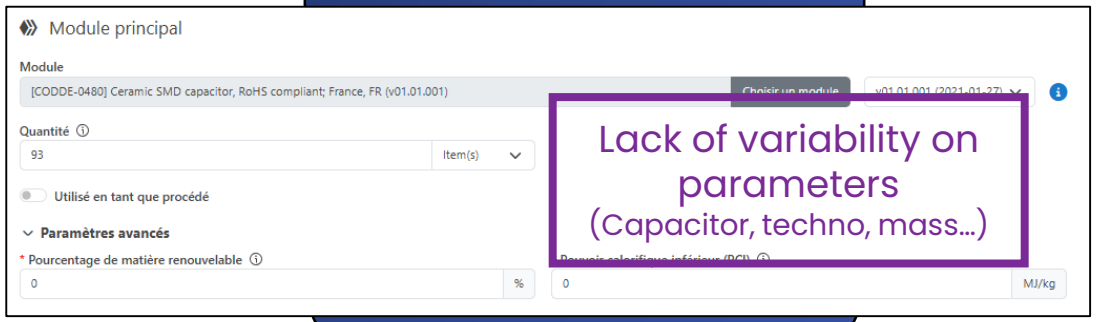
Datas from design

1uF	1uF	Capacitor (Semiconductor SIM Model)
10uF	10uF	Capacitor (Semiconductor SIM Model)
10uF		Polarized Capacitor TPSA105K020R3000
4.7uF	4.7uF	Capacitor (Semiconductor SIM Model)
10nF	10nF	Capacitor (Semiconductor SIM Model)
100nF	100nF	Capacitor (Semiconductor SIM Model)
330nF	330nF	Capacitor (Semiconductor SIM Model)
2.2uF	2.2uF	Capacitor (Semiconductor SIM Model)
220nF	220nF	Capacitor (Semiconductor SIM Model)
470nF	470nF	Capacitor (Semiconductor SIM Model)

LCA software

EIME





LCA Hypothesis

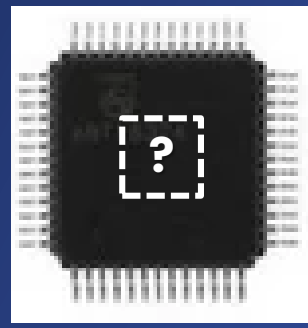
Case 2 : Lack of precision in BoM and industrial datasheets – **Example of unknown ICs**

Datas from design

LCA software

EIME

IC Dimensions



Technology node

28 nm – 50 masks
45 nm – 42 masks
65 nm – 38 masks
90 nm – 33 masks
130 nm –29 masks

Manufacturing location

China
Taiwan
Europe&Usa

LCA Hypothesis

Case 2 : Lack of precision in BoM and industrial datasheets – **Example of unknown ICs**

Datas from design

Hypothesis :

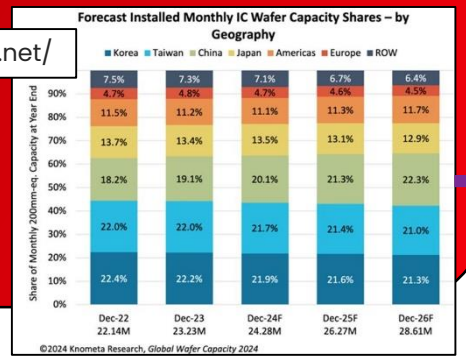
50 % Package dimension

(Uncertainty scenarios : **20%** and **80%**)

Hypothesis :

Mix from **28nm** to **130nm**

https://vipress.net/

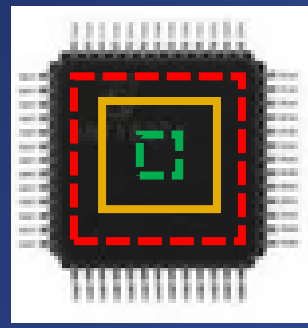


Refers to annual production data from 2022 to 2024

LCA software

EIME

IC dimension



Technology node

20 %	28 nm – 50 masks
20 %	45 nm – 42 masks
20%	65 nm – 38 masks
20%	90 nm – 33 masks
20%	130 nm –29 masks

Manufacturing location

China : 23%,
Taiwan&Japan : 61%,
Europe&Usa : 16%

Concordance of LCA model

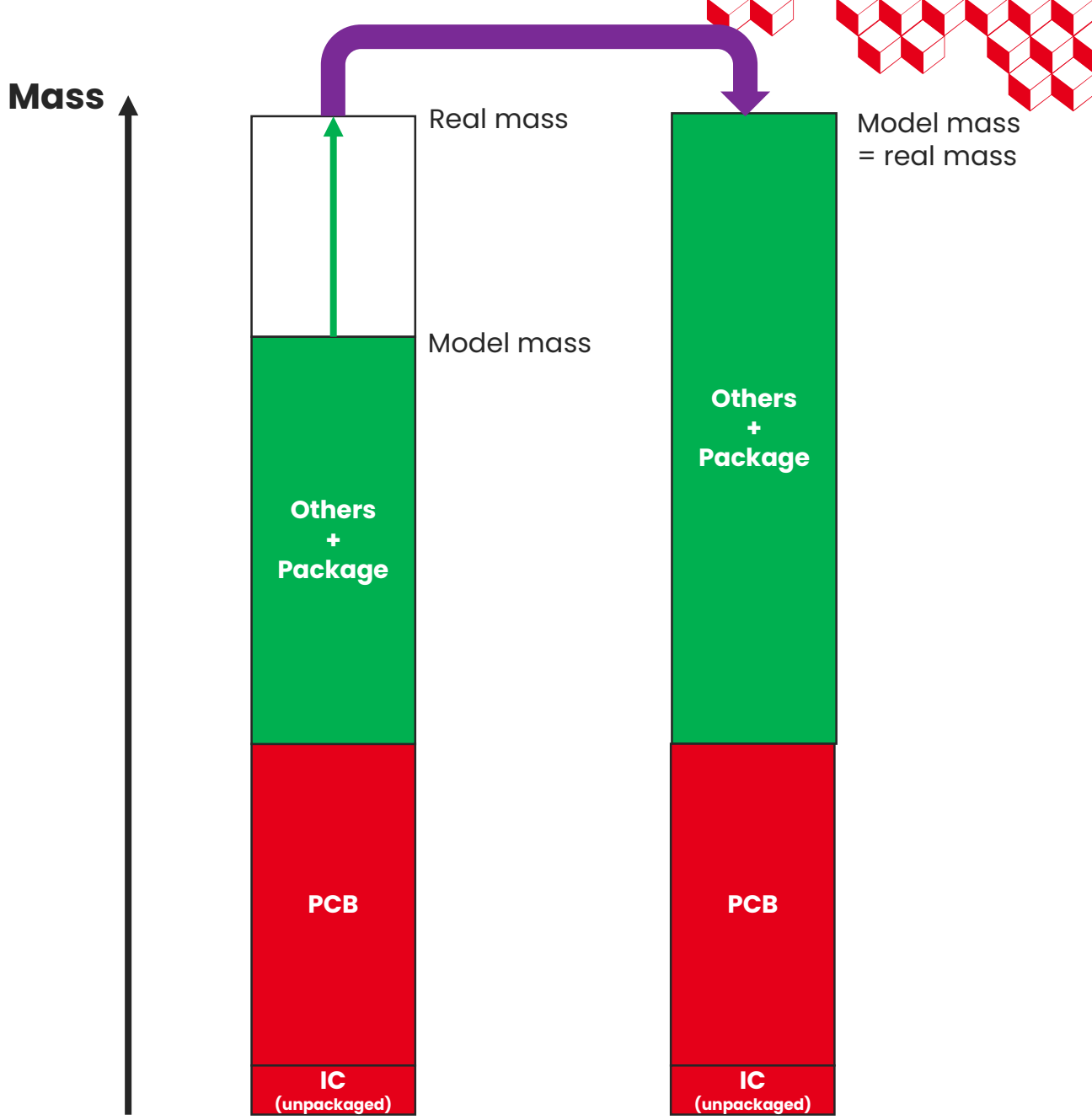
- Problem :
  - System mass = **237 g**
  - Model mass = **182 g (76%)**

  Error might come from **datasheets**

  → **Underevaluation of impacts**

- Solution : Bring back model **impacts up to 100%**

  Not concerned : PCB & Digital IC



LCA Results

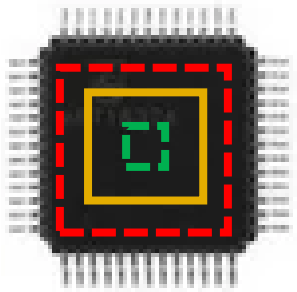
Results for
IC Area = 50%PackageSize

Total mass = 237 g

Emit **~15 kg CO2eq**
(Between **11 kg** and **18 kg**)

Only for **manufacturing**

Uncertainties :
Ic Area = 80%PackageSize
IC Area = 20%PackageSize



Global impacts = +/- 20%

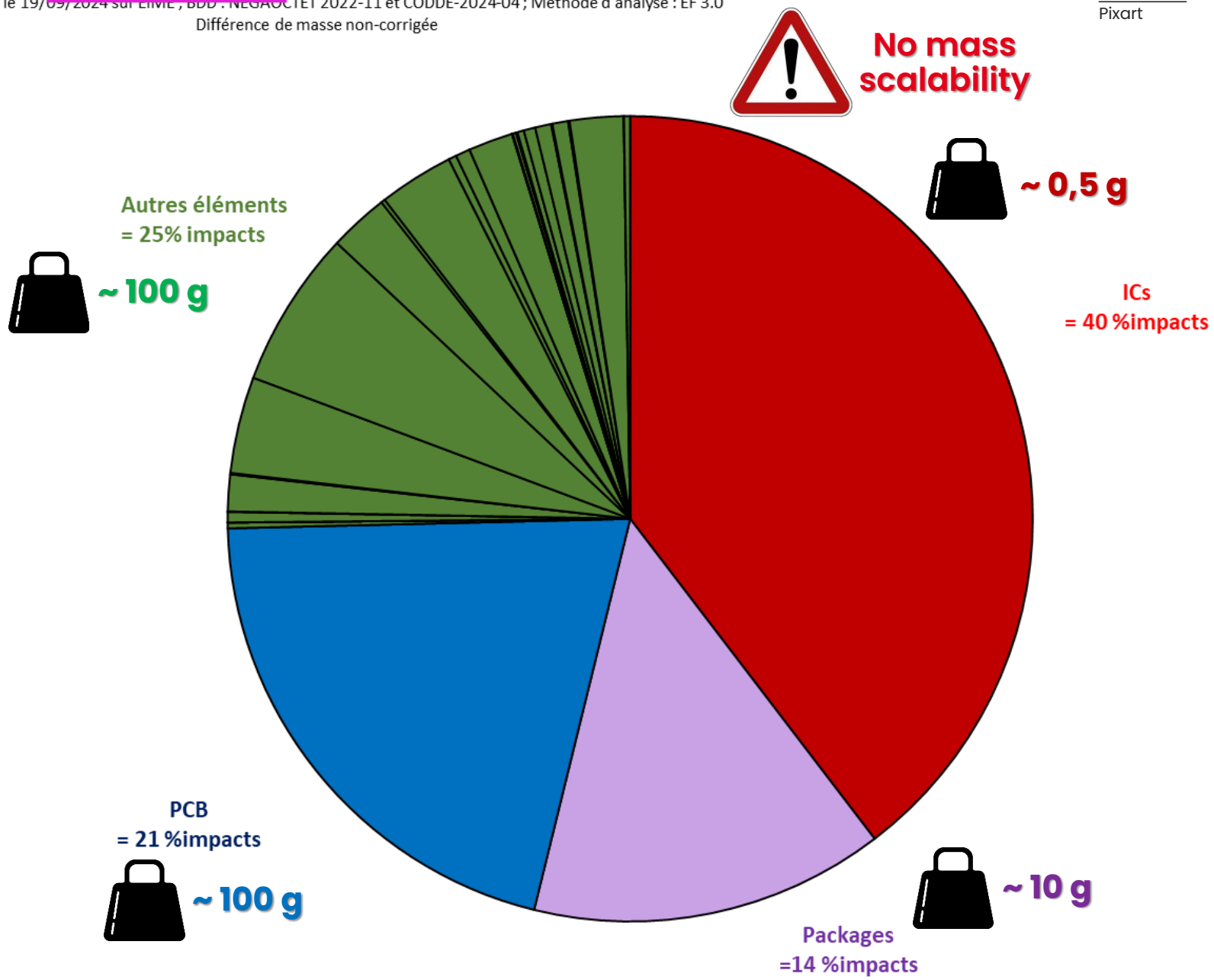
= pondération de l'ensemble des 16 catégories d'impacts

Résultats (en score unique) Manufacturing système StorAlge

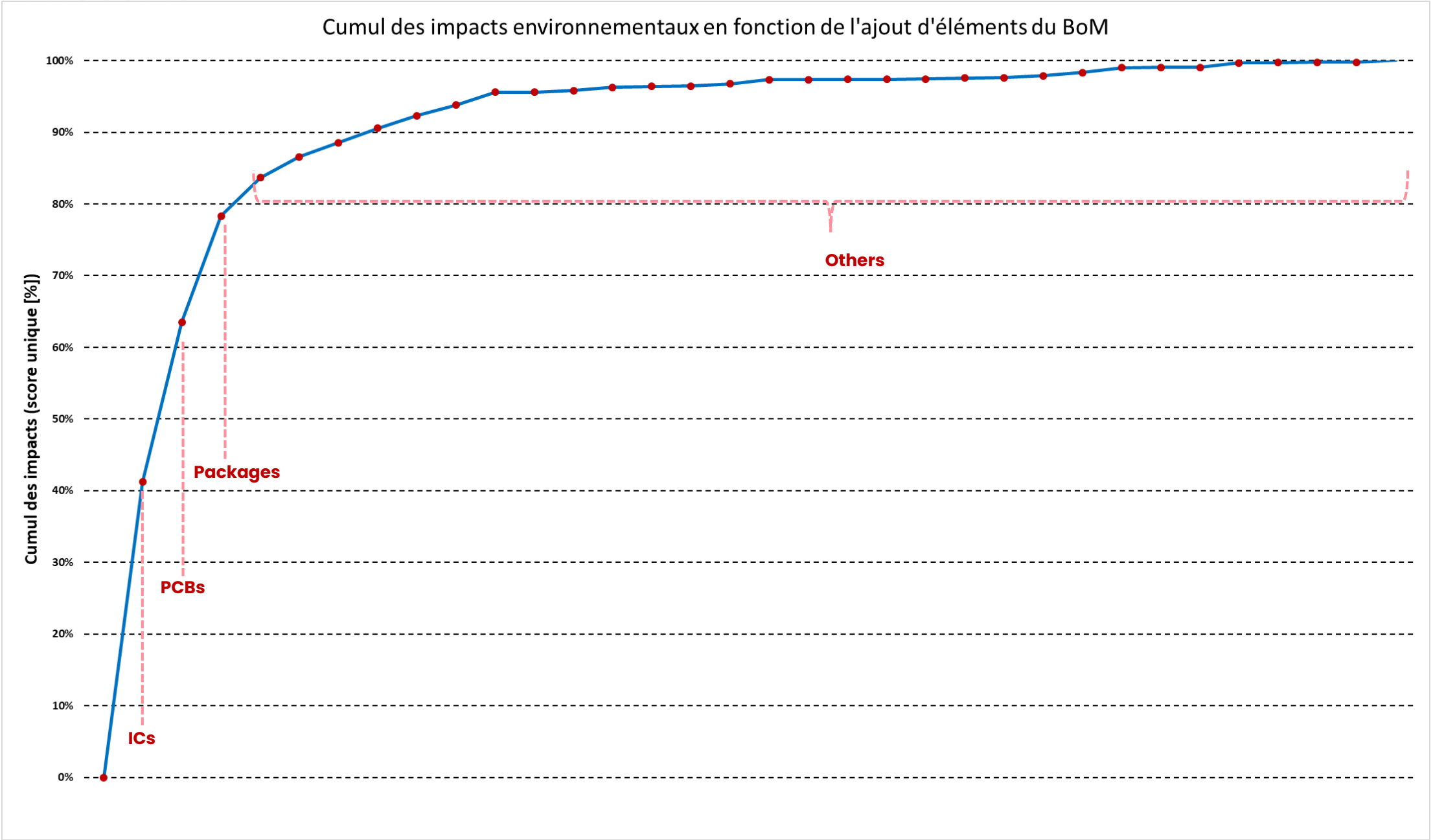
ACV réalisée le 19/09/2024 sur EIME ; BDD : NEGAOCTET 2022-11 et CODDE-2024-04 ; Methode d'analyse : EF 3.0

Différence de masse non-corrigée

Icon artist : Pixart



LCA Results


Cumul des impacts environnementaux en fonction de l'ajout d'éléments du BoM
Cumul des impacts (score unique [%])
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
ICs
PCBs
Packages
Others

Most valuables datas from design to LCA

	Most valuable data	Remarks / perspective
System Generalities	System total mass	For concordance of model
IC	**Technology node** or number of Mask **IC area** ~ IC to package ratio	**Main Hotspot** (most impactful component)
Package	Package **technology** **Mass** Number of input/output	
PCB	PWB Technology (FR2,3,4 or CEM1) Dimensions **Number of layers**	**2nd Hotspot**
Others components	**Bill of Materials** **Errors from datasheets (mass, dimensions, techno…)**	Problem : transposition of BoM to model is the **most time consuming** and need human intervention

Future works

Next steps of the exploration work :

- **Mapping** dimension[%] of **IC area** VS **package techno**
- Investigation of a **generics BoMs/cm²PCB**
- Extend the LCA to an **industrial version**
- Extend the scope to **usephase**, **transport** and **end of life**

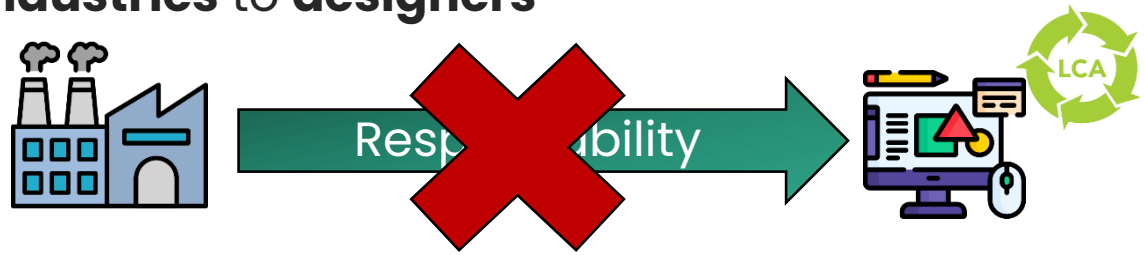
Automation of LCA :

- Execute **parametric LCA template** from design informations
- **Appa LCA** : open-source LCA tool to be easily integrated to **IC design flow**
  - Poster of this tool in symposium

Attention points

We shall not

- Transfer the **environmental responsibility** from **industries** to **designers**

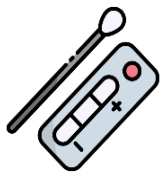


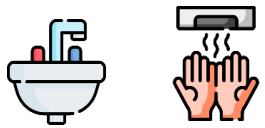
We have to

- Talk more about **sobriety & performance needs**

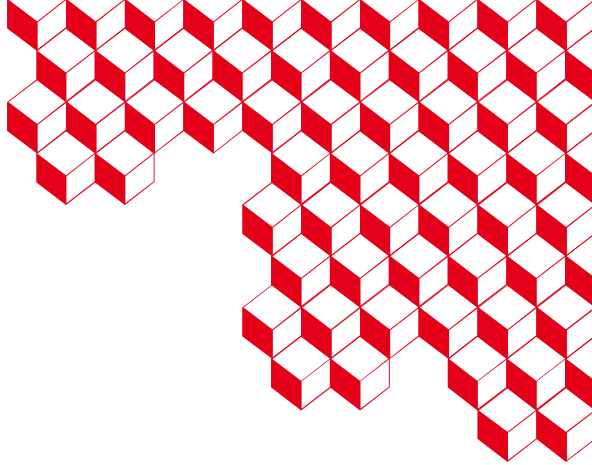
- Start to think from **specifications** about **rebound effect and** the **relevance of using a too powerful IC**

Do we really need IC in : rearview mirrors, disposable medical self-test, washbasin, etc. ?





Icon artists :
Freepik
Bearicons
Assia Benkerroum



Thanks for your attention ♪♫
Questions ?

Aknowledgments :

Jérémy BALLESTER, Mikael LE COADOU, Jean-Philippe NOEL, Maria RAMIREZ-CORRALES, Bénédicte ROBIN, Maxime PÉRALTA

CEA LIST