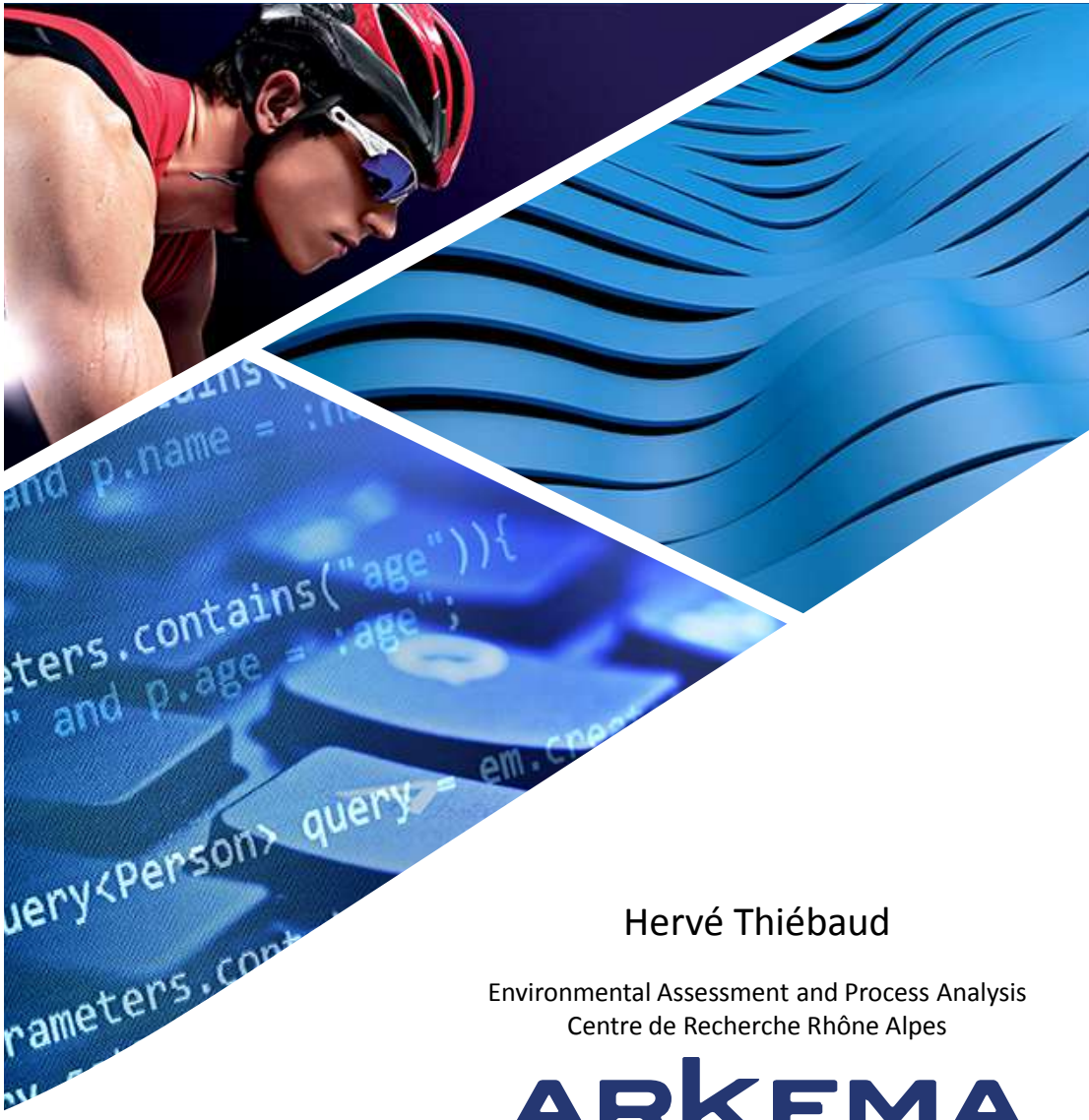
Life Cycle Thinking

or how to avoid the false good solutions



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ARKEMA
INNOVATIVE CHEMISTRY

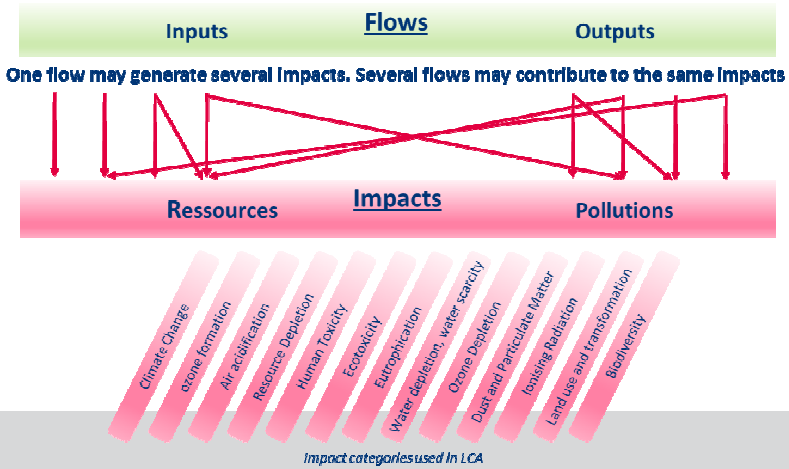
Life Cycle Assessment, a consensual tool for environmental evaluation

- **Inventories (data collection) of flows, input and output**

- **Conversion into impacts (characterization factors)**

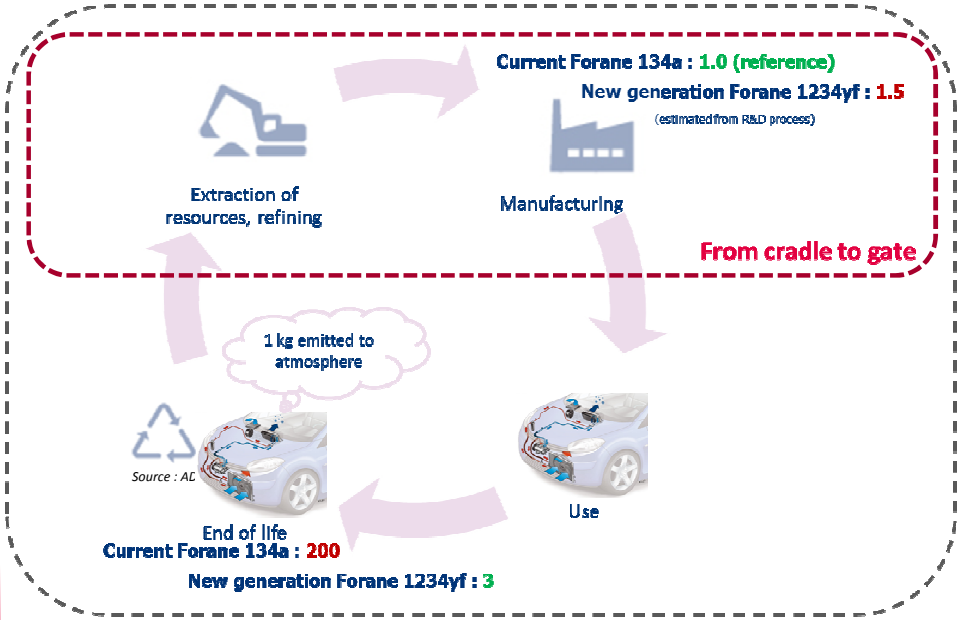
Inventory	Climate change	Acidification	Etc...
1 000 g of CO_2	X 1 = 1 000		
10 g of CH_4	X 25 = 250		
10 g of SO_2		X 1 = 10	
5 g of NO_x		X 0.5 = 2.5	
Etc...			
Total	1 250 g eqCO_2	12.5 g eqSO_2	

Source : ADEME



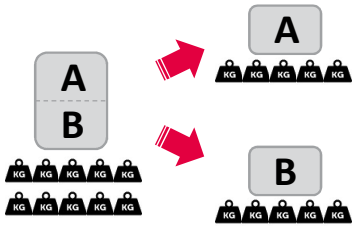
Impact categories used in LCA

Refrigerant for automotive air conditioning systems
Global Warming Potential (GWP)

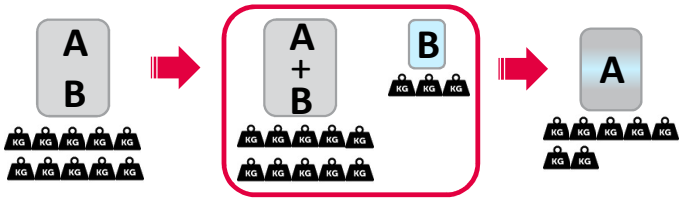


Allocation rules, a key methodological point

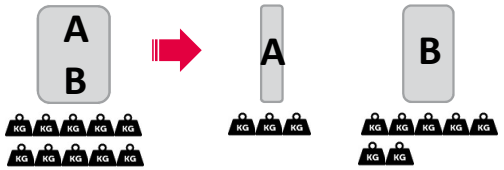
- 1 process/system ➔ several outputs (i.e. co-production of several chemicals)
- Issue: how to split/allocate the inventories/impacts between outputs ?



Subdivision



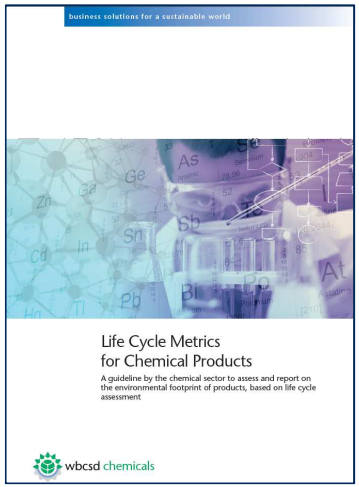
Expansion – Substitution (A+B-B)
B is named ''avoided product''



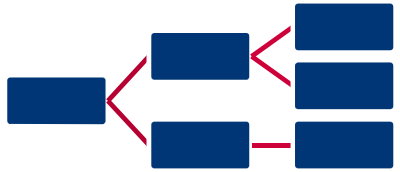
Allocation rule based on:
- Physical relation (mass alloc., …)
- Price (economic alloc.)
- Any other relevant parameter

System/Process Environmental burden X Product

The operator is the most suitable player to select and discuss the relevant allocation rules

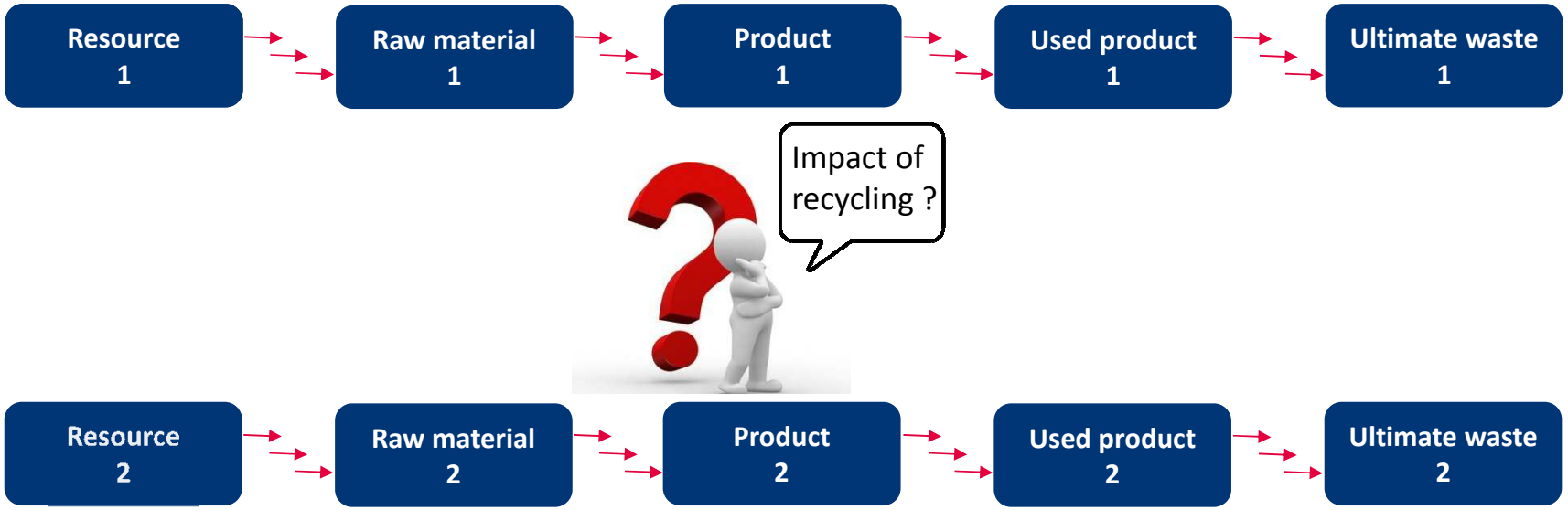


Allocation rules decision tree



Allocation rules, what about recycling ?

- Recycling could be closed loop or open loop (system perimeter to be carefully defined)
- Issue: how to split/allocate the inventories/impacts between outputs ?



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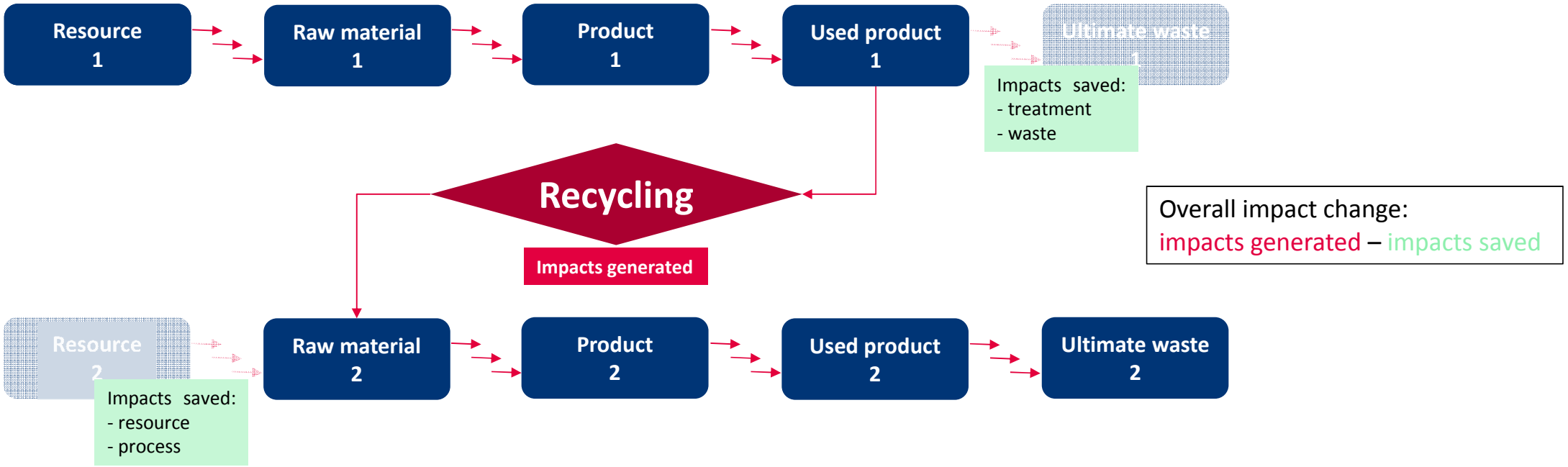


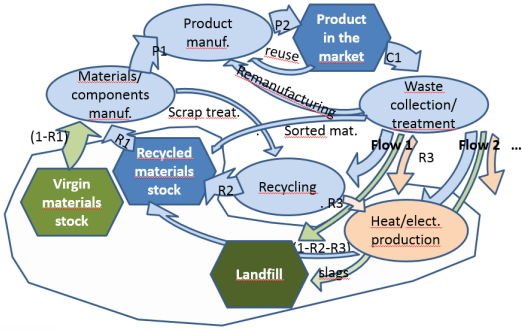
CONCLUSION

On-going work involving authorities and stakeholders

- Allocation of burdens/benefits between supplier and user of a recycled material
- Allocation according to sector (market incentive)
- Examples : French ADEME-AFNOR BPX30-323 and EC Joint Research Centre (JRC) for Product Environmental Footprint (PEF)

Evaluating the impacts in the frame of circular economy is not a simple question

- Complexity of recycling loops (open, closed) and End Of Live
- Avoided vs generated environmental burdens by LCA
  - Resource saved (scarcity)
  - Climate Change (energy use, incineration, ...)
  - Energy balance (use, valorization, …)
  - Impact on air, water and soil ecosystems (incineration, landfilling, ...)
  - …
- Beyond recycling issues, circular economy and sustainable development is far more complex → economic and social aspects



Source: The Advanced Rechargeable & Lithium Batteries Association, July 2016

Raw material	Steel, Glass, Paper	Plastic, Wood	Textile
Allocation	100% to producer producing recycled product	50/50 allocation	100% to producer using recycled product

Example of BPX30-323-0 approach (ADEME-AFNOR)

$$\left(1-\frac{R_1}{2}\right)\times E_V+\frac{R_1}{2}\times E_{recycled}+\frac{R_2}{2}\times\left(E_{recyclingEOL}-E^*_V\times\frac{Q_S}{Q_P}\right)+R_3\times\left(E_{ER}-LHV\times X_{ER,heat}\times E_{SE,heat}-LHV\times X_{ER,elec}\times E_{SE,elec}\right)+\left(1-\frac{R_2}{2}-R_3\right)E_D-\frac{R_1}{2}\times E^*_D$$

virgin + recycled content | recyclability | recoverability | disposal | Avoided disposal due to recycled content

EC Joint Research Centre (JRC)

United Nations Global Compact

A GLOBAL COMPACT FOR SUSTAINABLE DEVELOPMENT

https://www.unglobalcompact.org.pdf

ARKEMA

THANK YOU FOR YOUR ATTENTION

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