SARPI VEOLIA

université PARIS-SACLAY | GRADUATE SCHOOL Chimie

Digital Micro-Certification

Wastes, Chemistry, Circular Economy

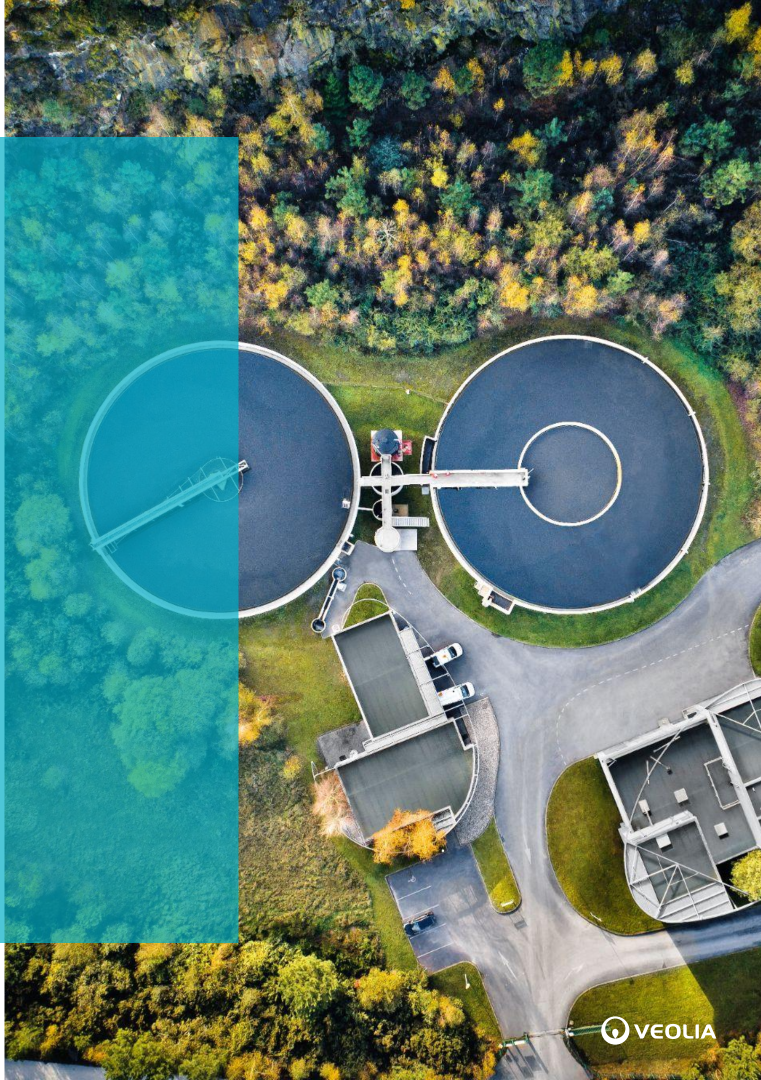
TO SUPPORT INDUSTRIAL
AND TERRITORIAL DEVELOPMENT
THROUGH SUSTAINABLE
RISK MANAGEMENT OF WASTE

Agenda

1. SARPI & Veolia
2. Once upon a time… Wastes before Regulation
3. What is Waste ?
4. Waste Management : “Linear” economy
5. Substances of Concern, Chemicals & Circular economy
6. Wastes Management : “Circular” economy
7. Wastes recycling Case studies

SARP Industries | Veolia

THE ESSENTIALS
OF VEOLIA



3 MAIN BUSINESSES IN NUMBERS

WATER

111 million people supplied with drinking water

97 million people connected to wastewater systems

4,130 drinking water production plants managed

3,506 wastewater treatment plants managed

WASTE

46 million people provided with collection services on behalf of municipalities

61 million metric tons of treated waste

533,759 business clients

823 waste processing facilities operated

ENERGY

44 TWh produced

46,922 thermal installations managed

680 heating and cooling networks managed

2,716 industrial sites managed

VEOLIA

A WORLD LEADER A STRONG GEOGRAPHICAL PRESENCE

Close to **220 000**
employees worldwide

58
countries on **5** continents

€42.9 bn
revenue

VEOLIA

THE BENCHMARK COMPANY FOR

ECOLOGICAL TRANSFORMATION

3

DECARBONIZATION

Veolia designs solutions for the climate that decarbonize our lifestyles and production methods and adapt them to the consequences of climate disruption.

ECONOMY & REGENERATION OF RESOURCES

Veolia invents green energy systems, recovers waste in the form of materials or energy, and promotes the recycling and reuse of wastewater and plastics.

DEPOLLUTION

Water, soil, air... Veolia offers a range of solutions to treat all types of pollution. The Group is a recognized player in the treatment of hazardous waste and degraded soil, and is a specialist in indoor air quality.

Hazardous waste - regulatory definition

ALL TYPES OF WASTE

that, because of their composition or properties, pose a danger to human health and the environment.

Hazardous waste is diverse and heterogeneous

MULTIPLE RISKS

Flammable
Toxic
Corrosive
…

MULTIPLE SOURCES

Mechanics/Automotive
Chemicals/Petrochemicals
…

PHYSICAL APPEARANCE MULTIPLE TYPES OF PACKAGING

Pill dispensers
Tanks

Some examples

10

SARPI's Fundaments

OUR MISSION

*" To support **industrial** and **territorial development** through sustainable **risk management of waste**."*

OUR JOB

*" Treatment and recovery of **hazardous waste** and **polluted sites**."*

OUR MODEL

*" A **european network** of facilities and services integrating the entire treatment and recovery chain including final containment of residual waste."*

OUR COMMITMENTS

*" **Risk management** to ensure the safety of all our stakeholders. **Traceability, non-dilution, and decontamination** of the waste life cycle to protect the environment from pollution."*

OUR VALUES

*" Strong **environmental convictions**, a sense of responsibility, the constant search for performance, an **entrepreneurial spirit, and social conscience**."*

Our core business: risk management

OUR SPECIFICITY,

CHARACTERISATION AND CONTROL TO PREVENT:

- Dangers to human health
- Industrial risks
- Environmental risks

10% of SARPI employees work in our laboratories.

Our Commitments

Dilution is not a treatment. SARPI does not mix waste before delivering it to treatment lines. All our facilities are designed to accept and treat waste with a high concentration of pollutants.

All our treatment and recycling processes include a step consisting of separating, isolating, and treating polluted materials. If such a decontamination stage was not included in the recycling process, pollutants would accumulate in and be released in products made from the recycled material.

The traceability of the waste that we process is guaranteed at all times: our management systems allow us to track waste from collection to final processing and provide our clients with complete transparency regarding the fate of their waste.

Our model

16 incineration lines with energy recovery

1 022 000 T/year

7 hazardous waste storage facilities

678 000 T/year

29 processing units physico-chemical biological

~ 2 500 000 T/year

14 mineral physico-chemical treatment units

~ 160 000 T/year

19 recycling units: solvents, oils, hydrocarbons, metals, batteries,...

47 DIS grouping transit sorting platforms

16 land management / treatment sites

Network of Remediation agencies in Europe

Treatment and recovery

2 600 employees
9 countries

Recycling

(cooking and black oils)

300 employees
France

Mineral waste

300 employees
France

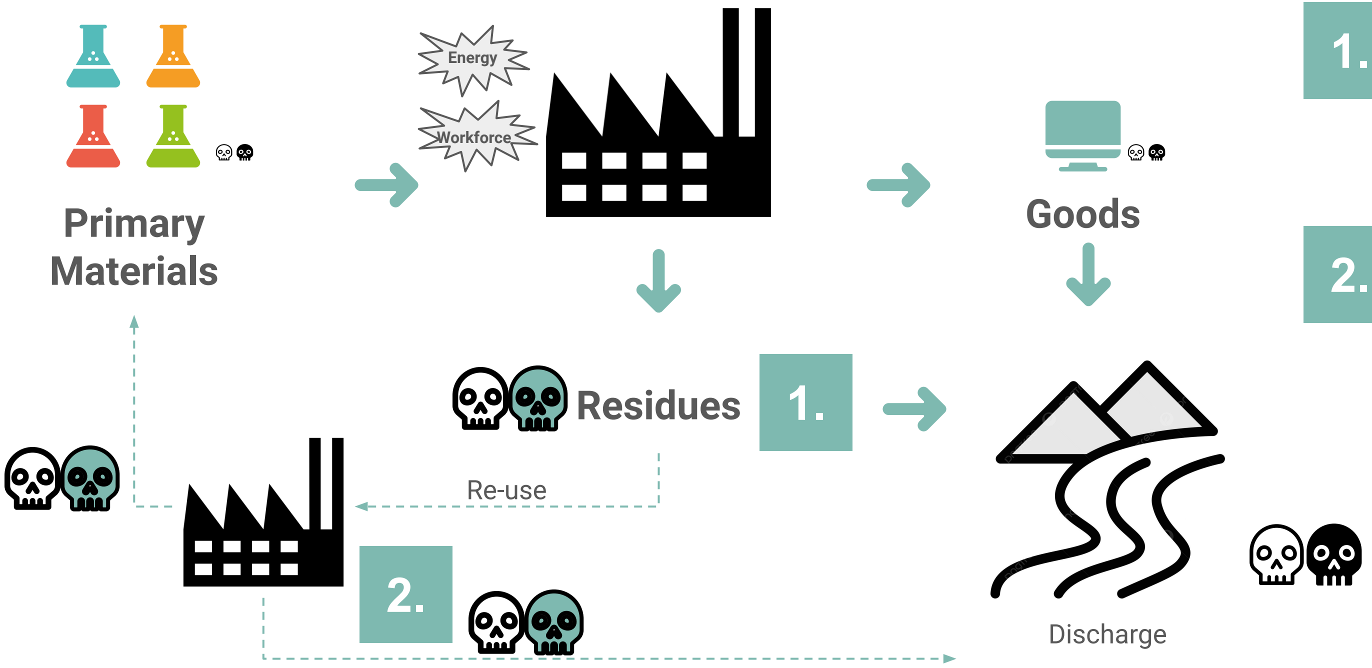
Decontamination Remediation

600 employees
6 countries

Once upon a time…
Wastes before Regulation


ORTHO

Before Regulation… Waste is not Waste…



1. Residues discharge in the Environment (Liquids, Solids, with or without Toxicity)

2. Economical interest in recycling.
Residues from recycling in the Environment

What is Waste ?

Waste definition - French regulation

Code de l’Environnement Livre V

Articles L541-1.-II :**« Tout** résidu **d ’un processus de** production**, de** transformation **ou d’**utilisation**, toute** substance**,** matériau**,** produit **ou plus généralement tout** bien meuble abandonné **ou que son détenteur** destine à l’abandon **»**

Notion de déchet indépendante du caractère valorisable ou non et de sa valeur économique

L’« abandon » de déchets n ’exonèrent pas le producteur de sa responsabilité vis à vis de l ’élimination de ce dernier

Who pollutes pays | Pollueur - Payeur

Articles L541-2 « Toute personne qui produit ou détient des déchets, dans des conditions de nature à produire des effets nocifs sur le sol, la flore et la faune, à dégrader les sites ou les paysages, à polluer l'air ou les eaux, à engendrer des bruits et des odeurs et d'une façon plus générale à porter atteinte à la santé de l'homme et à l'environnement, est tenue d'en assurer ou d'en faire assurer l'**élimination** conformément aux dispositions de la présente loi, dans des conditions propres à éviter lesdits effets. »

Notion d'élimination : collecte, transport, stockage, tri et traitement afin de réduire la nocivité du déchet

Waste taxonomy - Origin & Risks

Inert Wastes

Waste with no physical, chemical or biological evolution, and with very low pollutant impact

Construction debris, rubble, tiles…

Non Hazardous Wastes
Déchets Banals

Waste with no hazardous potential.

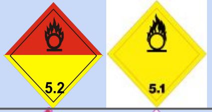
Paper, Cardboard, Plastics, Wood, Metal, Organic matters…

Hazardous Wastes

Waste with hazardous potential, from industries or household

Solvents, Paints, Varnishes, Inks, Pesticides, Medicines…

HAZARDS Classifications

Waste Framework Directive Hazard Property (HP) **WASTES**	CLP Regulation Hazard Pictograms **SUBSTANCES**		ADR Regulation Hazard Class Pictograms **DANGEROUS GOODS**
HP1 Explosive		Explosive	
HP2 Oxidising		Oxidising	
HP3 Flammable		Flammable	
HP4 Irritant			
HP5 Spec. Toxicity HP6 Acute Toxicity		Acute Toxicity	
HP7 Carcinogenic		Acute Health Hazard	
HP8 Corrosive		Corrosive	

HAZARDS Classifications

Waste Framework Directive Hazard Property (HP) **WASTES**	CLP Regulation Hazard Pictograms **SUBSTANCES**	ADR Regulation Hazard Class Pictograms **DANGEROUS GOODS**
HP9 Infectious		
HP10 Toxic for reproduction	 Acute Health Hazard	
HP11 Mutagenic		
HP12 Release an acute toxic gas		
HP13 Sensitising	 Health Hazard	
HP14 Ecotoxic	 Hazardous to Environment	
HP15 Waste with HP		

Not only Labels… Codifications too

EU Decision 2000/532/EC1

European Waste Codes

(839 codes)

20 chapters
111 Themes
839 Codes
(404 Haz)

Chap. 01-12 & 17-19 : Origin
Chap. 13-15 : Nature
Chap. 16 : Specific
Chap. 20 : Household

07 03 01 *
07 : Wastes From Organic Chemical Processes
07 03 : wastes from the manufacture, formulation, supply and use (MFSU) of basic organic chemicals
07 03 01 : organic halogenated solvents, washing liquids and mother liquors
* hazardous substances

Classification of Waste for statistics studies purpose - Not linked with Chemical properties or Hazards

ADR Regulation

UN Codes

(~3600 codes)

1- Single entries for well-defined substances or articles
Example : UN1090 Acetone

2- Generic entries for well-defined groups of substances or articles
Example : UN1133 ADHESIVES containing flammable liquids; UN1263 PAINT

3- Specific entries not otherwise specified (N.O.S.) covering a group of substances or articles of a particular chemical or technical nature
Example : UN 1987 ALCOHOLS, N.O.S.; UN 1224, KETONES, LIQUID, N.O.S

4- Generic entries not otherwise specified (N.O.S.) covering a group of substances or articles meeting the criteria of one or more classes or divisions
Example : UN 1993 FLAMMABLE LIQUIDS, N.O.S.; UN 1992, FLAMMABLE LIQUID, TOXIC, N.O.S

Not only Labels… Codifications too

CLP Regulation / GHS
H & P Phrases

Hazard
H
phrases

Physical Hazards

Health Hazards

Environmental Hazards

EU Specific hazards

H225	Highly flammable liquid and vapour
H226	Flammable liquid and vapour
H227	Combustible liquid
H301	Toxic if swallowed
H301+H311	Toxic if swallowed or in contact with skin
H301+H311+H331	Toxic if swallowed, in contact with skin or if inhaled
H400	Very toxic to aquatic life
H401	Toxic to aquatic life
H402	Harmful to aquatic life
EUH202	Cyanoacrylate. Danger. Bonds skin and eyes in seconds. Keep out of the reach of children.
EUH203	Contains chromium(VI). May produce an allergic reaction.
EUH204	Contains isocyanates. May produce an allergic reaction.

Precautionary
statements
P
phrases

General

Prevention

Response

Storage

Disposal

P101	If medical advice is needed, have product container or label at hand.
P102	Keep out of reach of children.
P221:	Take any precaution to avoid mixing with combustibles.
P222	Do not allow contact with air.
P302+P334	IF ON SKIN: Immerse in cool water or wrap in wet bandages.
P302+P350	IF ON SKIN: Gently wash with soap and water.
P405	Store locked up.
P406	Store in a corrosive resistant/... container with a resistant inner liner
P501:	Dispose of contents/container to ...
P502:	Refer to manufacturer or supplier for information on recovery or recycling

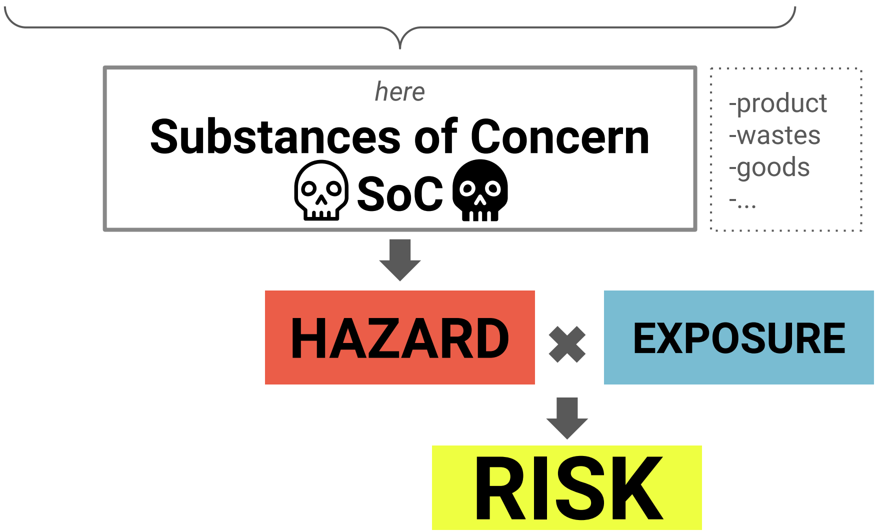
Substances of Concern - Substances préoccupantes

Registration, **E**valuation, **A**uthorisation and Restriction of **Ch**emicals

Under REACH, a **substance** means a chemical element and its compounds in the natural state or obtained by any manufacturing process, including any additive necessary to preserve its stability and any impurity deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition.

“Well defined substances”: substances with a defined qualitative and quantitative composition.
“UVCB substances”: substances of Unknown or Variable composition, Complex reaction products or Biological materials.

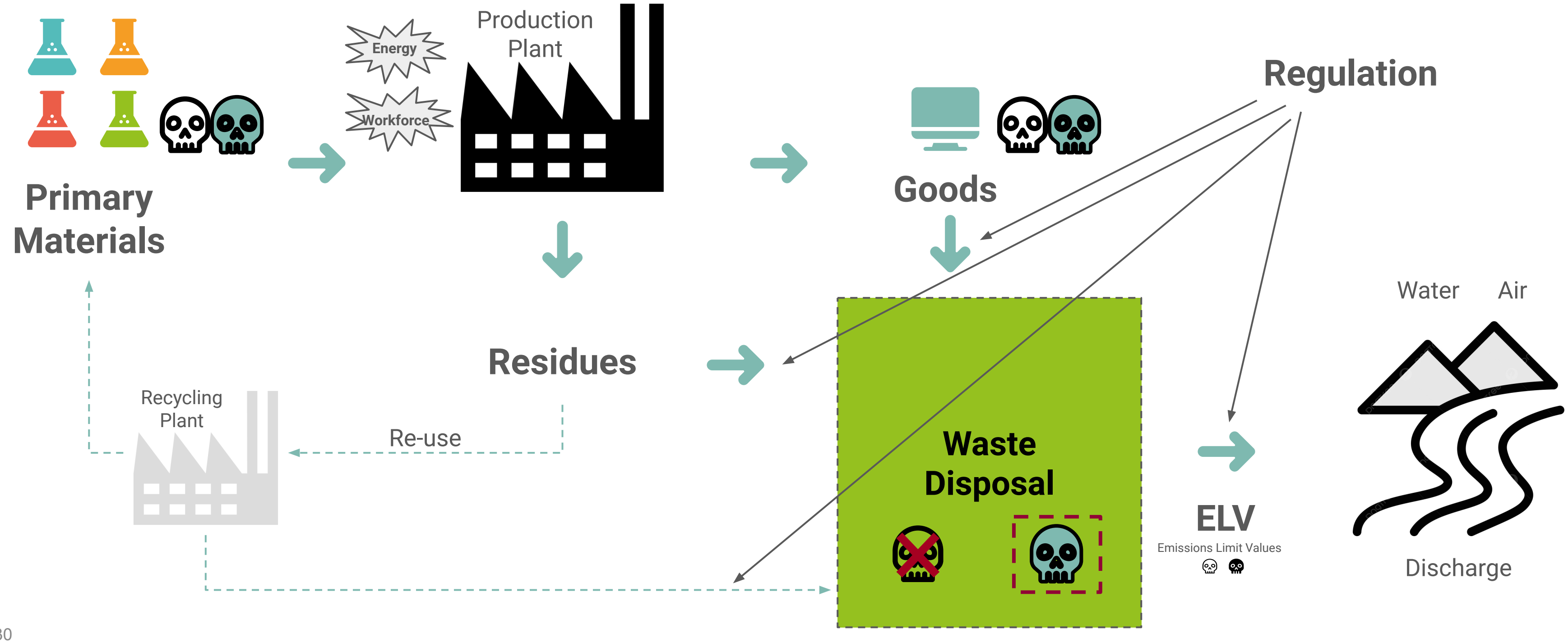
Substance of Very High Concern (SHVC)	REACH
Carcinogenic Mutagenic Reprotoxic (CMR) Substance	CLP
Substance of Concern (SoC)	BPR
Endocrine Disruptor…	CSS
Persistant Organic Pollutant	POP Regulation



CLP : Classification Labelling Packaging of substances and mixtures
BPR : Biocidal Product Regulation
CSS : Chemicals Strategy for Sustainability

Waste Management
“Linear economy”

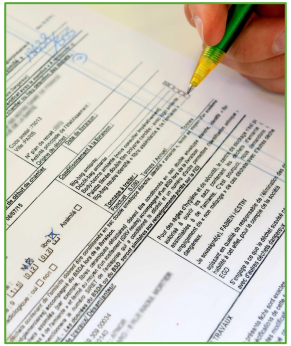
Waste disposal : Volume reduction / Toxicity control



Before anything : Analysis & Tracking
1- Pre-acceptance procedure

A **4 steps** process with the Lab in the center

①	②	③	④
Sample + **Waste Identification Form**	**Analysis**	**Acceptance** → Pre-Acceptance Certificate	**Commercial Offer**
Waste producer	Lab	Lab	Sales Department



Before anything : Analysis & Tracking
2- Scheduling & Entrance control

① Scheduling

Scheduling taking into account :

- Waste stock
- Production program
- Safety

Scheduling team

② Admin

Checking of the regulatory documents :

- ADR
- Waste tracking form
- Pre-Acceptance

Sales Admin. Team

③ Analysis

Conform with Pre-Acceptance
Yes → ④ Unloading
No → Price change / to another plant

Lab

④ Unloading

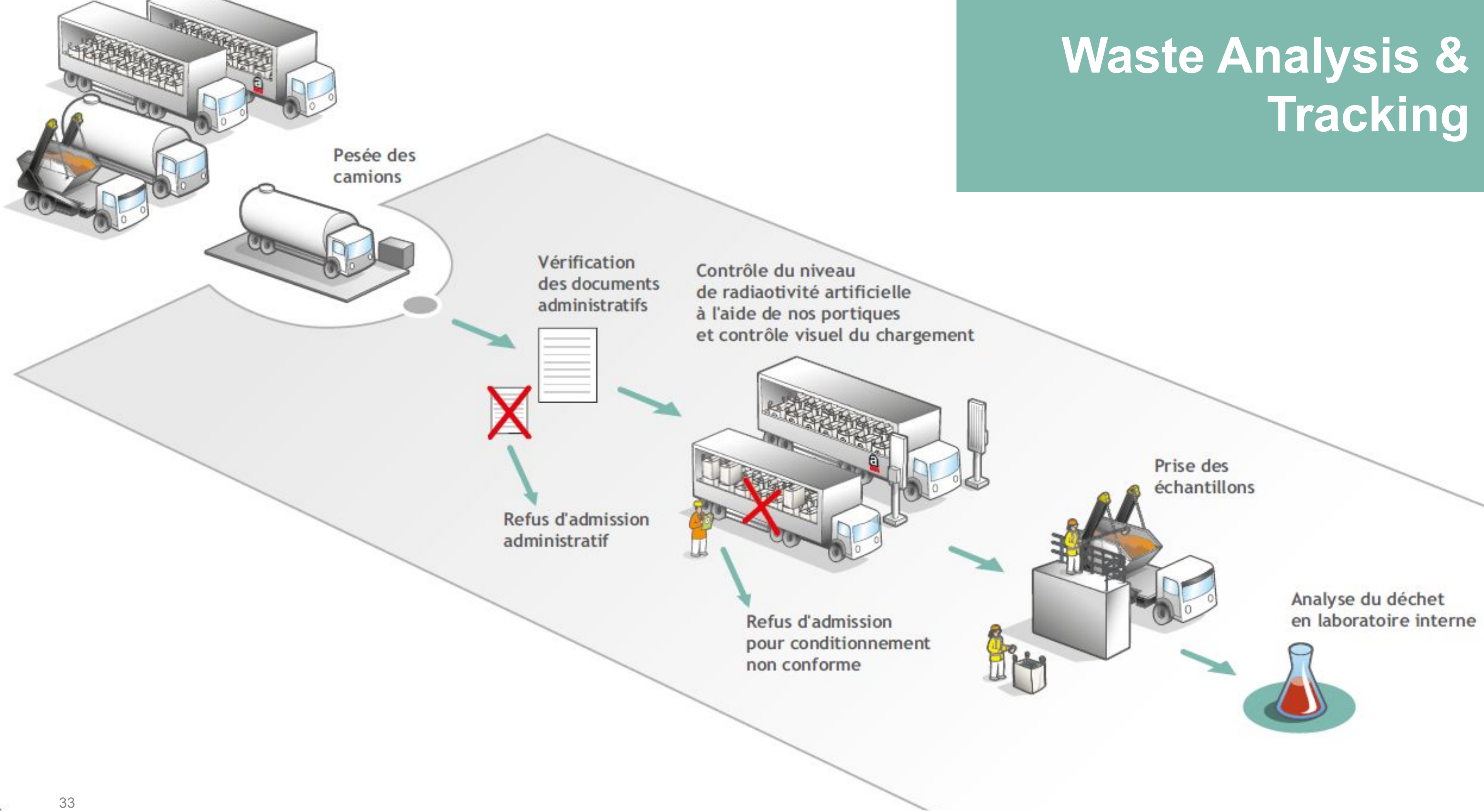
Yes:
- Unloading
- Safety

Operation

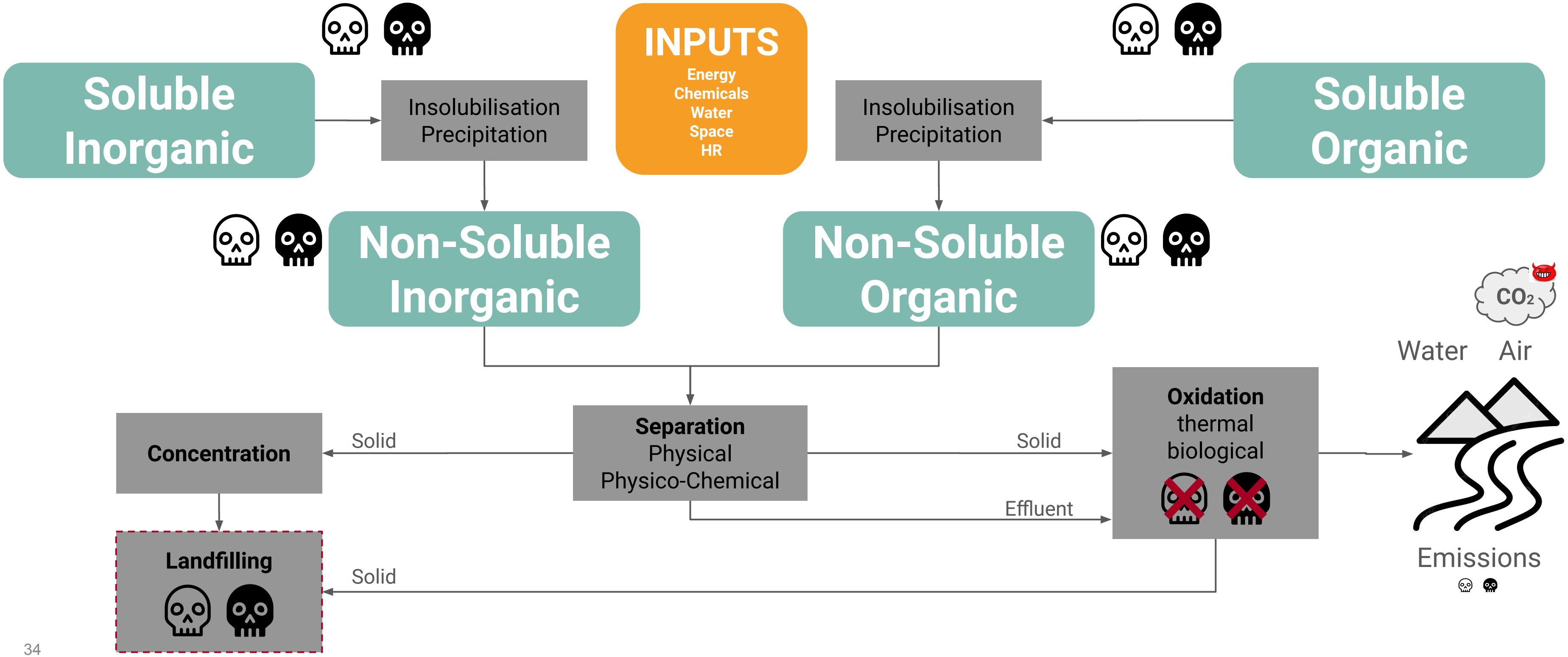
No:
- Price change
- to another plant

Sales Admin. Sales Team

Waste Analysis & Tracking

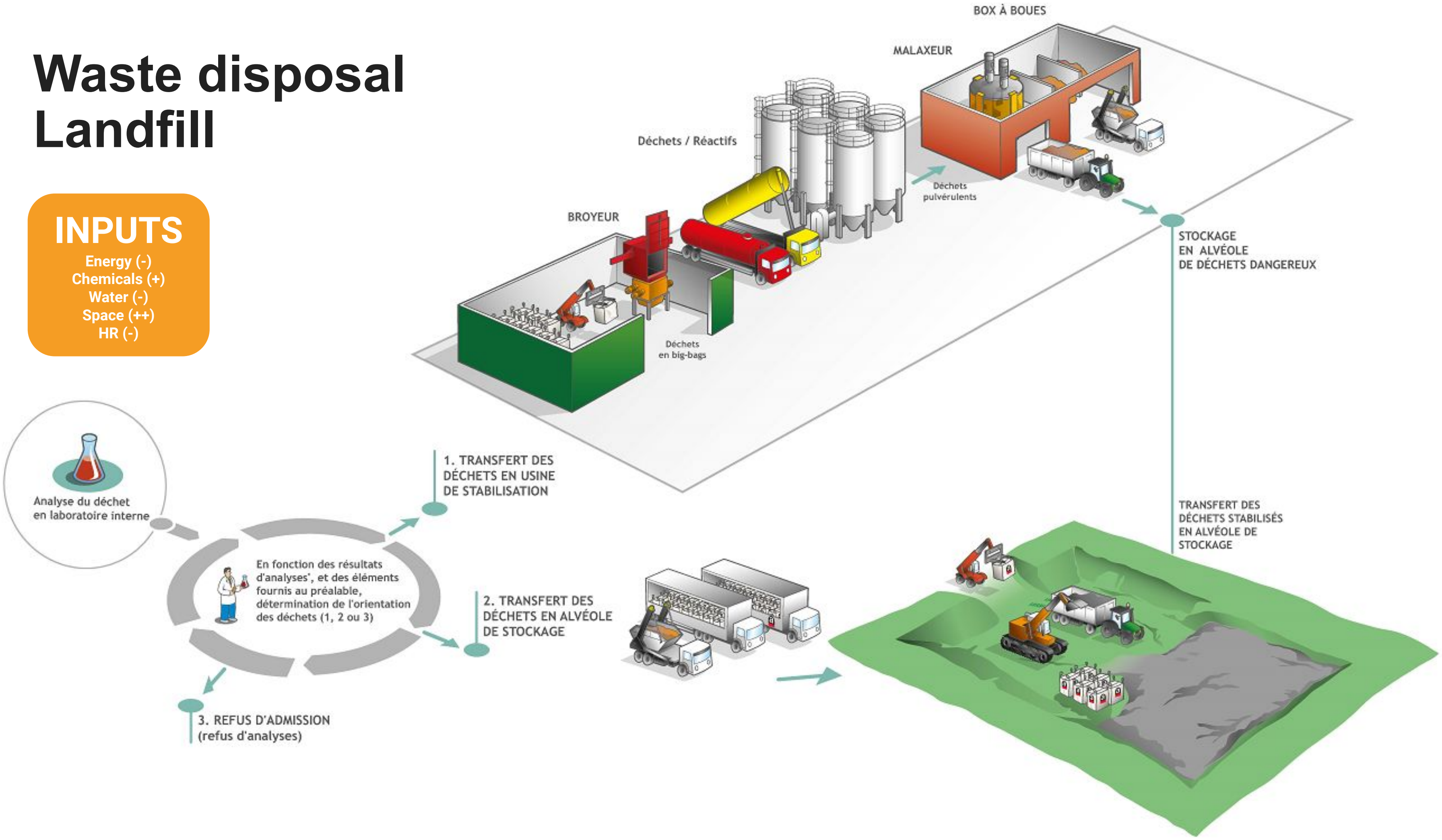


Waste disposal at a glance

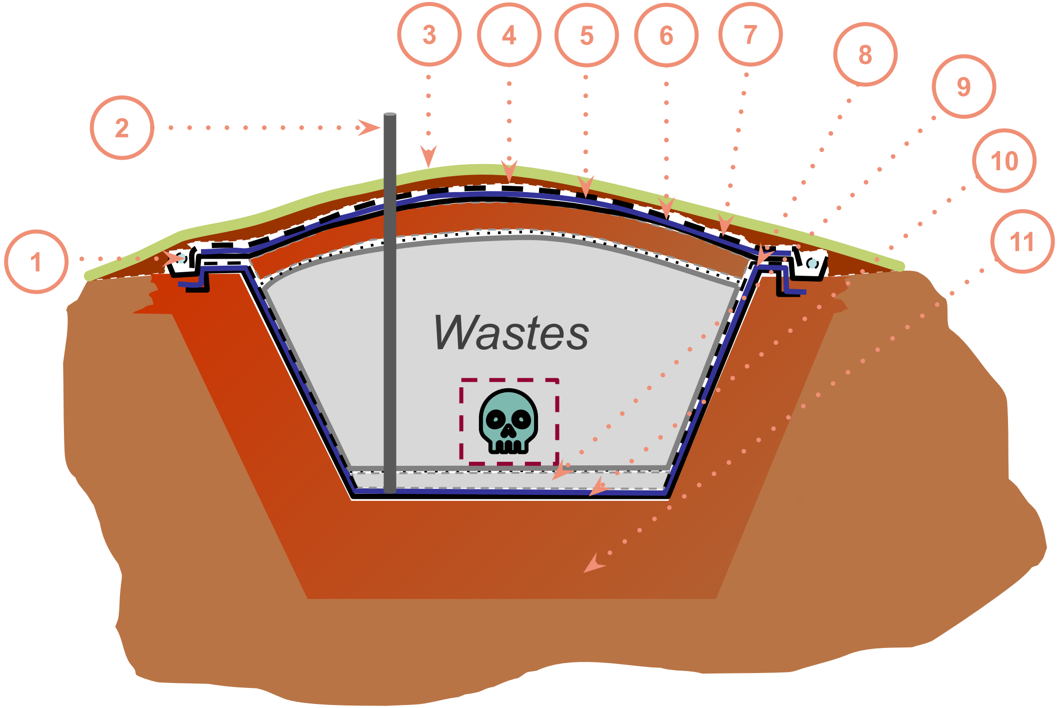


Waste disposal
Landfill

INPUTS
Energy (-)
Chemicals (+)
Water (-)
Space (++)
HR (-)



Waste disposal : Landfill

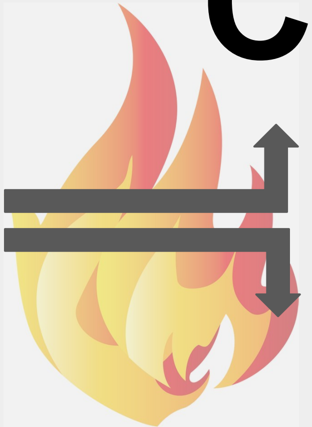


N°	DESCRIPTION
1	Fossé de ceinture pour les eaux pluviales
2	Puit de captage et contrôle des lixiviats
3	Couvert végétal
4	Terre végétale
5	Couche drainante
6	Géomembrane de couverture
7	Argile de couverture
8	Géomembrane (bleu) en flanc et géocomposite de drainage
9	Matériaux drainants
10	Géomembrane de fond (noir) et géotextile anti-poinçonnant (barrière active)
11	Matériaux argileux (barrière passive)


CASE


STOP
ARC

Waste Disposal : Incineration



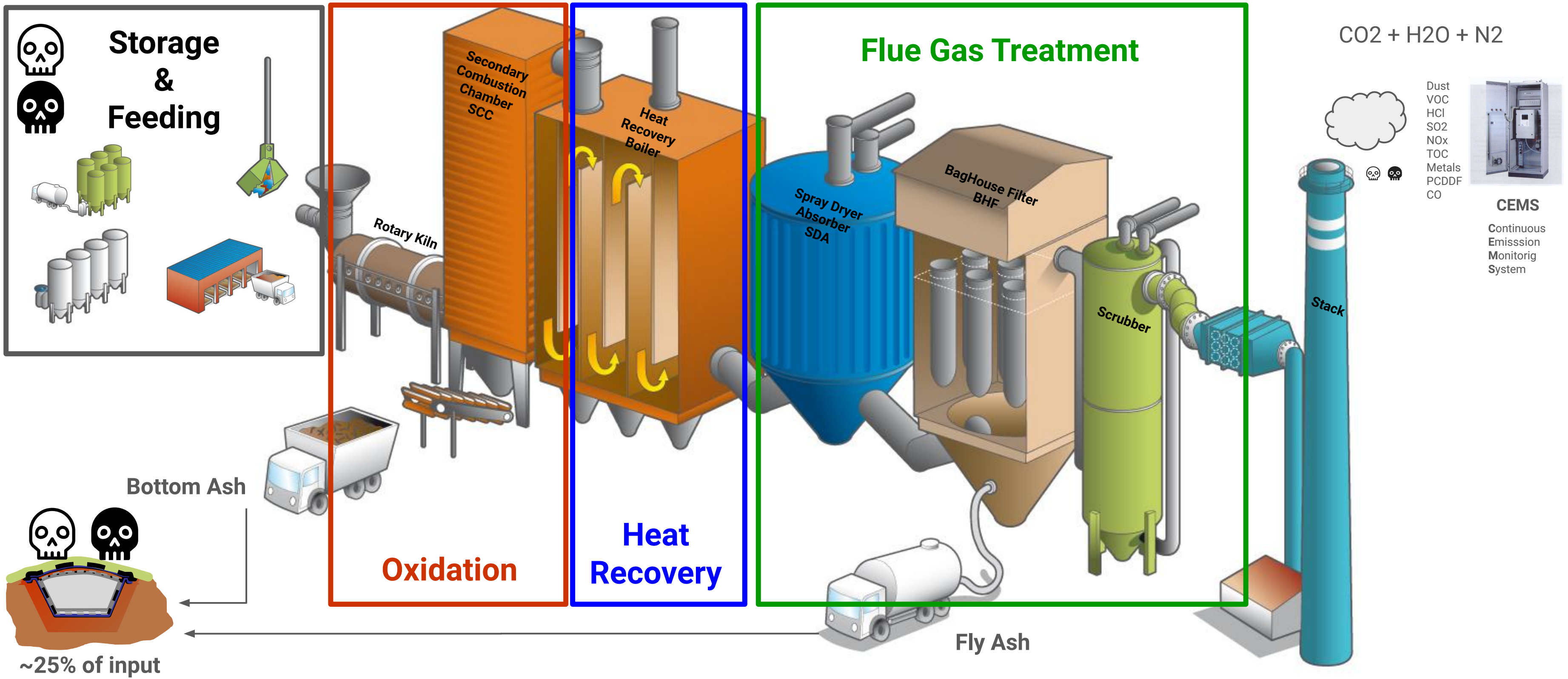
$CO_2 + H_2O$

inorganic pollutants

INPUTS

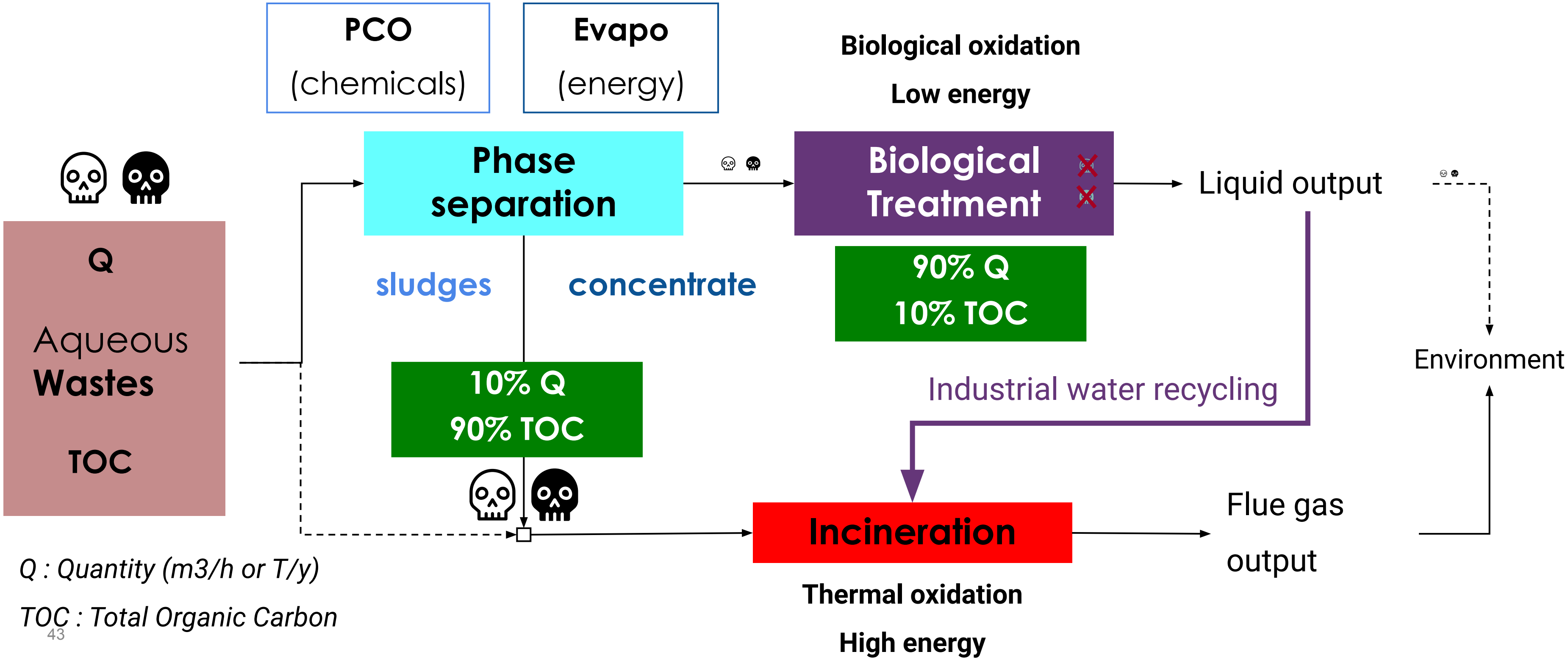
Energy
Chemicals
Water
Space (-)
HR (+)

Incineration process at a glance




VINCI

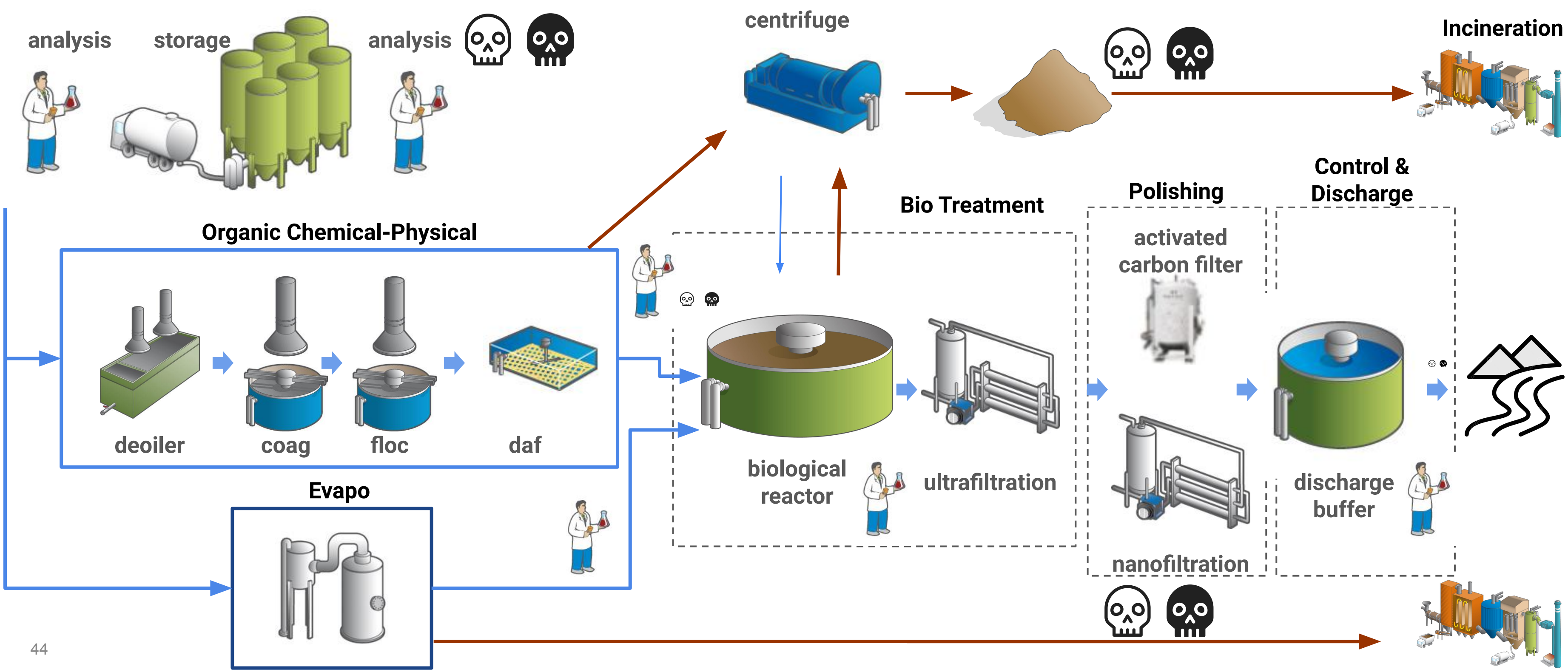
Physico-Chemical Organic Treatment + Biology



Q : Quantity (m3/h or T/y)

TOC : Total Organic Carbon

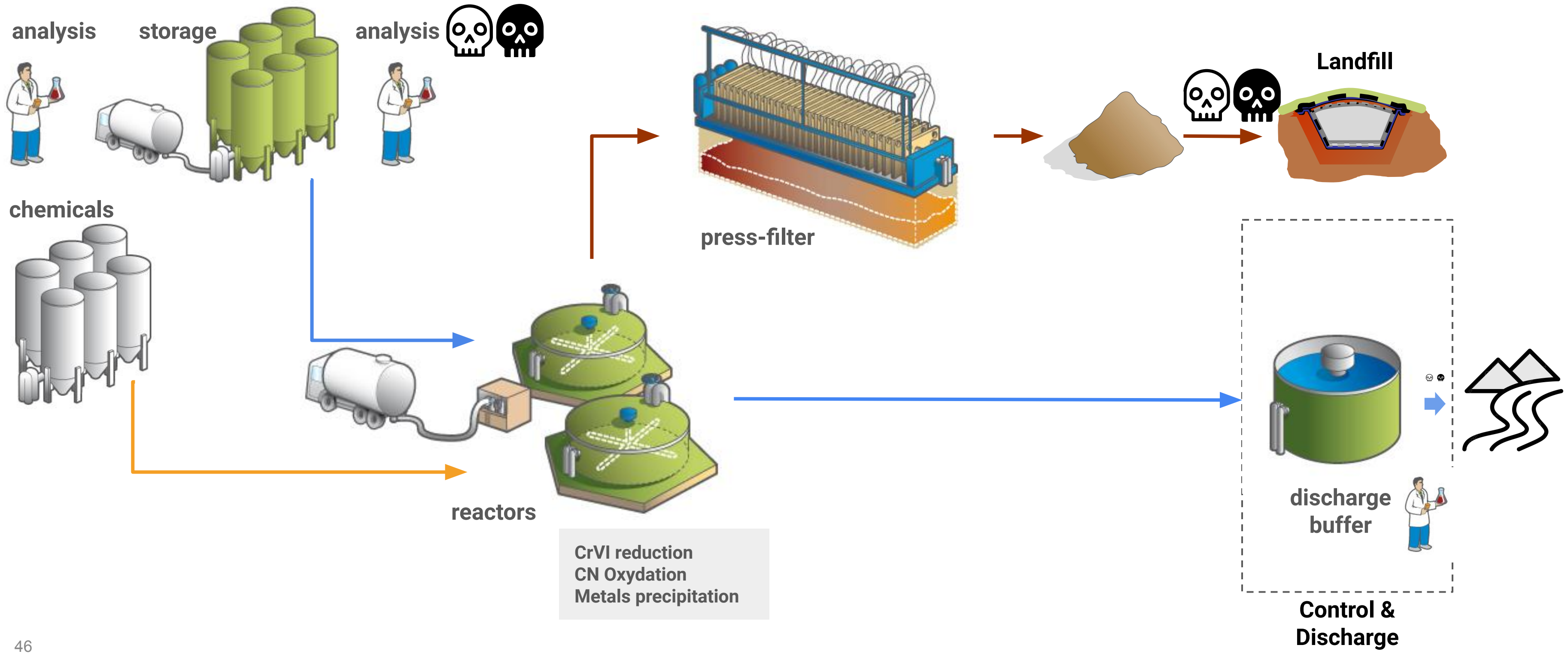
PCO+Bio process at a glance






Physico-Chemical Inorganic (PCI)

INPUTS
Energy
Chemicals (+)
Water
Space
HR

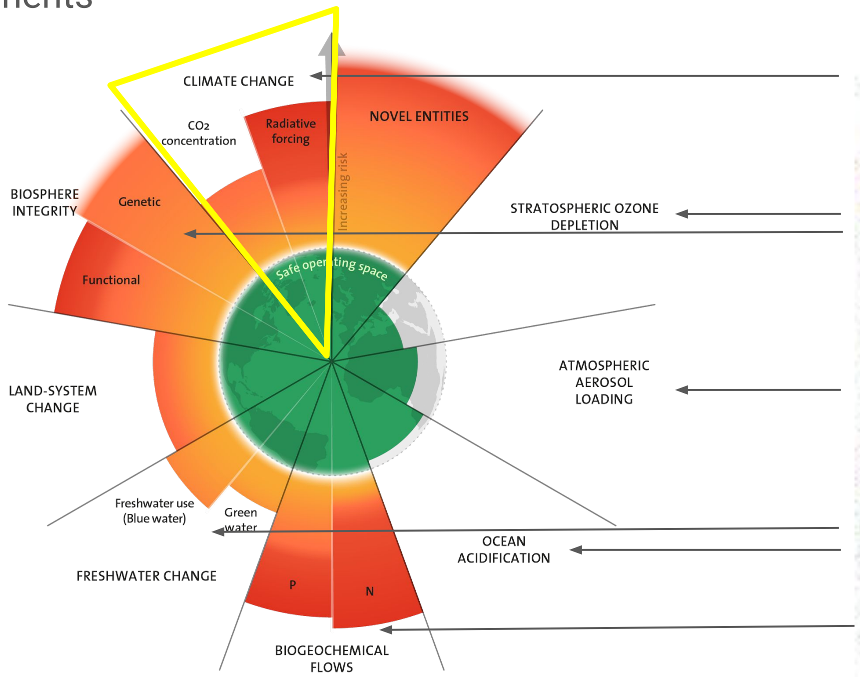



SICK
C 4000

Substances of Concern, Chemicals & Circular Economy

The Situation : The Planetary Boundaries Model

9 segments



Currently, Over-focused on Climate Change

➡ Impact of Chemicals on all the Segments

Chemicals, Hazard and Risks : some figures

Quantities

50x

Chemical production since 1950

3x

Chemical production by 2050

+79%

Plastics production between 2000 and 2015

Hazards

214

million tons

Production of Haz Chemicals to Health
EU 2021

85

million tons

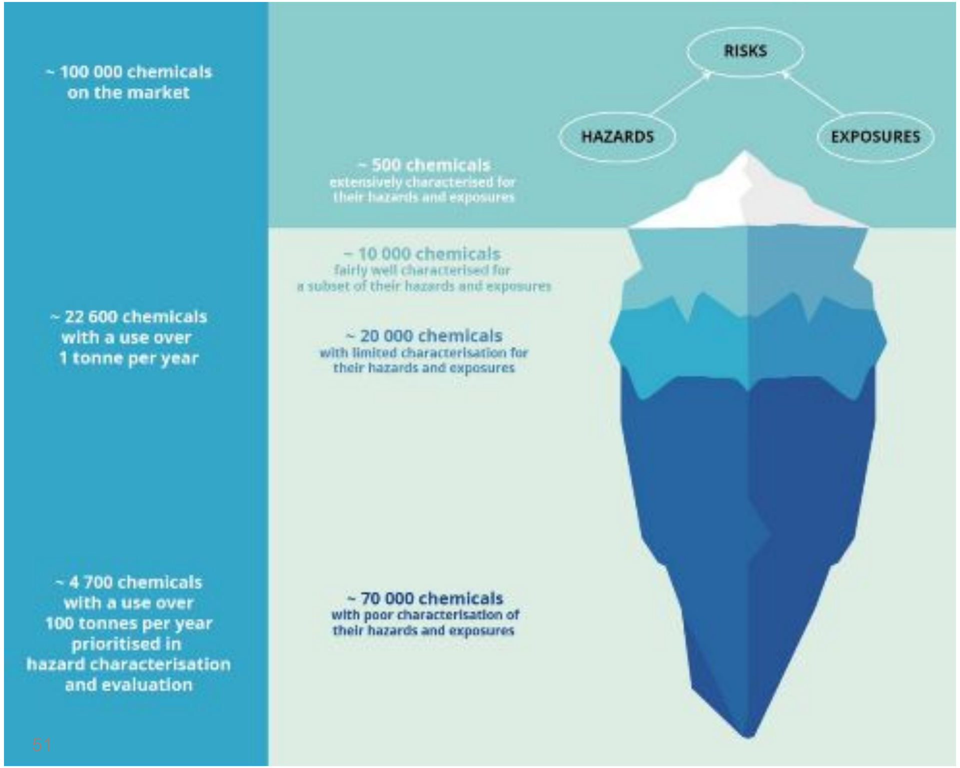
Production of Haz Chemicals to Environment
EU 2021

Impregnation

99%

of the global population is contaminated with PFAS

The Chemical Iceberg & The Initiatives



Increased Awareness of Hazards and Exposures to Chemicals

Various Initiatives over time

1990's
Responsible Care

RESPONSIBLE CARE®
OUR COMMITMENT TO SUSTAINABILITY

Green chemistry
12 principles

2000's
OECD
Sustainable Chemistry

OECD "Sustainable Chemistry" (1999)

1. Use of Alternative Feedstocks
2. Use of Innocuous Reagents
3. Employing Natural Processes
4. Use of Alternative Solvents
5. Design of Safer Chemicals
6. Developing Alternative Reaction Conditions
7. Minimizing Energy Consumption

OECD

2020's
EU Green Deal
Chemical Strategy for Sustainability

Toxic free 2030

Investors Initiative on Hazardous Chemicals

ChemSec SinList

EU Green Deal & "Zero Pollution" strategy

GREEN DEAL : TRANSFORMING OUR ECONOMY AND SOCIETIES

- Transports
- **Green industrial revolution** — The Green Deal Industrial Plan
- Energy system
- Buildings
- Nature, Biodiversity

The Green Deal Industrial Plan

1. **Predictable and simplified regulatory environment**
2. Faster access to funding
3. Enhancing skills
4. Open trade for resilient supply chains

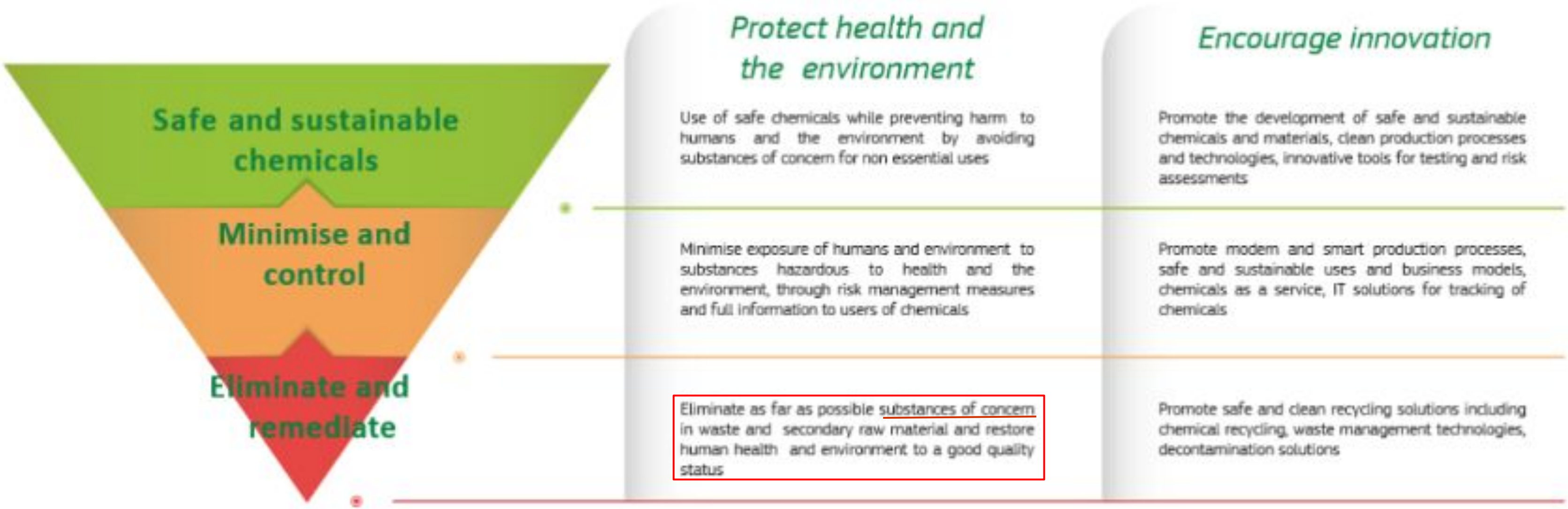
Net-Zero Industry Act
Critical Raw Materials Act
Reform of the electricity
Market design

Setting clear priorities for action
Building European capacities
Improving resilience
Investing in research, innovation and skills
Promoting a more sustainable and circular raw materials economy

The **recycling of raw materials must be promoted** and a strong secondary market enabled. This will be achieved by encouraging the **recovery** of critical raw materials **from extractive waste facilities** and increasing **efforts** to **mitigate adverse impacts** with respect to labour rights, human rights and environmental protection. Certification schemes to increase the sustainability of critical raw materials on the EU market must also be recognised.

EU Green Deal & “Zero Pollution” strategy

TOWARDS A TOXIC-FREE ENVIRONMENT: A NEW LONG-TERM VISION FOR EU CHEMICALS POLICY



EU Green Deal & “Zero Pollution” strategy

EU Communication on Chemical Strategy for sustainability toward a Toxic Free environment

Safe & Sustainable-by-Design

Substitution of Substances of Concerns
Bio-based Chemicals
Drive and Reward regulatory tools

Non-toxic material cycles

Adequate information on Chemical content of Products
SoC in products and recycled materials minimised
Derogations to REACH remain exceptional
Innovation to **decontaminate**

Innovative industrial production

Energy efficiency
Chemicals as a service
Re-skilling and up-skilling

Strengthening EU’s open strategy autonomy

Strategic dependencies
Strategic value chains
Strategic foresight on chemicals

EU Chemical legislation

Coordinate and simplify
CLP central piece

Protection against most harmful chemicals

Generic approach to risk management : **no SoC in consumer products**
Regulation on **group of chemicals**
Childcare articles
Criteria for essential use
Protection of workers at the same level of that of consumers

Endocrine disruptors

Ban in consumer’s product
Workers’ protection
Hazard identification and information

Chemical mixtures

Mixture assessment
Combination effects regulation

Chemical pollution in Natural environment

Endocrine disruptors, POP’s → SVHC
Decontamination solutions

PFAS

Ban all PFAS (except essential use)
Innovate for PFAS **decontamination**

The Chemical Transition

Human development and resource conservation

- **Avoid marketing** dangerous substances, simplify the transformation, the formula design of products and processes
- Favor a **culture of maintenance** as a first course of sustainable action
- Focus on the essentials and address the **essential needs** of the global population

SUFFICIENCY

DURABILITY

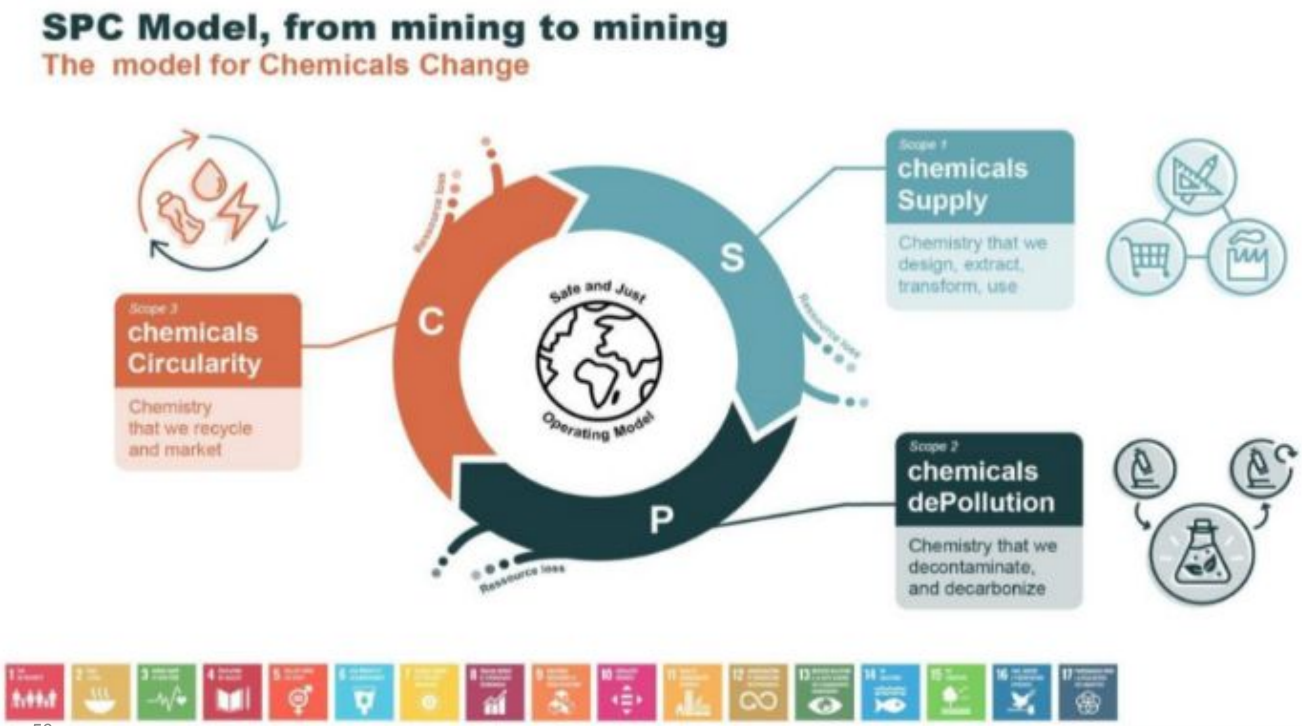
ESSENTIAL

Ensuring access to a clean, healthy and sustainable environment

- **Phase-out** the dangerous chemicals unless they have essential uses.
- Toxic free environment by 2030
- **Ban** of most dangerous families of chemicals
- Preventive impact assessment / **Treatability** / Circularity
- **Track** the life cycle of chemicals substances

Promote dialogue by creating a common language **based on science**

SPC Model : help structuring the Chemical Transition

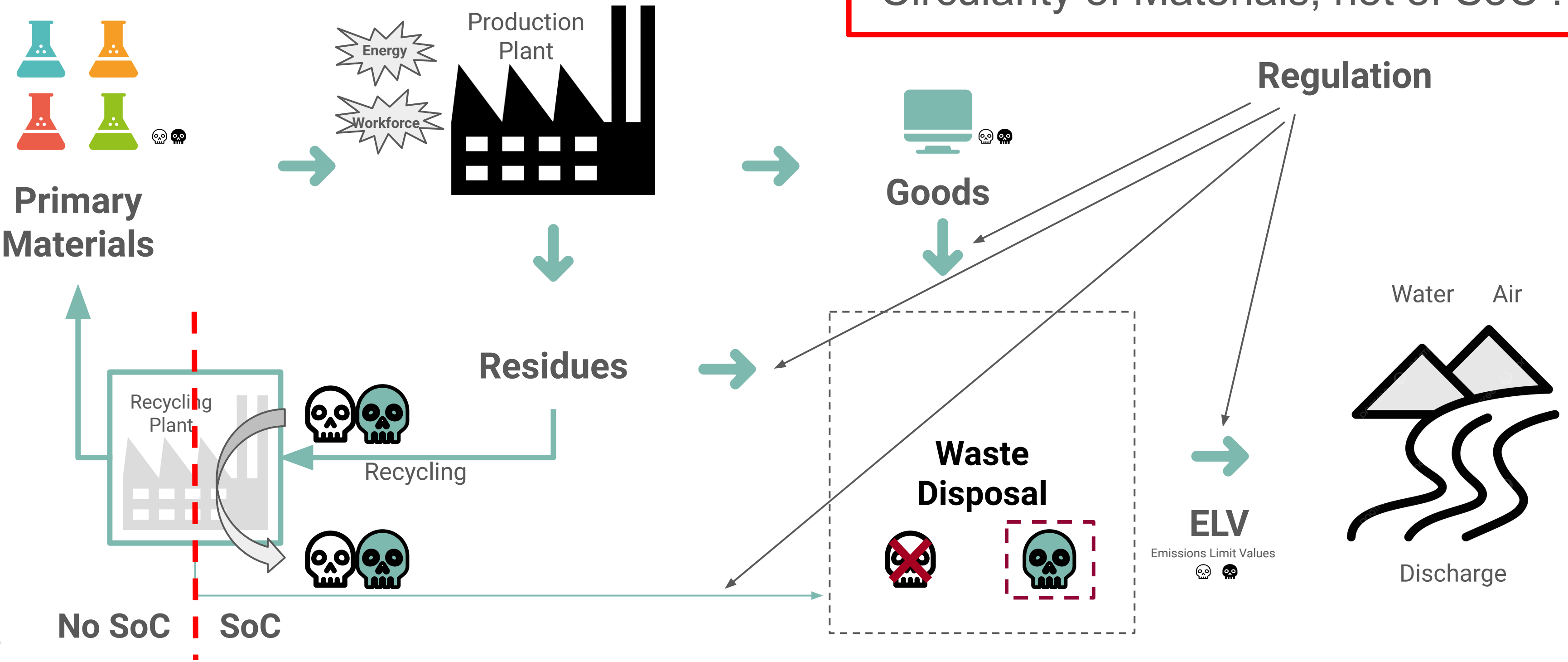


- **Avoid the use of concerning substances** for humankind and ecosystems.
- Taking stock of the negative, positive, and avoided impacts of chemicals.
- Defining the scientific, economic, social, and environmental stakes at each stage, including the role of Chemical Transition in respecting planetary limits.
- Mapping the existing frameworks, regulations, and solutions, or those currently being explored by various players, and analyze their advantages and limitations.
- Identifying all the players involved at each stage of the chemical cycle (miners, chemists, plants, manufacturers, contractors, consumers).
- Co-constructing comprehensive indicators and impact criteria for the Chemical Transition.

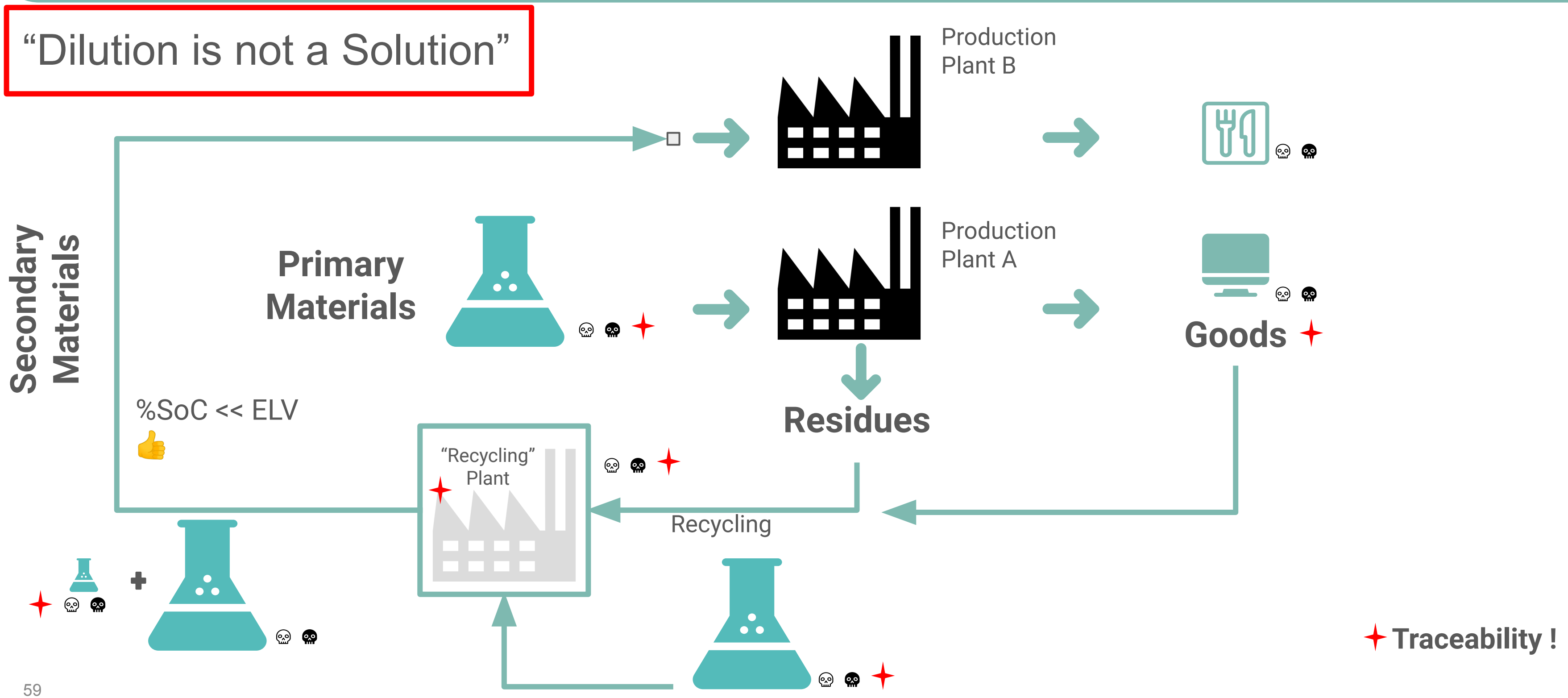
Waste Management “Circular economy”

Waste recycling : Circularity & SoC

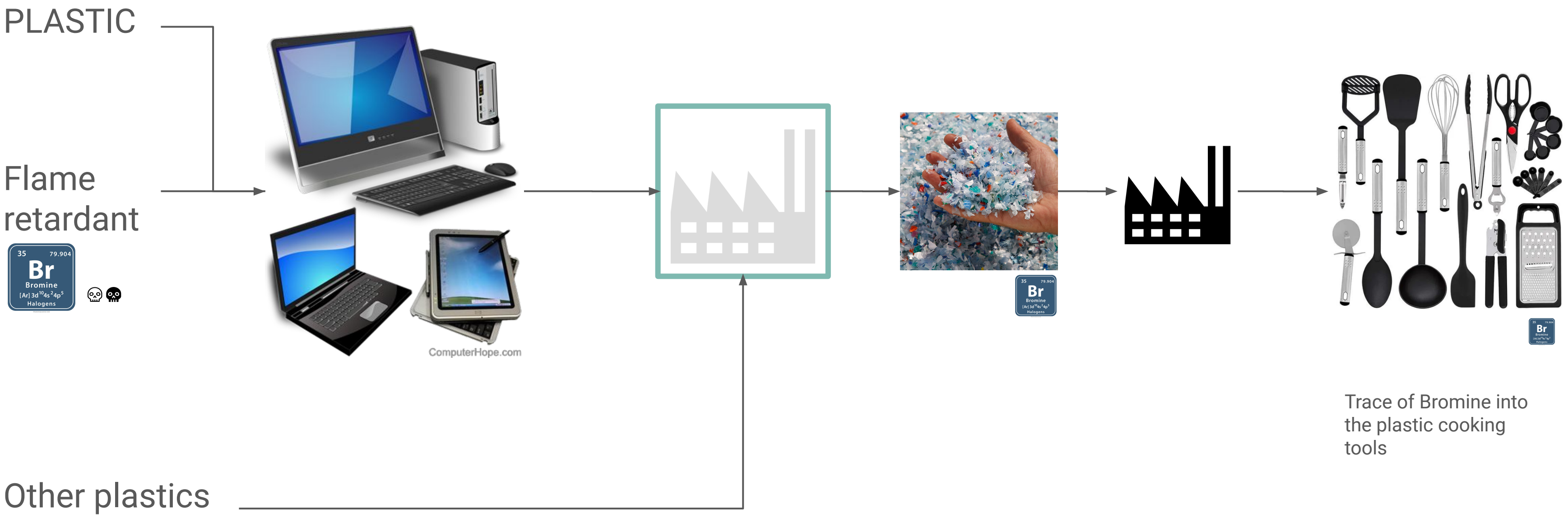
"Circularity of Materials, not of SoC !"



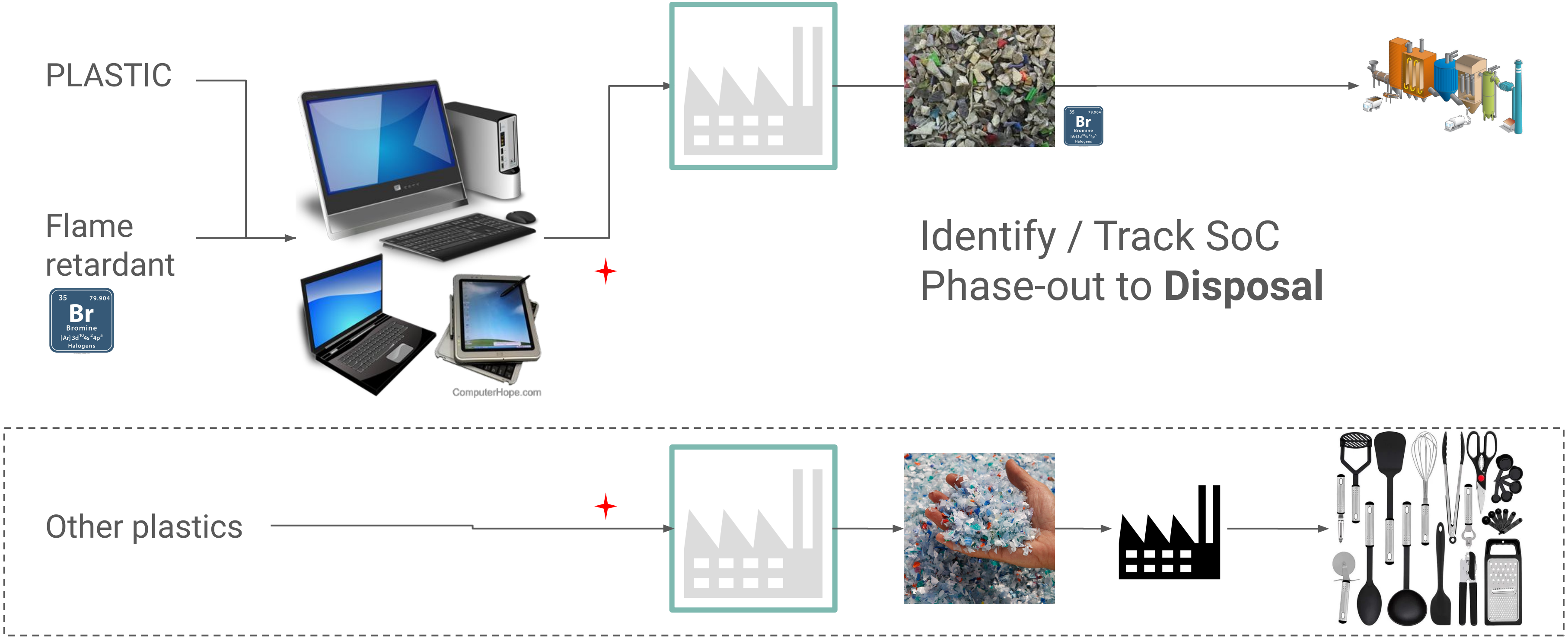
Waste recycling : Circularity & SoC



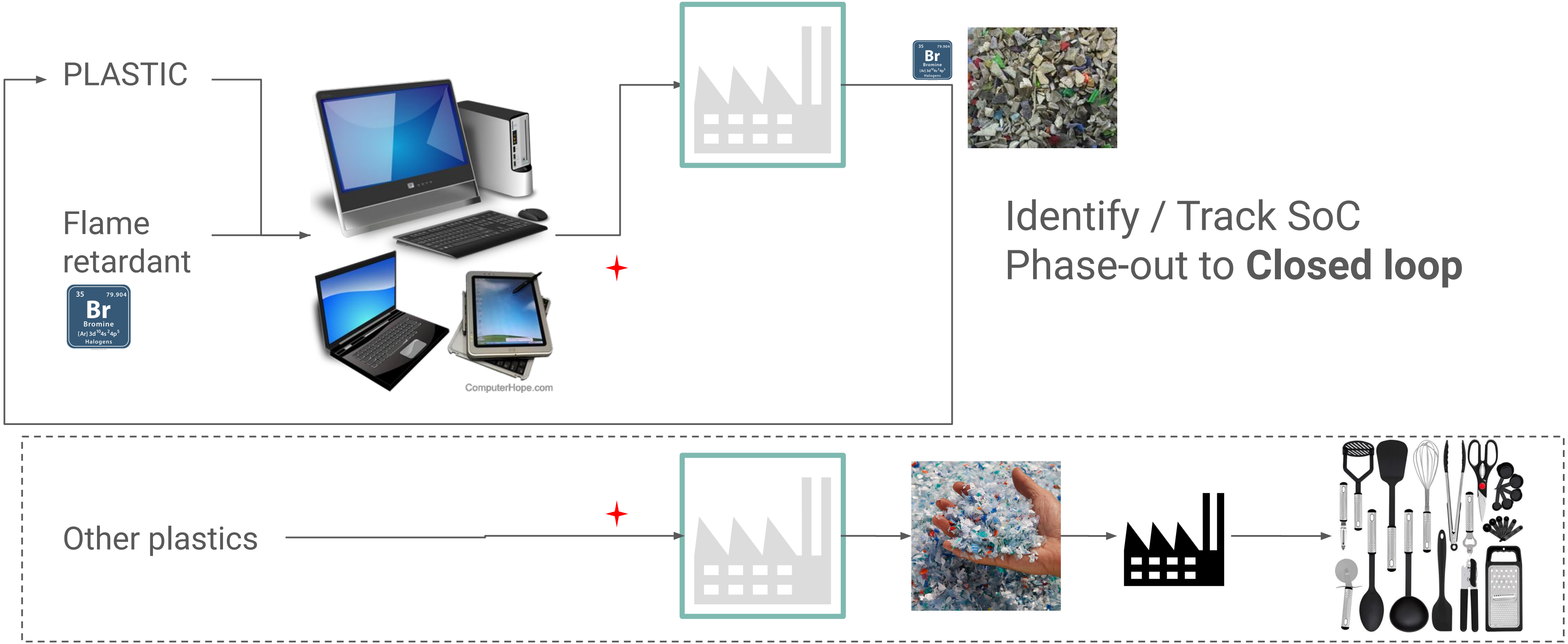
Case study : Brominated plastics



Case study : Brominated plastics



Case study : Brominated plastics



Identify / Track SoC
Phase-out to **Closed loop**

Waste recycling : Circularity & SoC

TRACEABILITY

Transparency on production chains

Analysis methods

Control

"ECODESIGN"

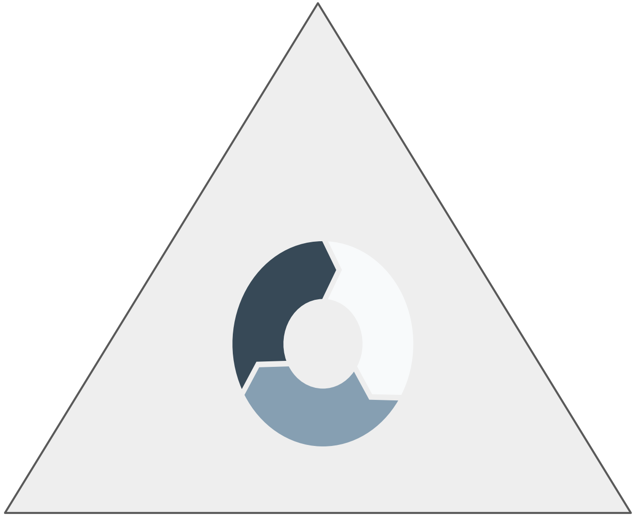
Disassembly plan

Digital passport on Chemicals, Energy, Resource

Electronic / Chemical "marking"

The Tricky Triangle of Recycling

Secondary raw material with acceptable value on the market



Waste with
not too complex matrix,
sufficient % of
recoverable material

Process with
not to much space,
energy, chemical
consumptions
enough recovery ratio

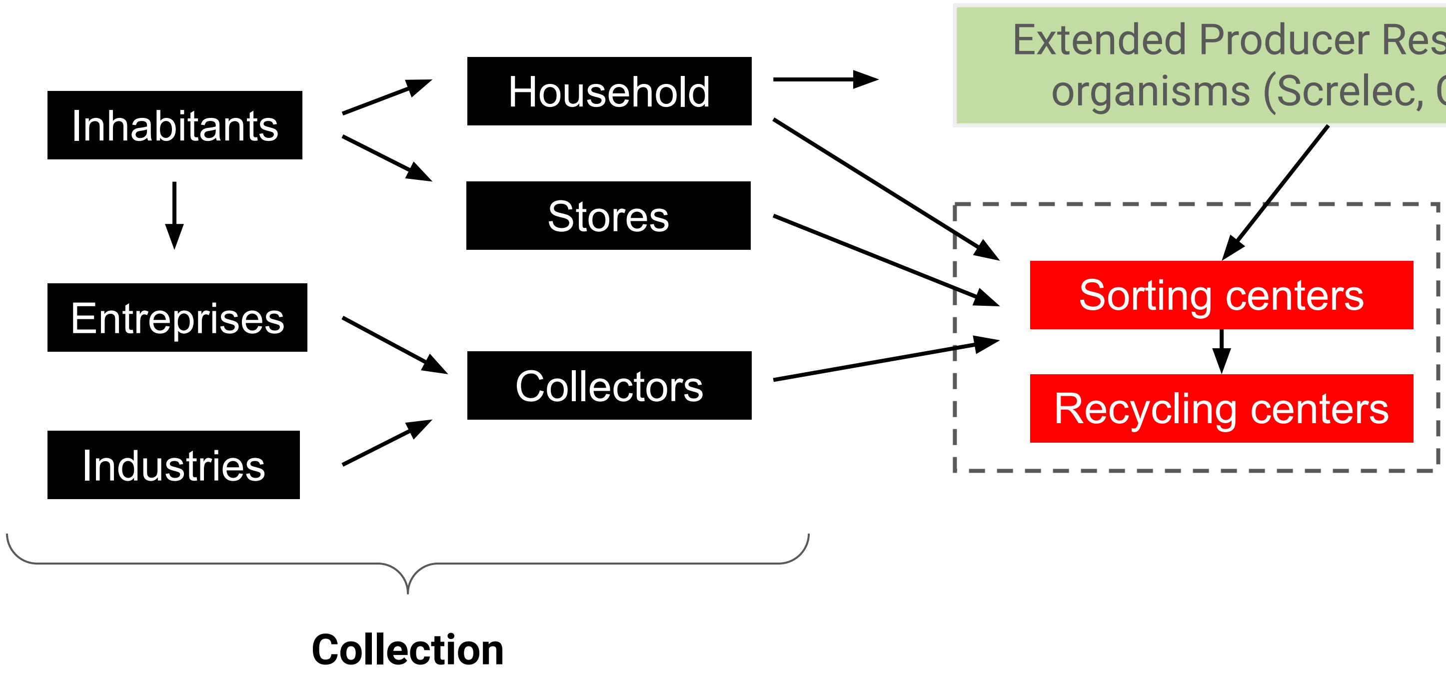
Waste Recycling Case Studies

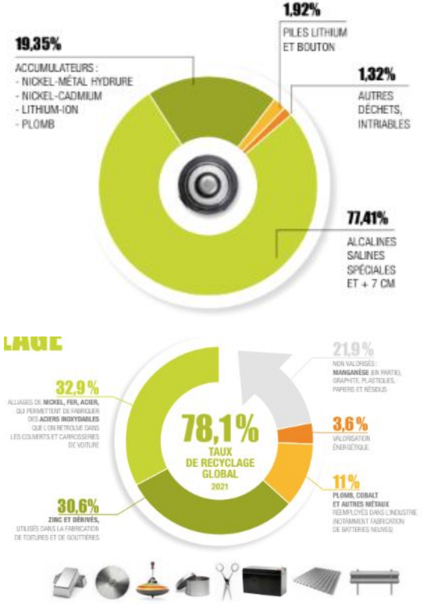
Waste recycling : some examples in HazWastes

- ⇨ **Batteries** recycling (EURODIEUZE)
- ➪ **Fluorescence tubes** recycling (Limay)
- ➪ **Solvents** regeneration (SPR)
- ➪ **Nickel / Zn** valorisation (Cedilor)
- ➪ **Motor Oil** recycling (Osilub)
- ➪ **Used Cooking Oil** (UCO) recycling (Dielix)
- ➪ **Plastic** recycling (Veolia / SPUR)

Batteries Recycling

Batteries recycling





source : Corepile 2021

Batteries recycling

Flow sketch

Non sorted Batteries

Sorting by categories

Lithium button

Lithium

Mercury button

NiCd / NiMH

Alkaline & Saline Batteries 85%

Shredding & Sieving

Energy valorisation

Papers & Plastics

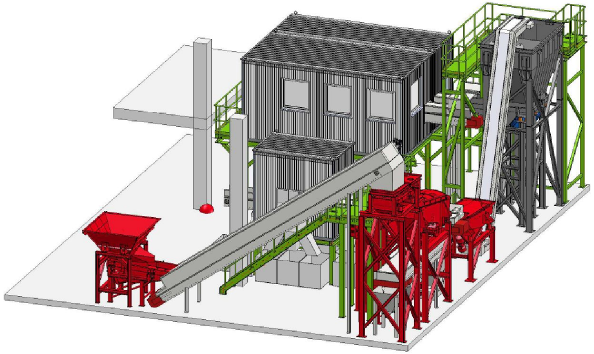
Material valorisation

Zinc
(Foundery)

Iron
(Steel industry)

Metal powder
(hydrometallurgy)

Batteries recycling

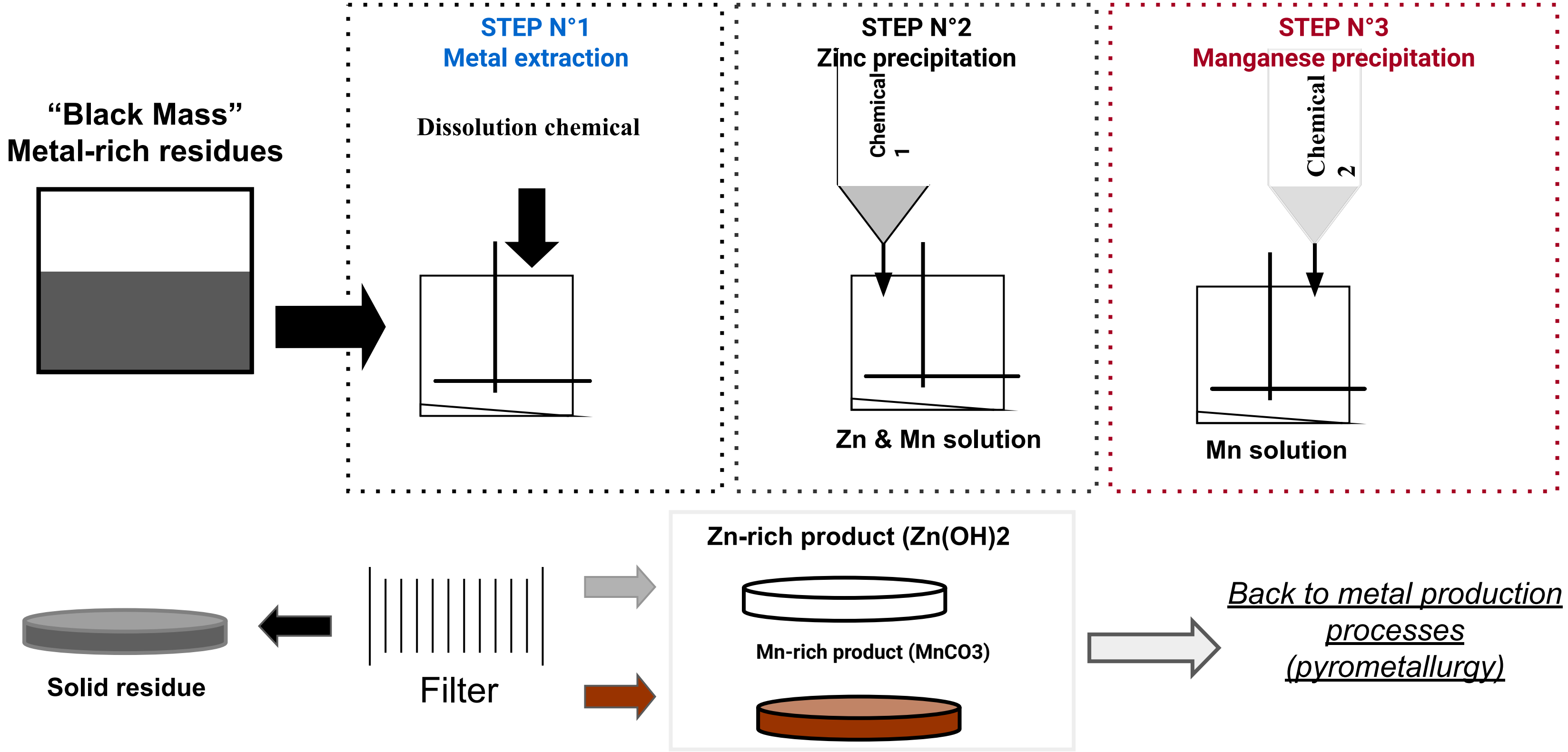


Batteries recycling

$ZnO + MnO2 + C + 2\ H2SO4$ □ $Zn^{2+} + Mn^{2+} + 2\ SO4^{2-} + C + 2\ H2O + 1/2\ O2$

$Zn^{2+} + SO4^{2-} + 2NaOH$ □ $Zn(OH)2 + Na2SO4$ (pH 7-8)

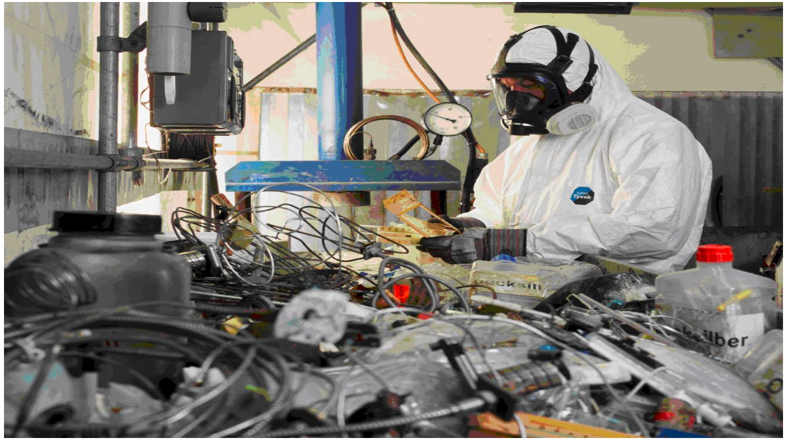
$Mn^{2+} + SO4^{2-} + Na2CO3 \ -> \ MnCO3 + Na2SO4$ (pH 8-10)



Batteries recycling : BATREC Switzerland

Zn / FeMn

Batteries recycling : Hg specific case

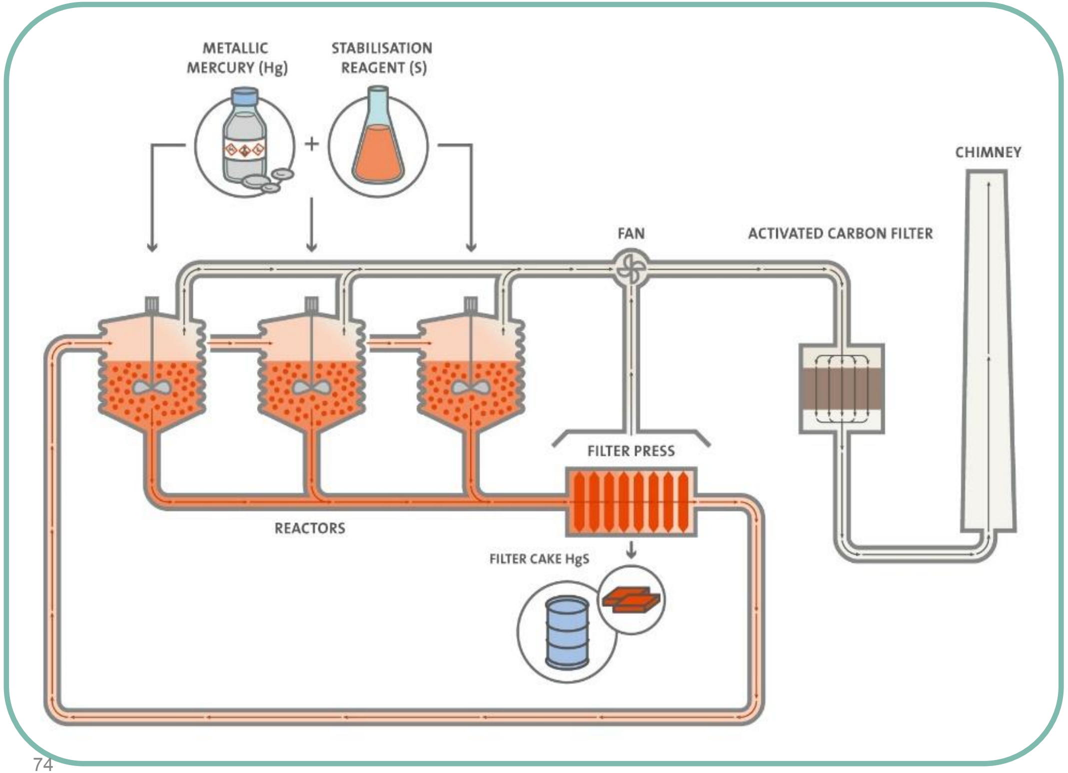


- 300 t/an of Hg containing wastes
- 3 distillation kilns
- Production of Hg with a 99,9999%

Production of Dental amalgame
30% of World production

Stabilisation and Landfill

Stabilisation of Hg



Cinnabar
HgS
Mercury
Sulfide

Specific Metal recycling

Case study : Zn / Ni recovery

→ **Step 1** : Zinc absorption on an Ionic exchange resin

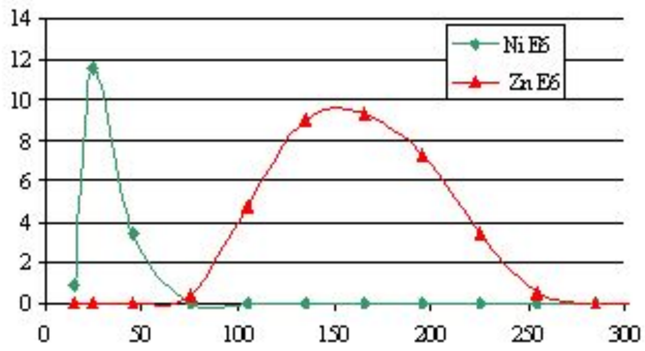
$Zn^{2+}_{liq} + 2\,Cl^-_{liq} + Cl^-_{résine} \rightarrow ZnCl^-_{3\,resin}$ *Zn on the resine*

$Ni^{2+}_{liq} + 2\,Cl^-_{liq} + Cl^-_{résine} \rightarrow NiCl_{2liq} + Cl^-_{resin}$ *Ni not fixed by the resin → passthrough*

→ **Step 2** : Zinc elution

$ZnCl^-_{3\,résine} + H_2O \rightarrow ZnCl_{2liq} + Cl^-_{resin}$ *Zn is eluted and back in solution*

→ **Step 3** : The 2 separated metallic solution are precipitated separately



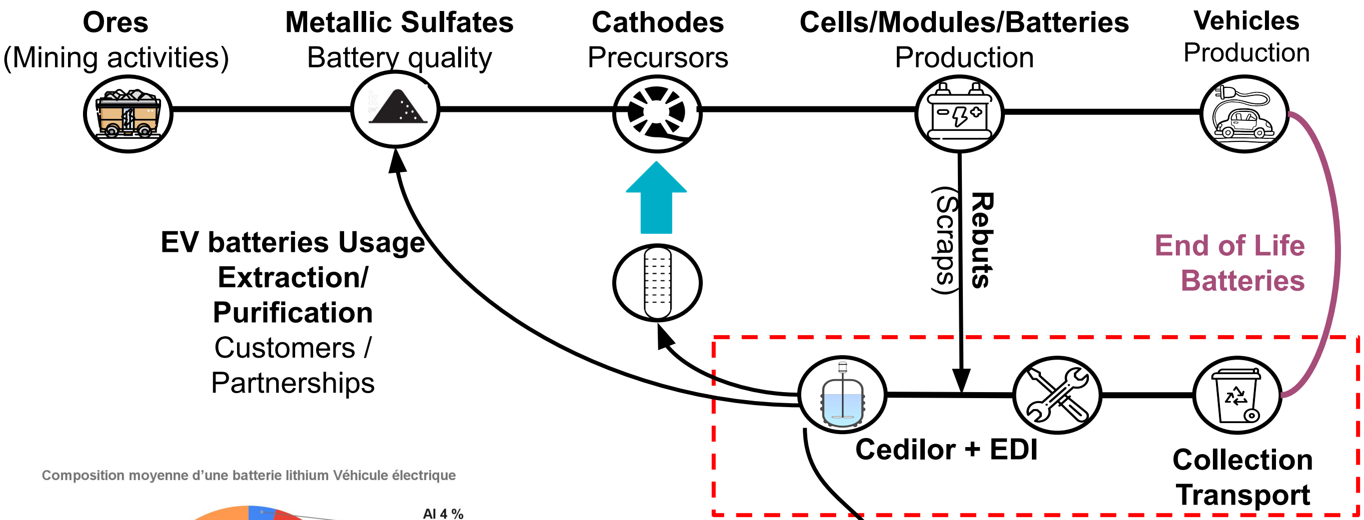
Nickel Hydroxyde

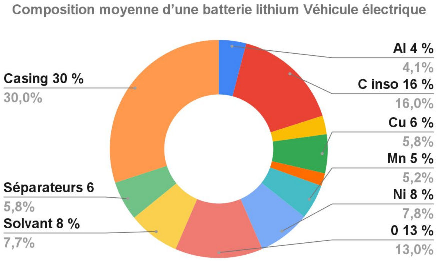
Zinc Hydroxyde

Case Study : Electrical Vehicle Batteries

EV Batteries
in a nutshell

- From 300 kg to more than 1000 kg per battery depending on vehicles
- From 15 kW to 100 kW power
- CMR containing
- Flammable solvents
- Different technologies and compositions :
  - NMC : Nickel, Manganese, Cobalt
  - LCO : Lithium, Cobalt, Oxide
  - LIP : Lithium, Iron, Phosphate





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A new industrial way for batteries recycling

EDI - FR 57 Dieuze
(Dedicated site for Batteries recycling)

25 years operation on batteries recycling
"8 000 t/an" all technologies (Alcaline, NiCd, LiP, Li-ion...)
Mechanical processes (sorting, shredding, seiving)
Chemical processes (Ni/Cd batteries recycling)

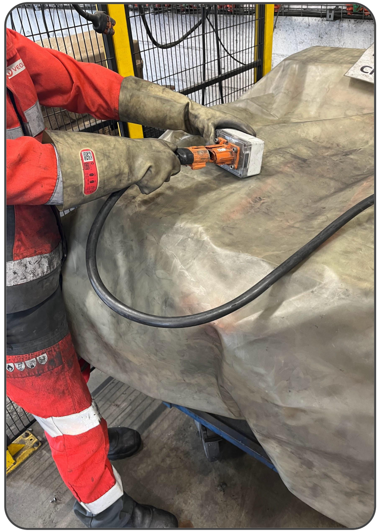
CEDILOR - FR 57 Amnéville
(Multi-recycling site)

50 years operation on hazardous waste treatment and recycling
Ni/Zn recycling
Re-Vision project (2024) : chemical processes on EV Batteries blackmass

Mechanical 1 : EV Battery dismantling

1

Electrical discharge



2

Dismantling of cables, casing, cooling system, insulation… (~ 30 %)

3

Modules extraction
(70 %)

Mechanical 2 : Shredding and Sieving

4

Wet shredding
with solvent electrolyte extraction

Electrolyte solvents
10 %

5

Mechanical separation of shredding material

Polymer membrane
15 %

Re-Vision : Hydrometallurgy on the Batteries'Metals

Yeraly capacity
7 000 tons of Blackmass

Production

Ni salts : 2100 t
Co salts : 840 t
Li salts : 2200 t

1,5 ton de CO_2 avoided per recycled battery

Leachate solutions containing the metals
(Cobalt, Nickel, Lithium, Copper,...)

Nickel Hydroxide
$Ni(OH)_2$

Cu < 0,01 %
Al < 0,01 %
Co < 0,2 %
Fe < 0,01 %

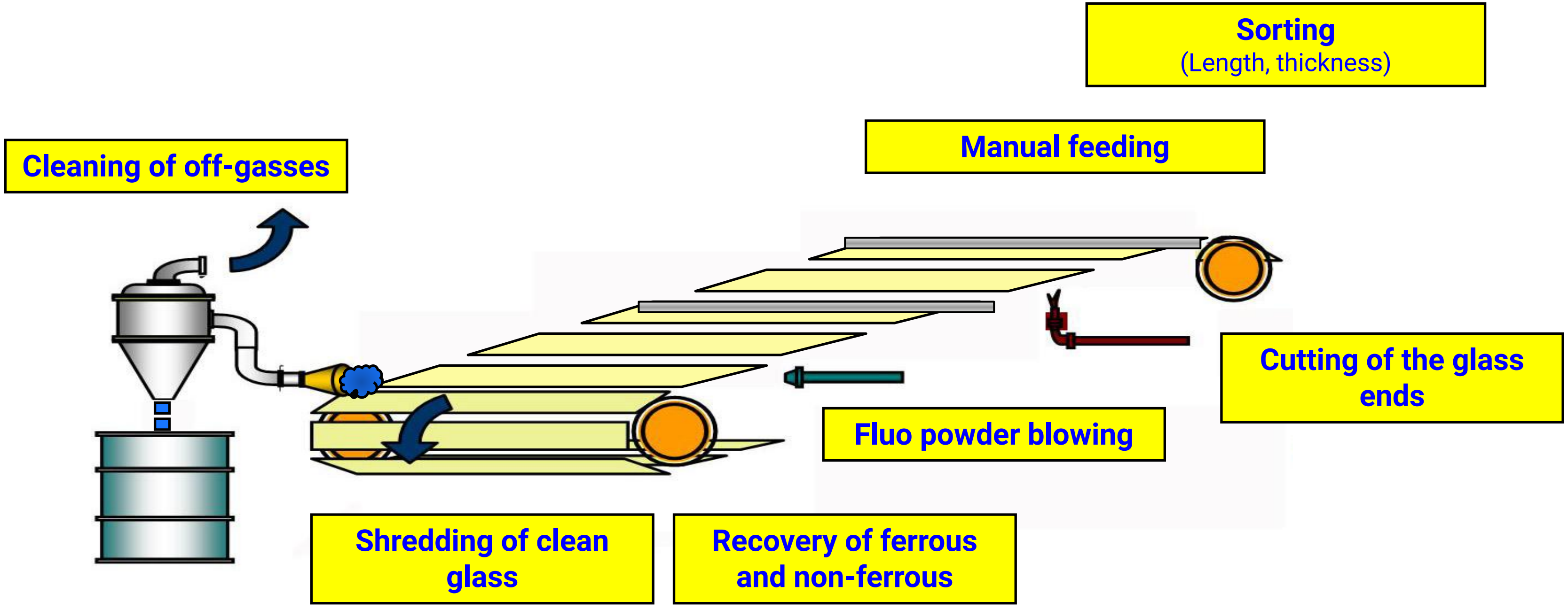
Cobalt Hydroxide
$Co(OH)_2$

Cu < 0,01 %
Al < 0,01 %
Ni < 1,2 %
Fe < 0,01 %

Lithium Carbonate
Li_2CO_3

Fluorescence tubes recycling

Fluorescence tubes recycling : story of a failure



Fluorescence tubes recycling : story of a failure

Initial project

- Dismantling of tubes
- Recovery of glass to new tube glass production
- Recovery of fluo powder (with Hg) to new fluo powder production
- Recovery of ferrous and non ferrous

Finally

- No recovery of glass → Demercurisation + Landfill
- No recovery of fluo tube → Demercurisation + Landfill
- Recovery of ferrous and non ferrous

→ the plant has closed in 2018

Solvent regeneration

Solvent regeneration

Growth forecasted !

- “Old” technology
- In place for more than 100 years
- In place on simple mixtures of solvents and impurities
- Toll market (loop)
- or Cascade market
- Will be boosted by **CO_2 regulations** :
  - Higher cost for the incineration of used solvents
  - Worth spending CAPEX & OPEX in more complex distillation processes

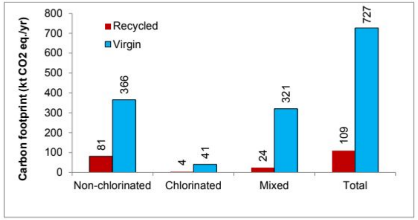
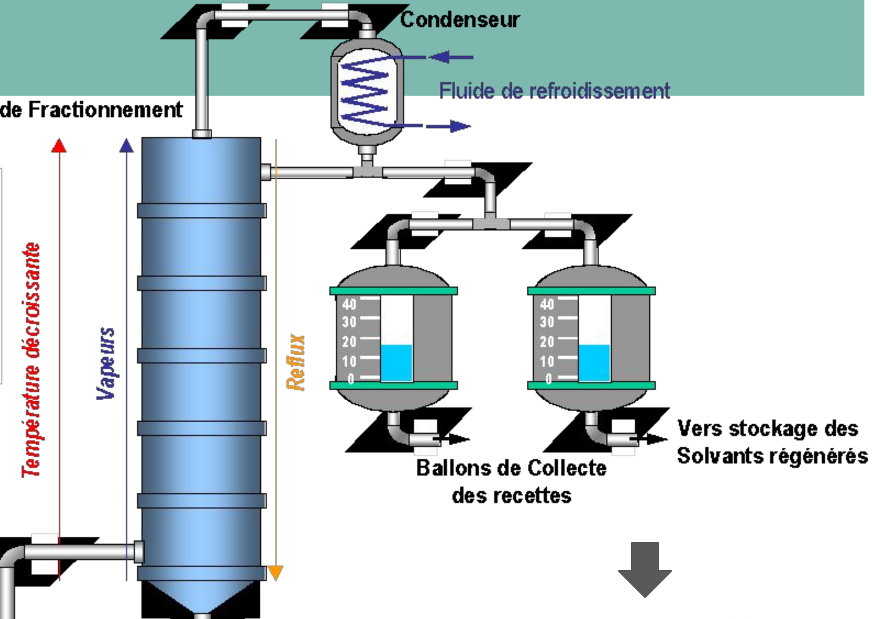
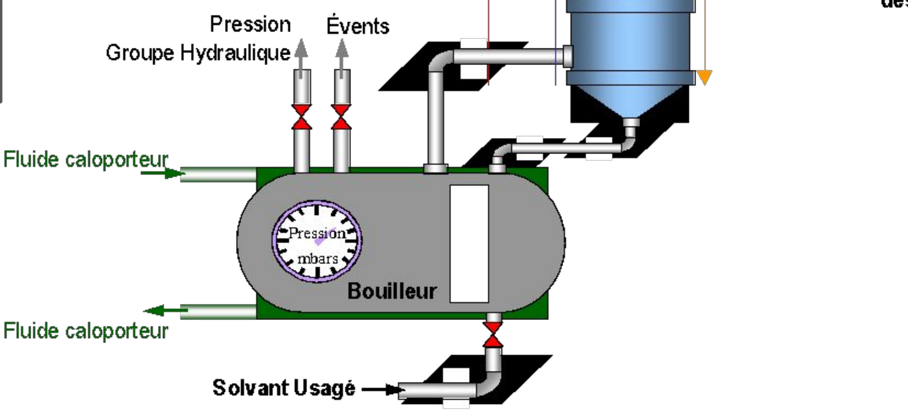
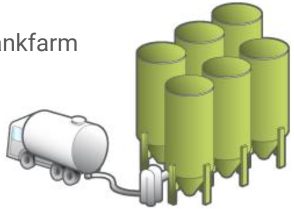


Figure 1 Annual carbon footprints of recycled and virgin solvents



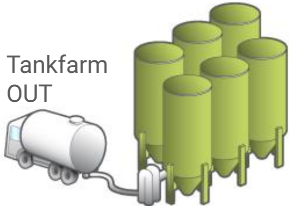


Tankfarm
IN



“Dirty” Solvents Mixtures

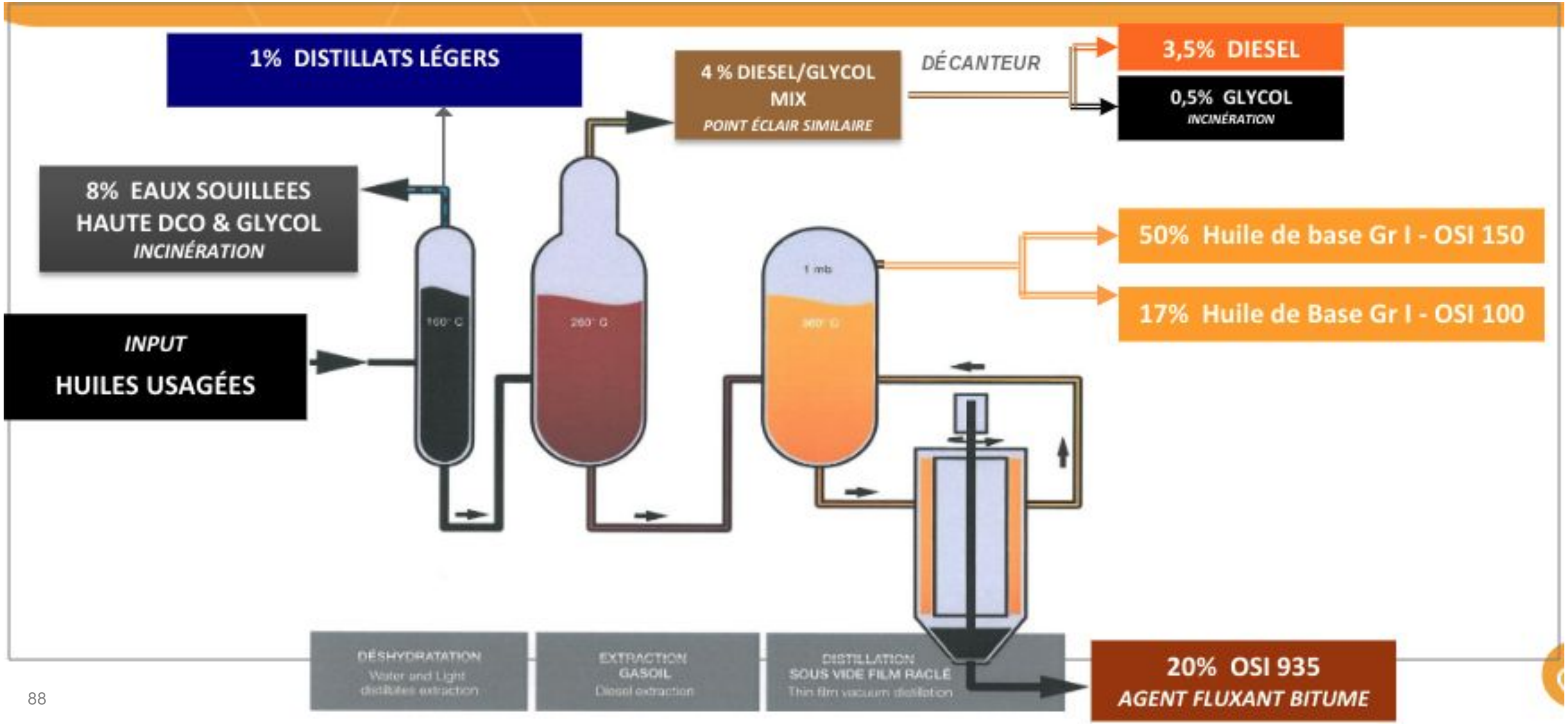
Tankfarm
OUT



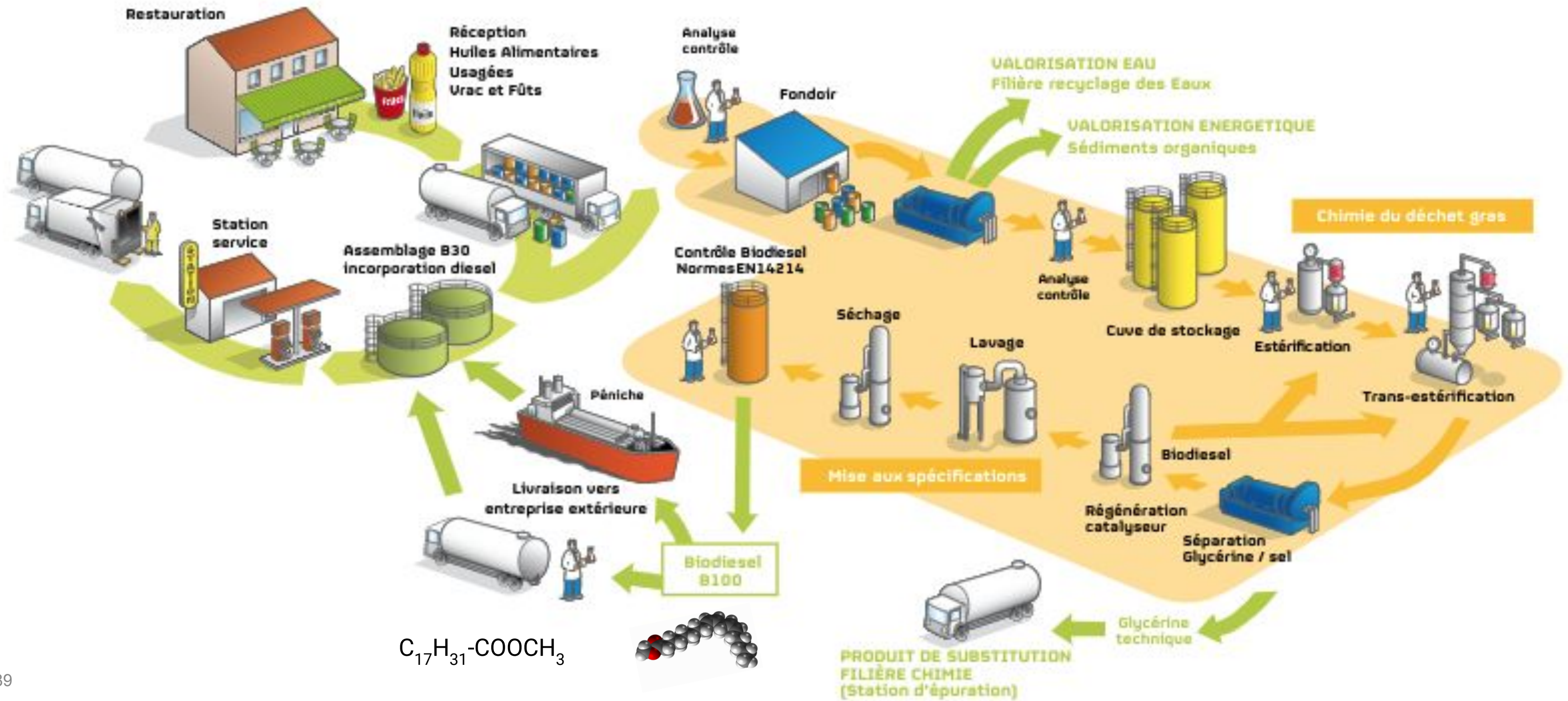
“Clean” Solvent Mixtures
Clean individual Solvents

Hydrocarbons recycling

Used motor oil regeneration



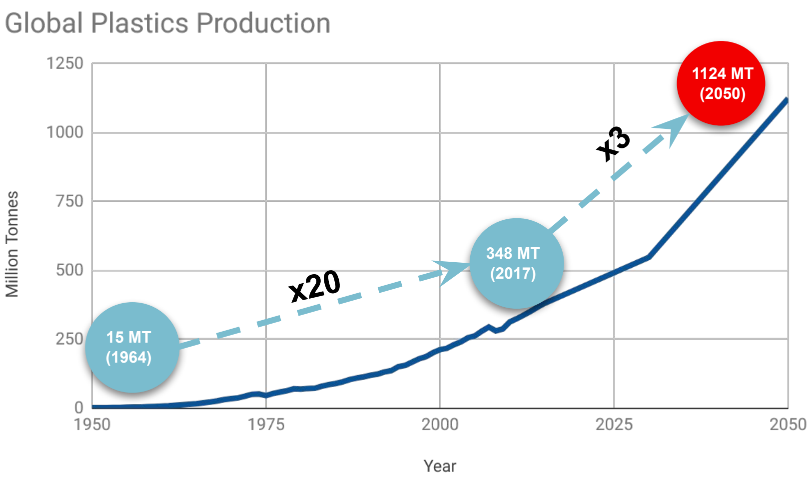
Used Cooking Oil (UCO) to Biodiesel

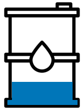


$C_{17}H_{31}\text{-}COOCH_3$

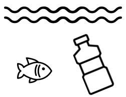
Plastics recycling

Plastics : a few (scarry) figures…



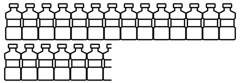


By 2050, 20% of oil extracted could be used to produce plastic



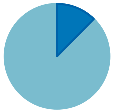
By 2050, there could be more plastics than fishes in the oceans

More than 50% of produced plastic is used only once



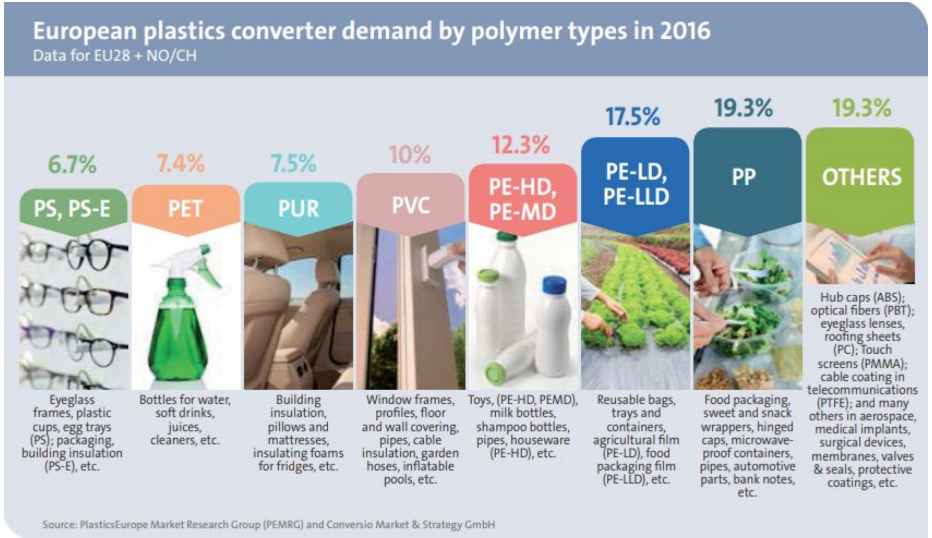
480 billion PET bottles have been sold in 2017

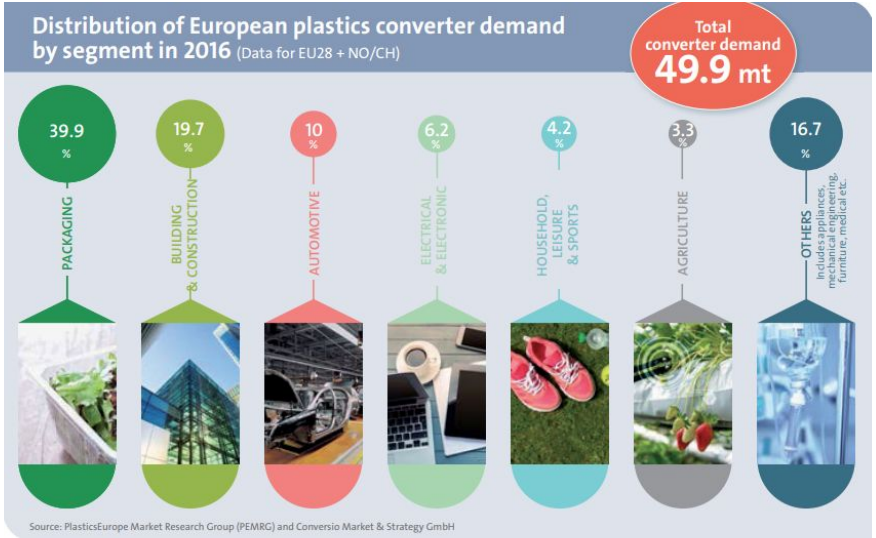
Less than 50% have been recycled



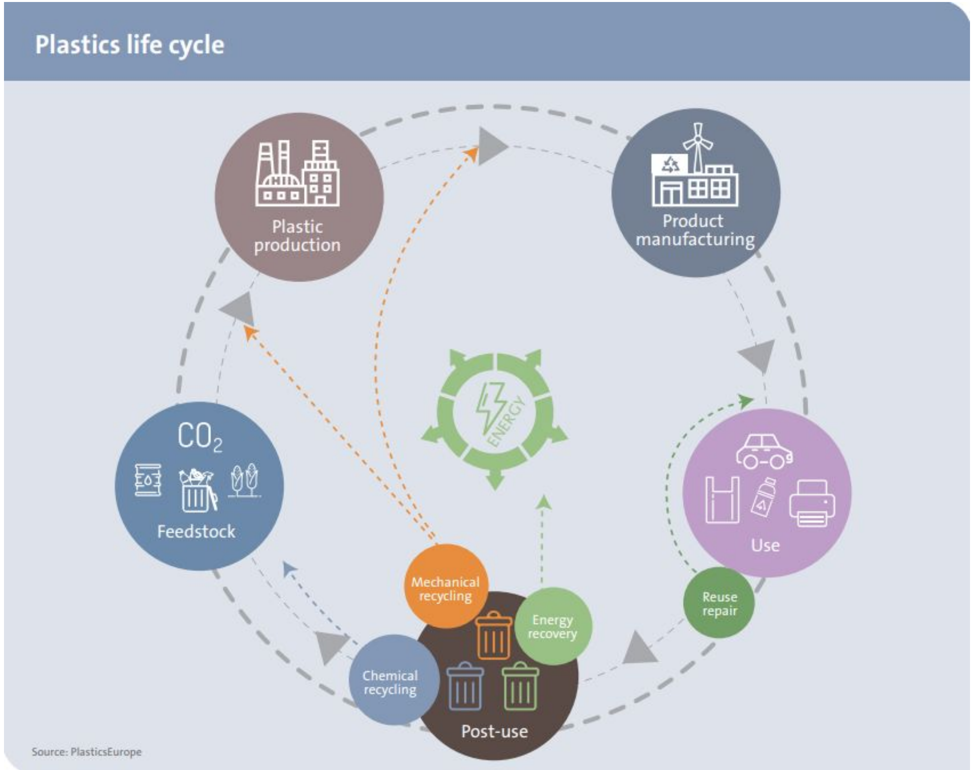
10% of total waste generated by Humans is plastic

Plastics : What ? What for ?





Plastic recycling at a glance



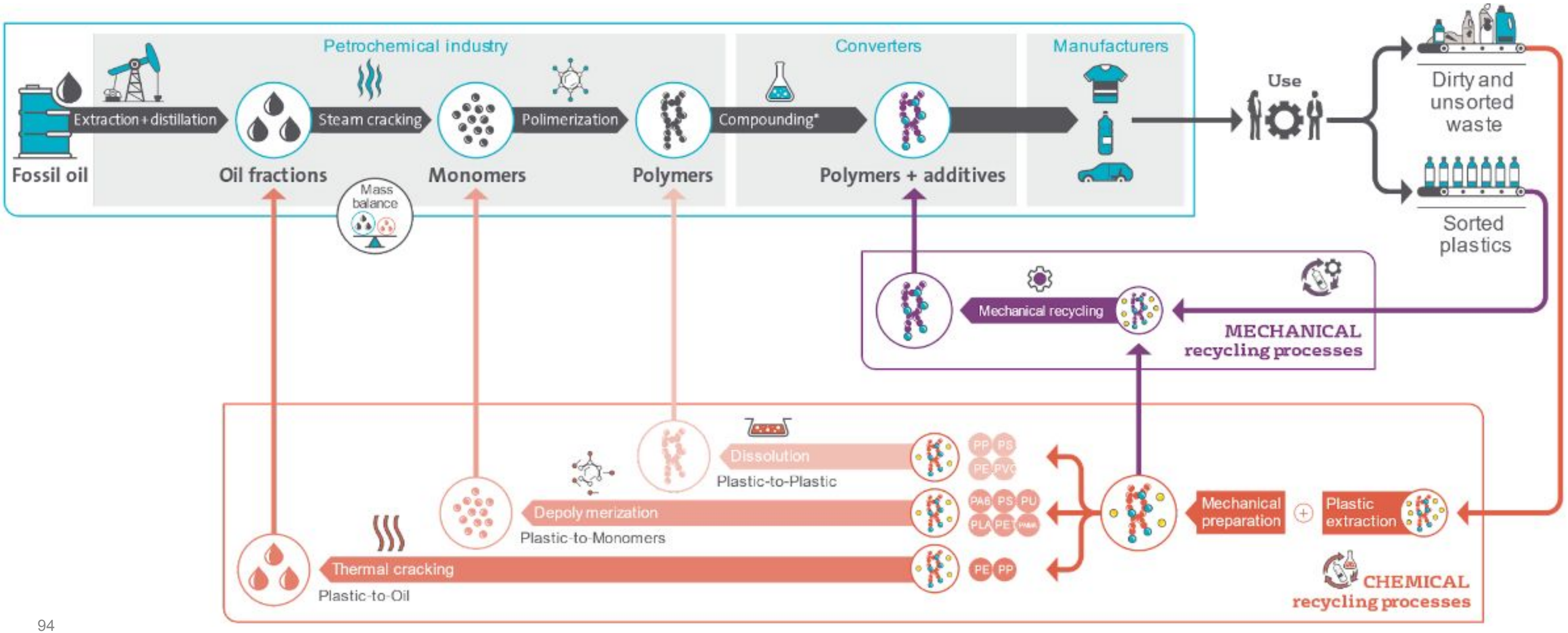
<u>SoC becomings</u>
SoC = additives (Lead stearates…)

Energy recovery : atm pollutants (Metals, HCl, HF, PFAS…) → Flue Gas Treatment → Landfill

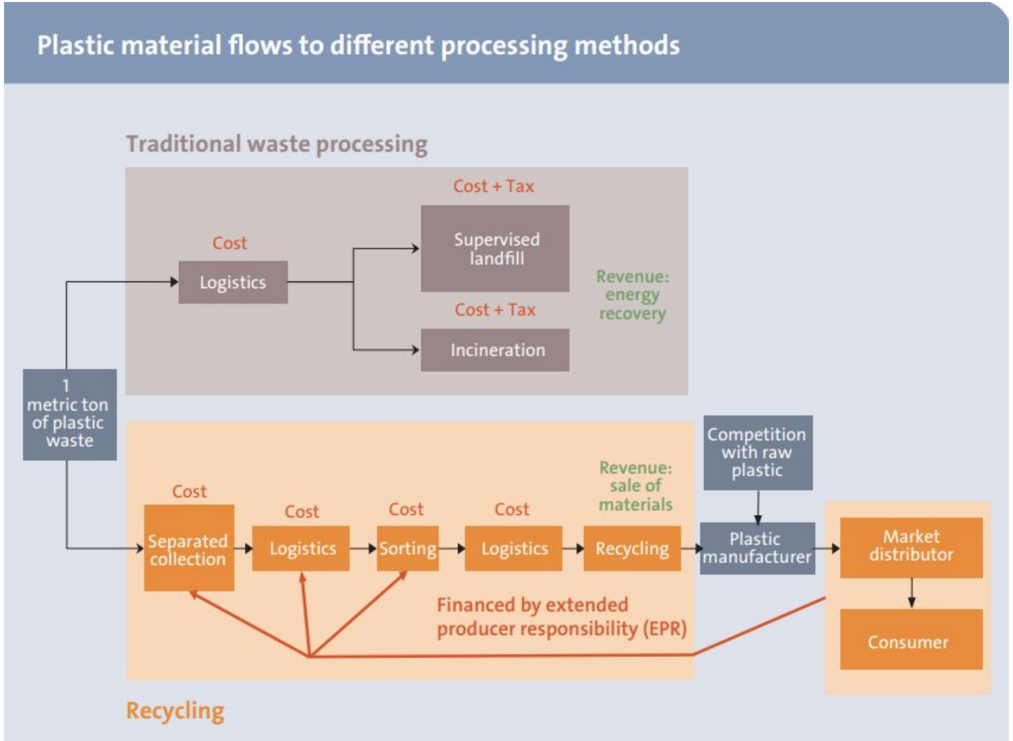
Mechanical recycling
Impregnation in resins → risk of “looping the SoC”
Analysis / Control / Decontamination / Closed loops

Chemical recycling : under development

Mechanical vs Chemical Plastic recycling

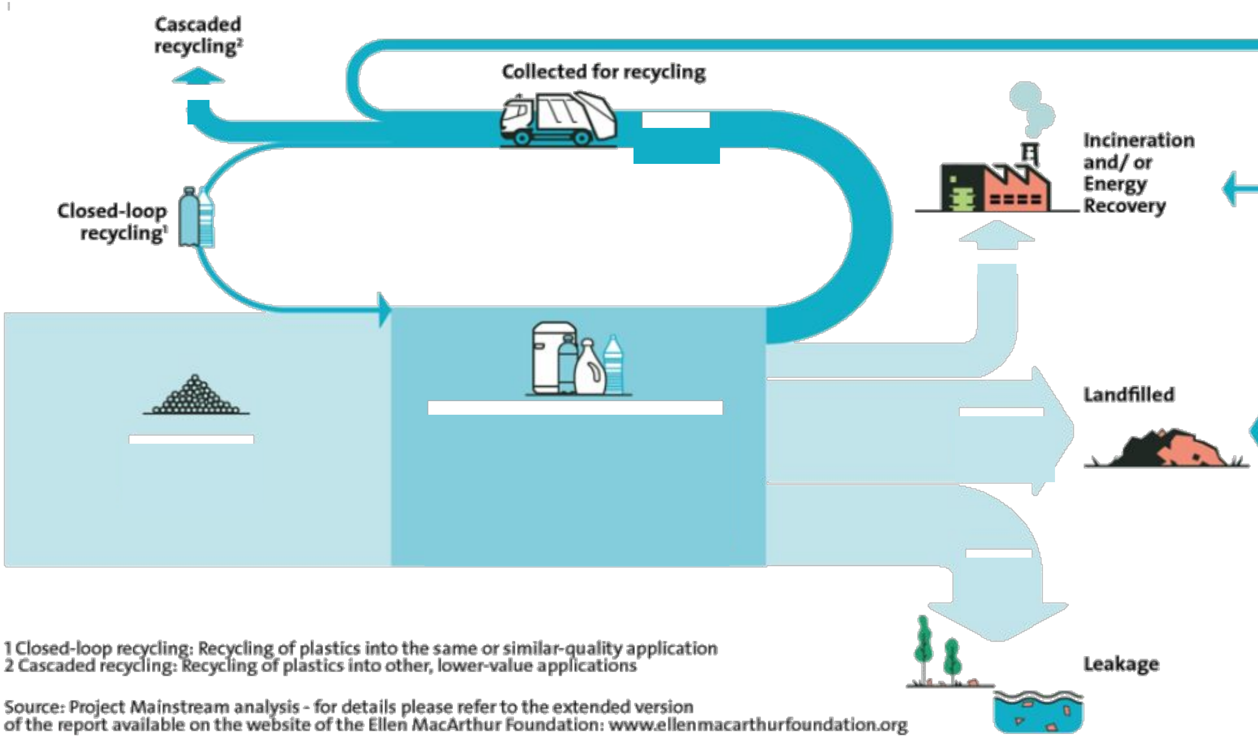


Plastics Mechanical recycling



Pro's	Con's
C sink SoC sink Low energy	No Material recycling
SoC disposal / sink Energy recovery	No Material recycling CO2 emissions
Material recovery	Logistic Numerous steps Numerous actors Risk of losing trace Risk of “Soc looping”

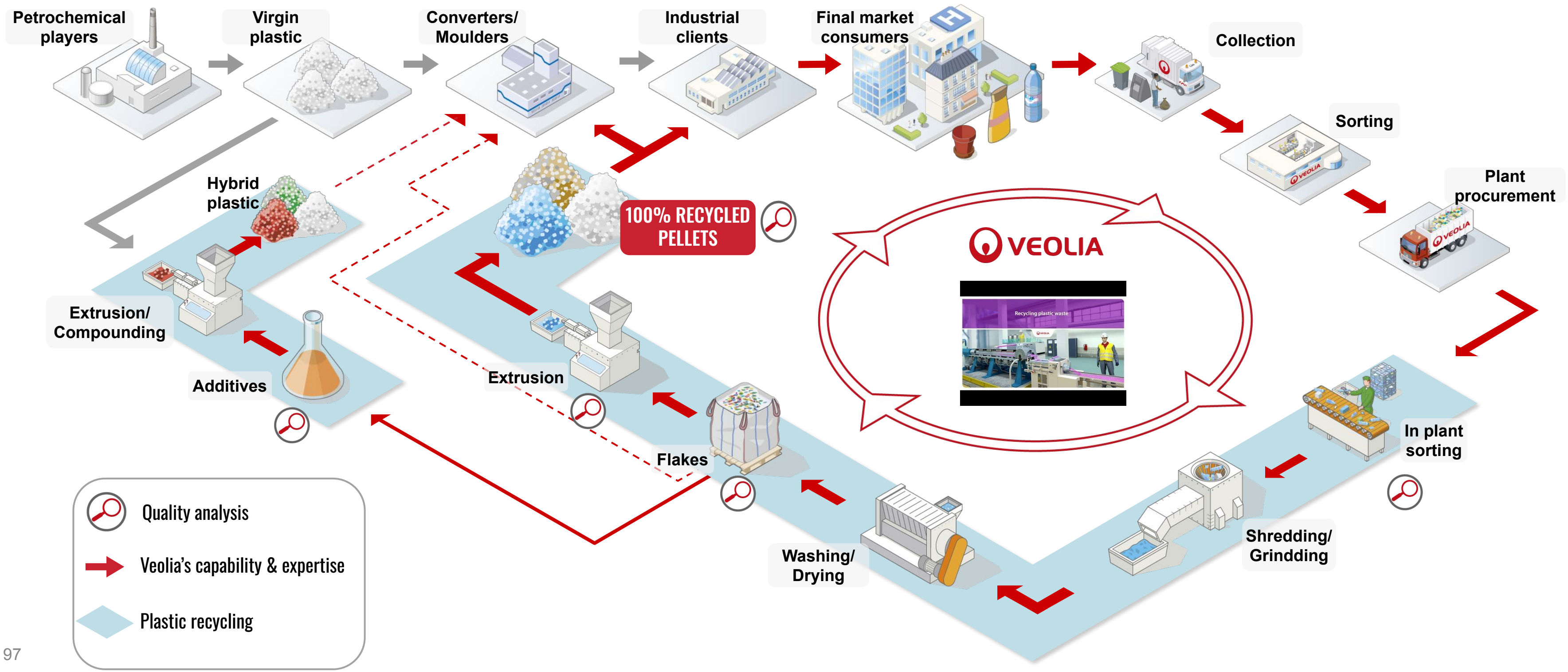
Plastic Recycling today : can do better !



Recycling rates 2015

Europe	30%
USA	9%
Australia	14%
China	25%
Brazil	19%
South Korea	45%
India	60%

Understanding Plastics Mechanical recycling



Plastics recycling : what is produced ?

RESULTS OF RECYCLING

There is also a very wide scope for **plastics resulting from mechanical recycling**

FLAKE

The resulting **small, flat shaped pieces** of material created when plastic are **grinded and washed**

PELLET

A form of plastic created when washed flake is **extruded** into a strand and chopped into **uniformly sized pieces.**
Purpose: achieving higher bulk density than flake with better feeding and conveying performance

COMPOUNDS

Compounding is the best method for **changing and improving the characteristic** of engineered thermoplastics. The final compound product is a blend of plastics and additives

CONVERTERS PRODUCTS

Pellets (or Flakes) are converted into items such as **fibers, films, sheets, and rigid packaging** along with **semidurable and durable goods**

Understanding Plastics Chemical recycling

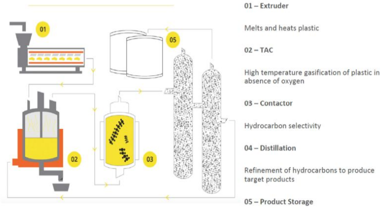
FUTURE UNDER DEVELOPMENT CHEMICAL RECYCLING

This upcycling technology offers many opportunities. **Total complementarity with mechanical recycling**

PLASTIC

Low quality mix of polyolefins (not qualified for mechanical recycling) → stretch film, soiled or coloured polyolefins, agricultural film, potato chips bag

PYROLYSIS



PYROLYSIS OIL

Can be turned into fuel or recycled plastic through **steam cracking and polymerisation unit**

VIRGIN-LIKE POLYMER

High quality plastics which can be processed in **any application** : trays, textiles, films, bottles

Plastic recycling at SARPI

Plastic Sorting (by resins) → Shredding / Granulation

Shredding / Granulation → Cleaning (Water / Steam)

Shredding / Granulation; Cleaning (Water / Steam) → Various resins granulate → Compounders Tech plastics

Granulation process

Steam cleaning

Phénix bucket

- Granulate of PP
- Transfer to compounder (additives)
- Transfer to a converter
- Production of a specific bucket, ADR compliant to feed SARPI Incineration for Direct Feeding

SARPI VEOLIA

Conclusion

Waste is **complex** (Regulation, Matrix, Actors…)

SoC are present and more and more pointed by Science, Regulation, Medias

More recycling, more circularity, YES, but with a higher control of SoC through

- Traceability
- Ecodesign

Many challenges for Chemistry to control existing SoC and design futur "SoC-free" Chemicals