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Sustainable solid waste management (SWM) framework

Vincent Chatain

INVESTIR L'AVENIR

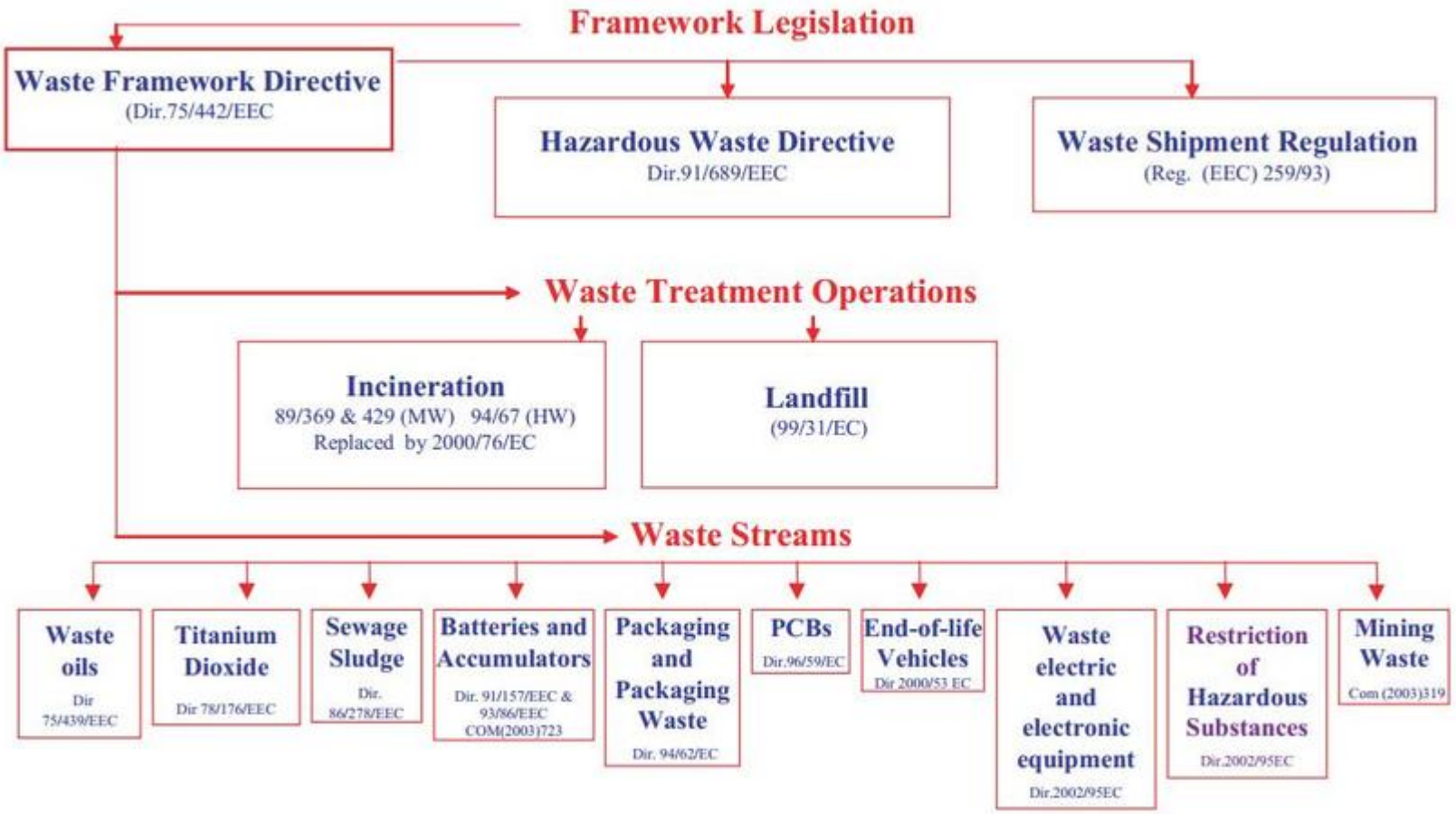
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LECTURES OVERVIEW



- Introduction - Waste system
- **Classification and current legislation**
- Sustainable waste management

EC WASTE LEGISLATION



– **horizontal** legislation;

– legislation on **waste treatment operations**;

– legislation on **specific waste streams**.

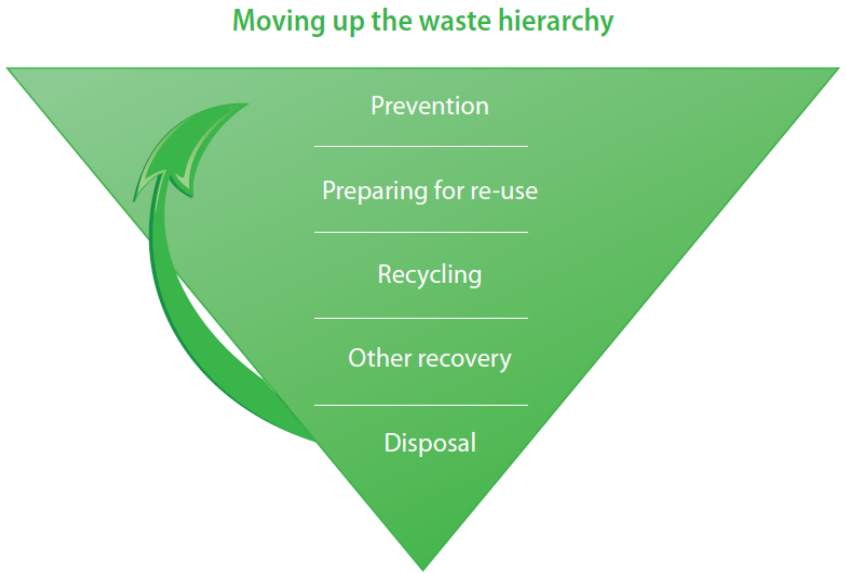
HORIZONTAL LEGISLATION

Horizontal legislation establishes the overall framework for the management of waste.

Council **directive 75/442/EEC of 15 July 1975 on waste** (the "**waste framework directive**" or **WFD**) includes the main definitions and principles concerning waste management. It was comprehensively revised in 1991, 1996 and again in 2008 and finally in 2018 (**Directive (EU) 2018/851**).

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.150.01.0109.01.ENG

WASTE FRAMEWORK DIRECTIVE



In essence, the WFD requires Member States to give priority to

- **Waste prevention** and to
- **encourage re-use and recovery of waste**.

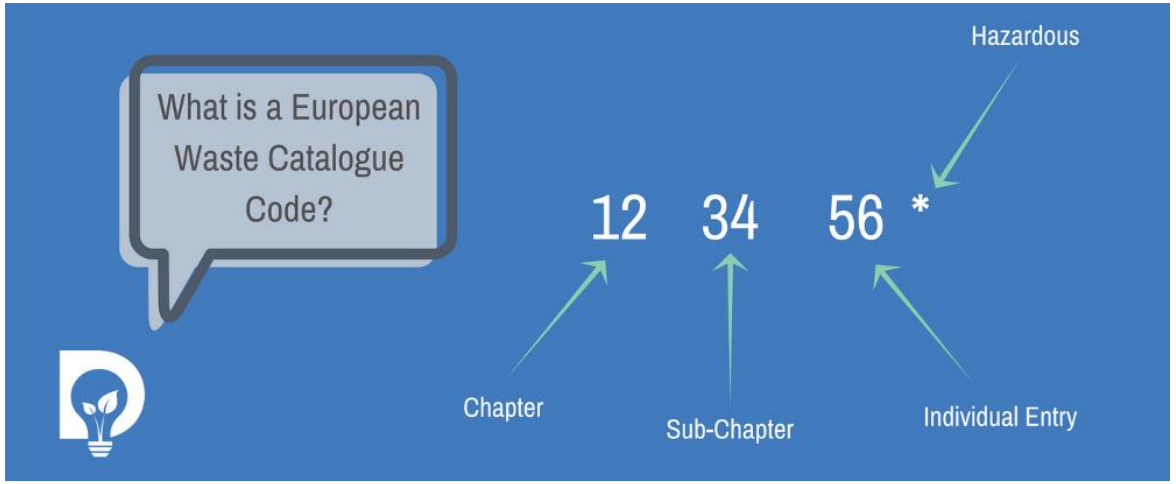
- Member States must also ensure that waste is recovered and disposed of **without endangering human health** and
- **without using processes or methods which could harm the environment**.

- The directive also requires Member States to draw-up **waste management plans** and to establish a system for the authorization of waste management installations.

WASTE FRAMEWORK DIRECTIVE

The WFD defines : "**Waste means any substance or object that the holder discards, intends to discard, or is required to discard**." Annex I of the WFD lists 16 categories of waste.

In practice, waste classification is based on the European List of Waste, which assigns six-digit codes and identifies hazardous entries with an asterisk.



Finally, the Waste Framework Directive (EU) 2008/98/EC (updated in 2018 - Directive (EU) 2018/851) sets criteria for By-products and End of Waste process

WASTE FRAMEWORK DIRECTIVE

What are the end-of-waste criteria, and why are they needed?

The material must have a specific use, an existing market or demand, comply with applicable technical and legal requirements, and not cause overall adverse environmental or human-health impacts.

According to Article 6 of the WFD 2008/98/EC, certain specified waste shall cease to be waste when it has undergone a recovery (including recycling) operation and complies with specific criteria to be developed in line with certain legal conditions, in particular:

- *the substance or object is commonly used for specific purposes;*
- *there is an existing market or demand for the substance or object;*
- *the use is lawful (substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products);*
- *the use will not lead to overall adverse environmental or human health impacts.*

Examples: a plywood panel made with a certain percentage of packaging wood chips, a fleece jacket made from waste plastic bottles ...

WASTE FRAMEWORK DIRECTIVE

Hazardous Waste Directive & Waste Shipment regulation

Council directive 91/689/EEC of 12 December 1991 on hazardous waste, as amended, complements the WFD for hazardous waste.
Annex III of the directive lists 15 properties of waste which render them hazardous within the meaning of the directive.

The directive also contains substantive requirements concerning, for example :

- ✓ the **permitting of installations handling hazardous waste**.
- ✓ **it contains additional requirements concerning**, for example,
  - **limitations of mixing** of hazardous waste,
  - **record keeping** and the **shipment of waste at national level**, which must be accompanied by a **tracking form**.

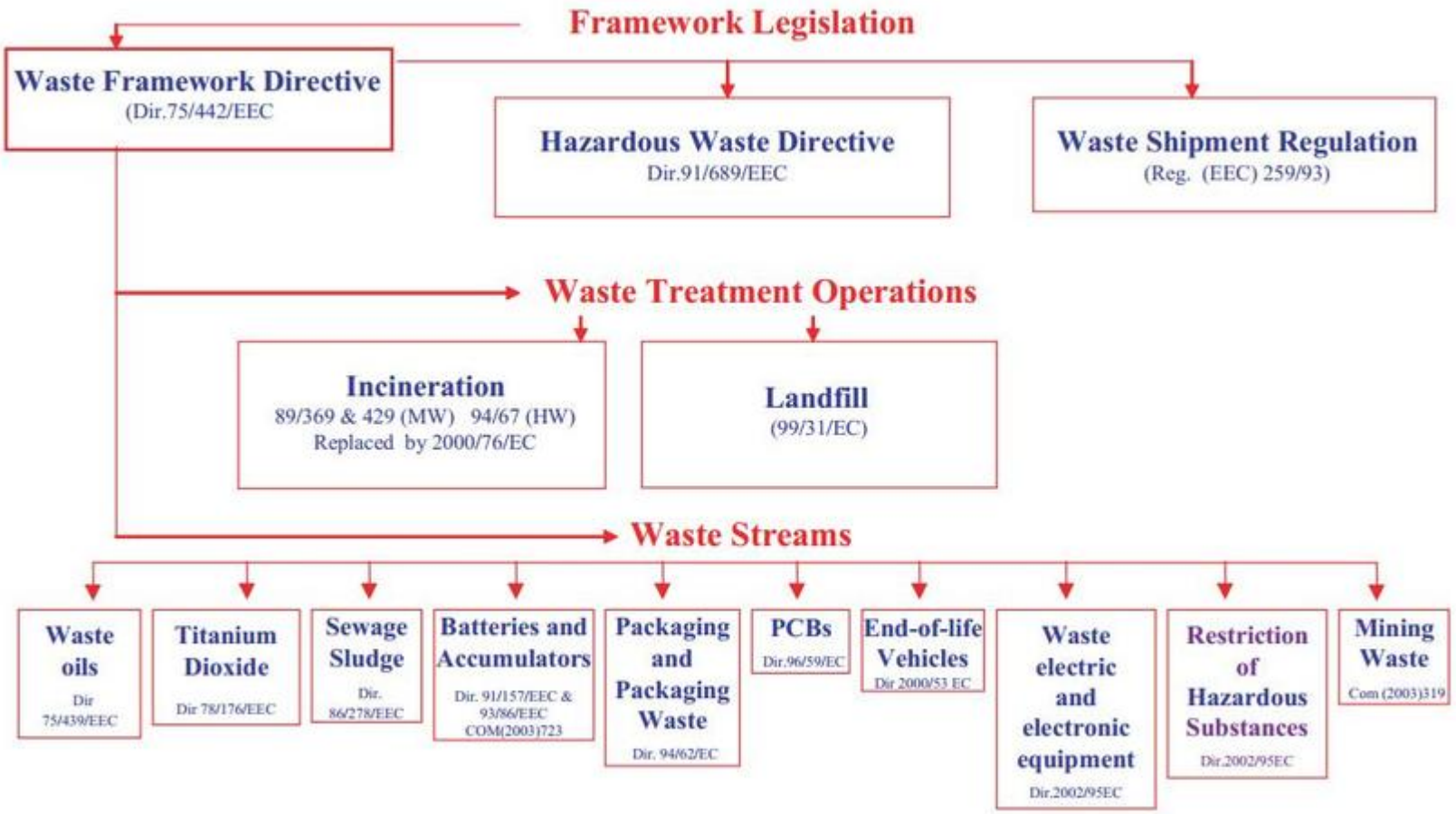
The Community has also adopted legislation concerning the **cross-border shipment of waste.** The main legal instrument in this field is **Council regulation (EEC) No 259/93 of 1 February 1993 on the supervision and control of shipments of waste** within, into and out of the European Community, as amended.

Hazardous waste – List of hazardous properties

H1	"Explosive": substances and preparations which may explode under the effect of flame or which are more sensitive to shocks or friction than dinitrobenzene.
H2	"Oxidising": substances and preparations which exhibit highly exothermic reactions when in contact with other substances, particularly flammable substances.
H3A	"Highly Flammable" - liquid substances and preparations having a flashpoint of below 21°C (including extremely flammable liquids), or - substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or - solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or - gaseous substances and preparations which are flammable in air at normal pressure, or - substances and preparations which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities.
H3B	"Flammable": liquid substances and preparations having a flashpoint equal to or greater than 21°C and less than or equal to 55°C.
H4	"Irritant": non-corrosive substances and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation.

H5	"Harmful": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve limited health risks.
H6	"Toxic": substances and preparations (including very toxic substances and preparations) which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death.
H7	"Carcinogenic": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence.
H8	"Corrosive": substances and preparations which may destroy living tissue on contact.
H9	"Infectious": substances containing viable micro-organisms or their toxins which are known or reliably believed to cause disease in man or other living organisms.
H10[2]	"Toxic for reproduction": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may produce or increase the incidence of non-heritable adverse effects in the progeny and/or of male or female reproductive functions or capacity.
H11	"Mutagenic": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce hereditary genetic defects or increase their incidence.
H12	Substances and preparations which release toxic or very toxic gases in contact with water, air or an acid.
H13	Substances and preparations capable by any means, after disposal, of yielding another substance, e.g. a leachate, which possesses any of the characteristics listed above.
H14	"Ecotoxic": substances and preparations which present or may present immediate or delayed risks for one or more sectors of the environment.
HP 15	'Yielding another substance': waste capable of exhibiting a hazardous property listed above not directly displayed by the original waste.

EC WASTE LEGISLATION



– horizontal legislation;

– legislation on waste treatment operations;

– legislation on specific waste streams.

LEGISLATION ON WASTE TREATMENT OPERATIONS

Landfill

Directive 1999/31/EC of 26 April 1999 on the landfill of waste ("the landfill directive") sets out a number of administrative requirements, including:

- **permit conditions**,
- **technical requirements** and **environmental standards** applying to landfills accepting various categories of waste (**inert, non-hazardous and hazardous waste**),
- **reduction of biodegradable waste** disposed of in landfills,
- **banning of the landfilling of certain types of waste**, such as liquid wastes, infectious waste and most tires.

LEGISLATION ON WASTE TREATMENT OPERATIONS

Landfill terminology

Use consistently:

- **landfill** for the general facility;
- **landfill cell** for a specific engineered compartment;
- **leachate** rather than “lixiviate”;
- **landfill gas** or **biogas** depending on the context;
- **hazardous-waste landfill / non-hazardous-waste landfill / inert-waste landfill**.

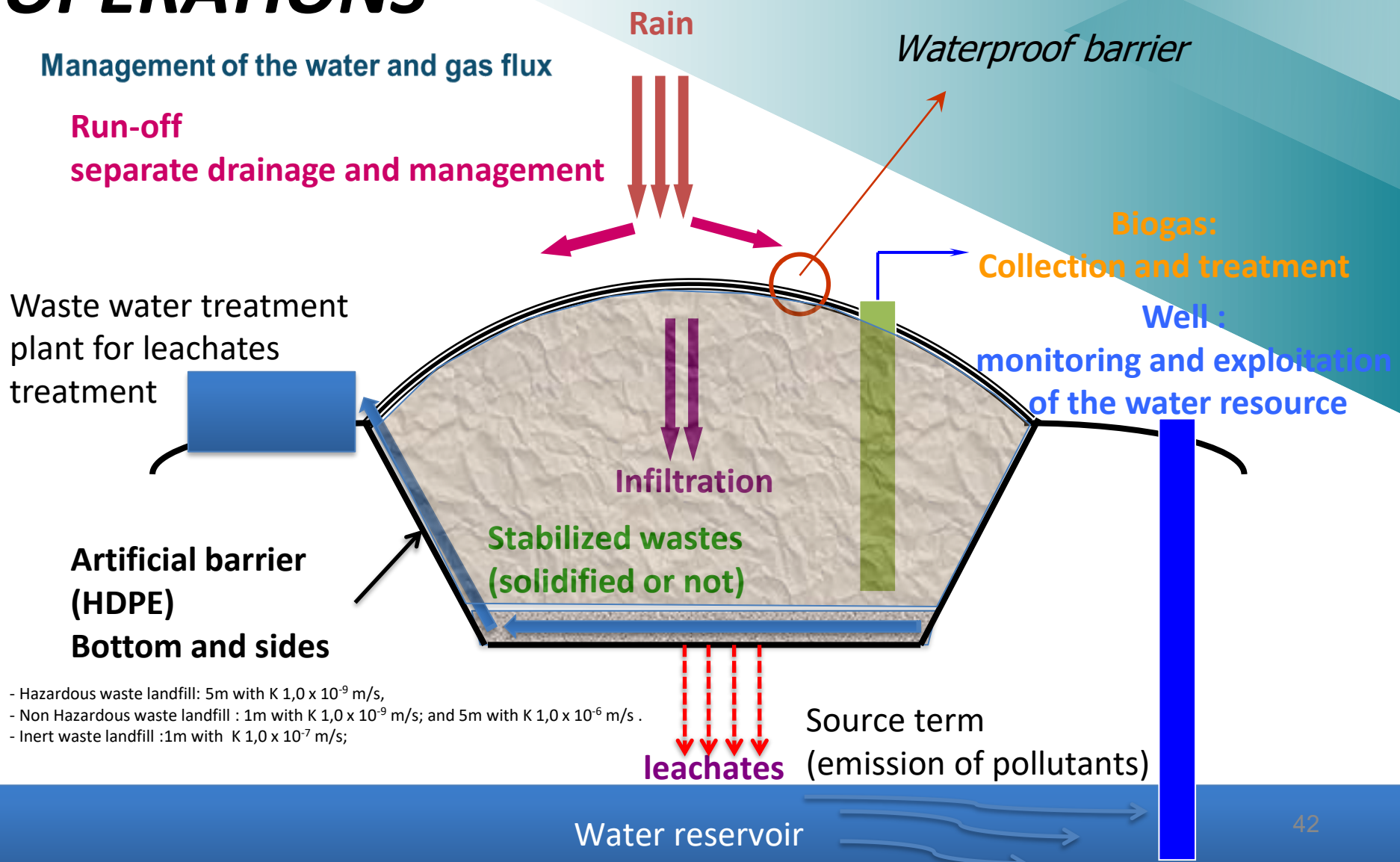
LEGISLATION ON WASTE TREATMENT OPERATIONS

Main principles to ensure environmental protection

The landfill directive also requires **all costs** relating to the **establishment, operation and closure of a landfill** are **internalized into the price charged by the operator**.

Description and illustration of **general criteria** for the Landfill Directive in order to protect the environment

LEGISLATION ON WASTE TREATMENT OPERATIONS



LEGISLATION ON WASTE TREATMENT OPERATIONS

Criteria for the limitation of the source term (via the leaching of waste prior to acceptance)

	L/S=10 l/kg dry matter in mg/kg			C_0 (essai de percolation) mg/l		
	inertes	non dangereux	dangereux	inertes	non dangereux	dangereux
As	0,5	2	25	0,06	0,3	3
Ba	20	100	300	4	20	60
Cd	0,04	1	5	0,02	0,3	1,7
Cr total	0,5	10	70	0,1	2,5	15
Cu	2	50	100	0,6	30	60
Hg	0,01	0,2	2	0,002	0,03	0,3
Mo	0,5	10	30	0,2	3,5	10
Ni	0,4	10	40	0,12	3	12
Pb	0,5	10	50	0,15	3	15
Sb	0,06	0,7	5	0,1	0,15	1
Se	0,1	0,5	7	0,04	0,2	3
Zn	4	50	200	1,2	15	60
Chlorures	800	15 000	25 000	460	8500	15 000
Fluorures	10	150	500	2,5	40	120
Sulfates	1 000,00	20 000	50 000	1500	7000	17 000
Indice phénols	1	-		0,3	-	
COT sur éluat **	500	800	1000	160	250	320
FS (fraction soluble)***	4 000	60 000	10 000	-	-	

10%

LEGISLATION ON WASTE TREATMENT OPERATIONS



The makeover of one of Europe's largest landfills

https://www.youtube.com/watch?v=c36kP3vp_kk

International Finance Corporation

LEGISLATION ON WASTE TREATMENT OPERATIONS

Incineration

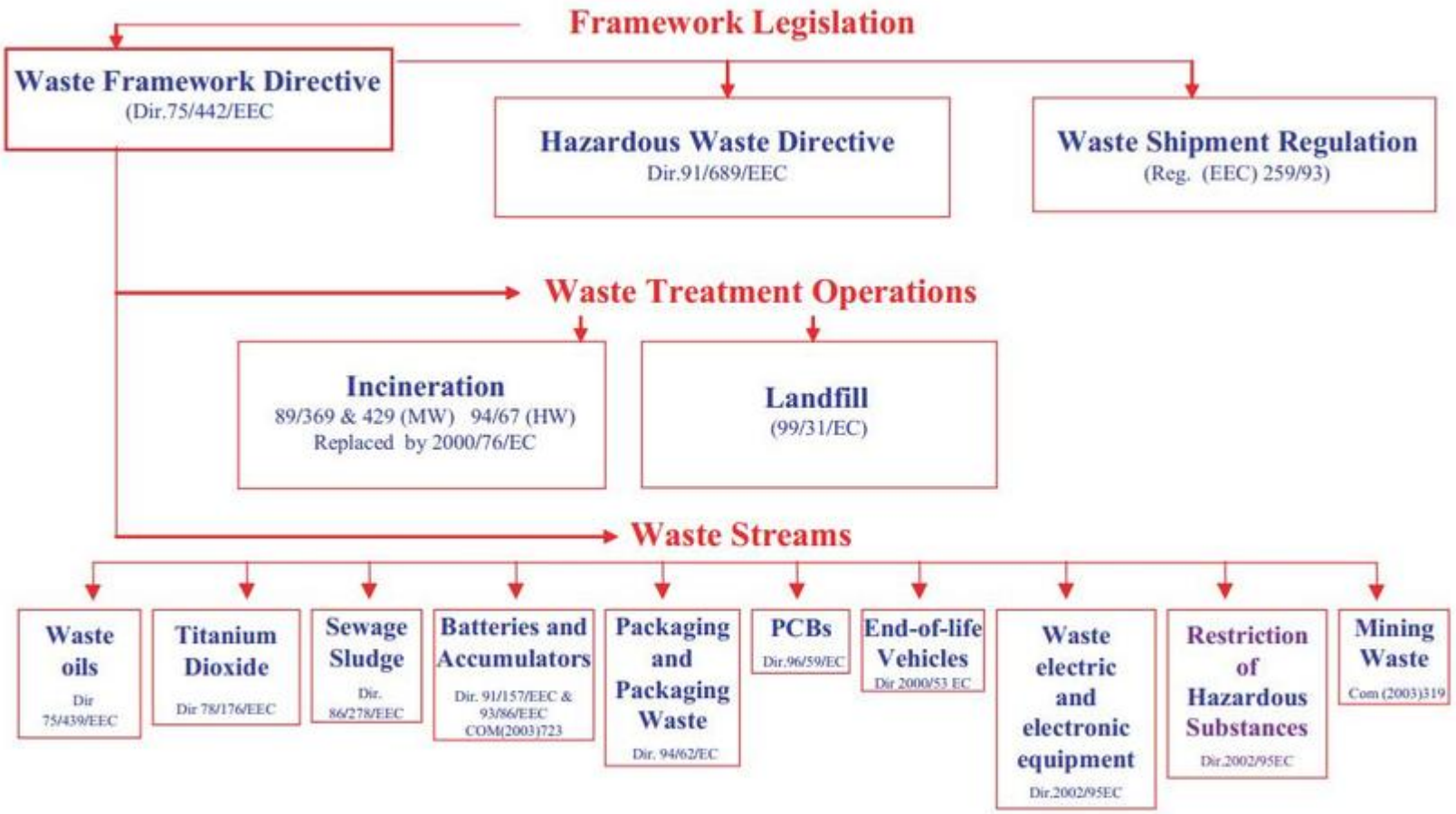
Directive 2000/76/EC was subsequently integrated into the Industrial Emissions Directive 2010/75/EU. Current requirements for waste incineration are based on the IED, its amendments and the applicable BAT conclusions

The directive establishes the **permitting conditions** for incineration plants, including under abnormal operating conditions, as well as limit values in relation to, for example, emissions to air and discharges to water.

The directive includes requirements concerning **waste incineration**, **co-incineration**, **air emissions, water discharges**, and **incineration residues**.

Finally, it also includes requirements on **control, monitoring and measurement**.

EC WASTE LEGISLATION



- horizontal legislation;
- legislation on waste treatment operations;
- **legislation on specific waste streams.**

SPECIFIC WASTE STREAMS

- **The directive on Waste Electrical and Electronic Equipment (WEEE) adopted in January 2003** contains a number of targets concerning the recovery of WEEE – these are described in Article 6 and must be met since the 31 December 2006. The recycling targets range from 50% to 80% depending on the type of equipment and recovery rates are also set for the different types of equipment. This directive also makes producer responsibility mandatory.

- **…**

SPECIFIC WASTE STREAMS

- **Extended Producer Responsibility (EPR)** is a policy approach under which producers are given responsibility — financial and/or operational — for the management of products when they become waste.

- EPR applies the polluter-pays principle to products placed on the market.
- Producers may comply individually or collectively through an approved producer responsibility organization.
- EPR can finance collection, sorting, reuse, repair, recycling and, in some cases, cleanup of abandoned waste.
- EPR is also intended to encourage eco-design, durability, reparability and recyclability.

SPECIFIC WASTE STREAMS

- **EPR does not mean that all waste-management costs are automatically covered. The level of financial and operational support depends on the scheme, the contract and the applicable rules.**

- **The OECD's guidance identifies principles on the use of EPR, outlines possible options and details the benefits and trade-offs of different approaches. In this way, the OECD helps to harmonize the use of EPR schemes across countries.**

ERP: Basic facts and key principles : https://www.oecd.org/en/publications/extended-producer-responsibility_67587b0b-en.html

LECTURES OVERVIEW



- Introduction - Waste system
- Classification and current legislation
- **Sustainable waste management**

FRANCE: KEY WASTE FIGURES — REFERENCE YEARS VARY BY INDICATOR

The national context

- 307 million t of waste are generated in France each year, ≈ 4.5 t per inhabitant.
- Municipal and similar waste (DMA*): 37.8 million t, ≈ 559 kg per inhabitant.
- 50% of municipal and similar waste directed to material or organic recovery in 2023; target: 60% in 2030.
- Public waste-management service: €11.1 billion per year, about €162 per inhabitant.
- Source-separation of food waste was available to 51.6% of the population in the data reported by AMORCE.

**French abbreviation DMA includes household waste and similar waste from small businesses, shops and public facilities when handled by the public service.*

RESIDUAL HOUSEHOLD WASTE: A SYSTEM DIAGNOSIS

Only 31% of residual household waste is "genuinely residual".

- 37% falls within extended producer responsibility (EPR) schemes.
- 32% is biowaste, including food waste and garden waste.
- According to the characterization presented by AMORCE, up to 98% of residual household waste could theoretically be directed toward recovery or another management route. *!!! This does not mean that 98% is effectively recyclable under every local technical, economic and regulatory condition. !!!*
- **Residual waste** reveals failures in product design, collection systems, sorting, prevention and responsibility.

**Indicative potential allocation: 40% org. recovery, 38% mat. recycling & 20% ener. recovery. These percentages are characterization-based estimates, not guaranteed local performance targets.*

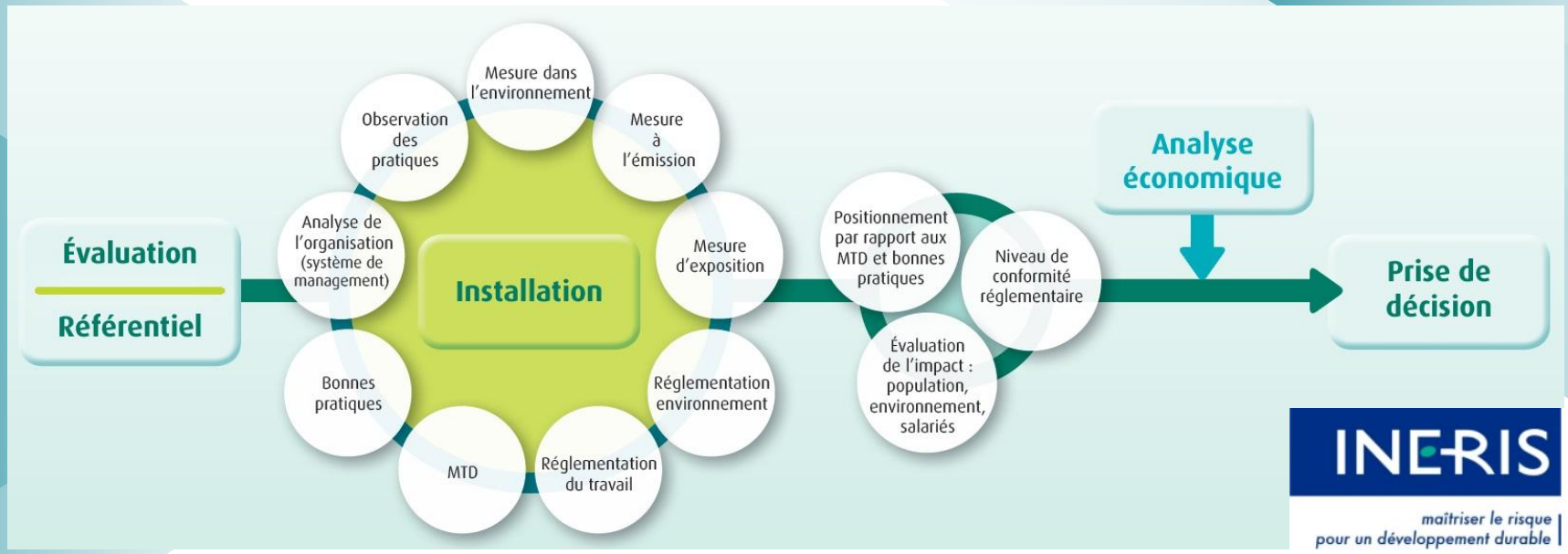
CIRCULARITY MUST BE DEMONSTRATED

A material should not circulate indefinitely merely to increase a recycling rate.

- Each loop may concentrate contaminants, degrade material quality, consume energy or generate residual waste.
- Ask: how much material is actually recovered? What energy and transport are required?
- Ask: what happens to residues? Are contaminants destroyed, immobilized or transferred?
- Ask: does the secondary material actually replace virgin material?
- Use a multi-criteria assessment and life-cycle assessment (LCA) to demonstrate an overall environmental benefit.

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Waste Management and Best Available Techniques (BAT) in relation to Life Cycle Assessment (LCA)

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INTRODUCTION

In a world where resource management and the reduction of environmental impacts are becoming crucial, businesses and communities must adopt innovative and sustainable techniques to manage waste.



- **Concept of Best Available Techniques (BAT): the most effective and advanced stage of development of activities and their operating methods, allowing the avoidance and, when that is not possible, the reduction of emissions and the overall environmental impact.**

- **By techniques, we mean the technologies used (production processes and/or waste treatment methods), but also the design of the installation, its construction, maintenance, and operation (organizational arrangements and preventive measures), as well as its decommissioning.**

- **Connection between waste management, Best Available Techniques (BAT), and planetary boundaries**

INTRODUCTION

INDUSTRIAL EMISSIONS DIRECTIVE (IED)

Directive 2010/75/EU on industrial emissions (IED), amended notably by Directive (EU) 2024/1785. It aims to prevent and reduce pollution from installations covered by the directive through an integrated approach.

- Achieve a **high level of protection of the overall environment** and human health through an integrated approach to pollution and consumption prevention and reduction (within the framework of the **BAT concept**).

Scope: Regulatory requirement for the evaluation of environmental performance for most new or existing industrial and agricultural activities.

Environmental limits: Different fields include water, air, soil, waste, energy... and various scales...

INTRODUCTION

EUROPEAN WASTE REGULATION

- What are the benefits of a Best Available Techniques-based approach?



What are the benefits of a Best Available Techniques-based...

https://www.youtube.com/watch?v=d2kprBd8Tk0

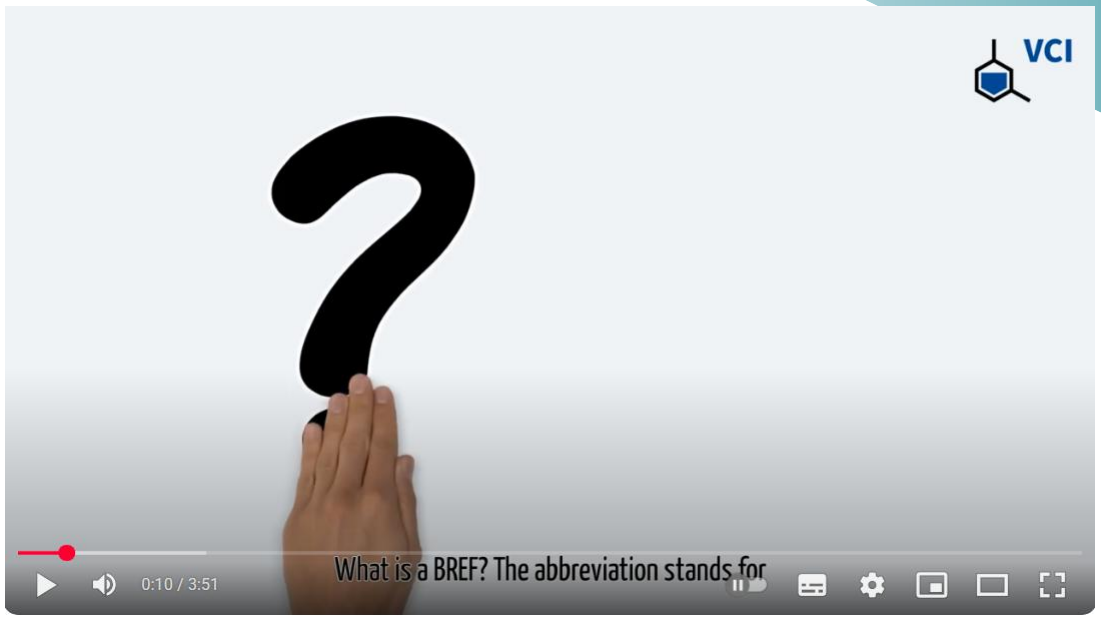
STRIVING FOR THE ECO-COMPATIBILITY OF INDUSTRIAL SYSTEMS

DEFINITION OF BAT (BEST AVAILABLE TECHNIQUES)

- The term "**Best**" refers to techniques that, compared to others, are the most effective in protecting the environment.
- "**Techniques**" includes both the technologies used and the way installations are designed, built, maintained, and operated.
- "**Available**" means that these techniques are developed to a point where they can be realistically applied in the economic and technical conditions of the installation in question, taking into account the costs and benefits.

STRIVING FOR THE ECO-COMPATIBILITY OF INDUSTRIAL SYSTEMS

THE BREF PROCESS EXPLAINED IN SIMPLE TERMS



https://www.youtube.com/watch?v=Rg4AliCcXqY&pp=ygUglINldmlsbGEgcHJvY2VzcyIgRVUgZW52aXJvbm1lbnQ%3D

STRIVING FOR THE ECO-COMPATIBILITY OF INDUSTRIAL SYSTEMS

OBJECTIVES OF BAT

BAT conclusions are adopted through Commission Implementing Decisions and form the regulatory basis for permit conditions for installations covered by the IED.

BAT are implemented to address environmental concerns such as:

- **Reducing emissions into air, water, and soil**
- **Improving energy efficiency**
- **Managing and treating waste**
- **Rational use of raw materials**

BAT = BEST AVAILABLE TECHNIQUES



Criteria for defining BAT :

BAT are selected based on 12 criteria, such as :

- **Efficiency:** How does the technique reduce emissions or resource use?
- **Technical feasibility:** Is the technology feasible with current knowledge and infrastructure?
- **Cost**: Is the implementation cost justified by the environmental benefits obtained?
- **Overall environmental impact:** A local reduction in emissions should not cause an increase elsewhere (e.g., shifting pollution from one medium to another).

This approach leads to the adoption and publication of **BAT reference documents** (BREF).

BAT REFERENCE DOCUMENTS (BREF)

These **documents** result from the exchange of information between member states, industry, and non-governmental organizations. They describe techniques, emissions, and consumption, as well as what will be considered the **Best Available Techniques** for a given sector.

BAT conclusions are adopted by Commission Implementing Decisions. They provide the reference for competent authorities when setting permit conditions, including emission limit values, taking BAT-AELs into account.

The Aida site provides access to BREF documents, national guides related to the IED directive, and a summative search tool that allows full-text keyword searches across all past and current BREF documents in both French and English.

https://aida.ineris.fr/guides/directive-ied

BAT REFERENCE DOCUMENTS (BREF)

A sectoral BREF typically brings together:

- a technical and economic overview of the sector;
- techniques in use and associated consumption / emission data;
- candidate techniques and the BAT selected;
- associated environmental performance and emerging techniques.

Keep the distinction clear: the BREF is the technical reference document; BAT conclusions are adopted by Commission Implementing Decisions.

Always check the current version and applicable conclusions in the EU / national reference sources.

EXAMPLE OF A BREF

https://aida.ineris.fr/guides/directive-ied

https://aida.ineris.fr/guides/directive-ied/documents-bref



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Accueil | Inspection des ICPE | Réglementation | Aide réglementaire | Guides et BREF | Recherche

Documents BREF et conclusions MTD

Seule la version anglaise d'un BREF fait foi.

Pour connaître les BREF en cours de révision, se reporter au site du Bureau Européen IPPC

Pour télécharger la version sommative des documents IPPC/IED (fichier .zip, indexation full text, 700 Mo), cliquer ICI

Pour vous aider à utiliser cette version sommative, un tutoriel est disponible en cliquant ICI

Industries d'activités énergétiques

Code	Titre	BREF	Conclusions sur les MTD	Résumé technique
REF	Raffineries (avril 2015)	Version anglaise	BAT Conclusions 10/2014 corrigées Conclusions sur les MTD corrigées	
LCP	Grandes installations de combustion (juillet 2017)	Version anglaise	Bat conclusions 07/2017 Conclusions sur les MTD	

Production et transformation des métaux

Code	Titre	BREF	Conclusions sur les MTD	Résumé technique

BAT REFERENCE DOCUMENTS (BREF)

Definition of BAT-associated emission levels (BAT-AELs; French: NEA-MTD)

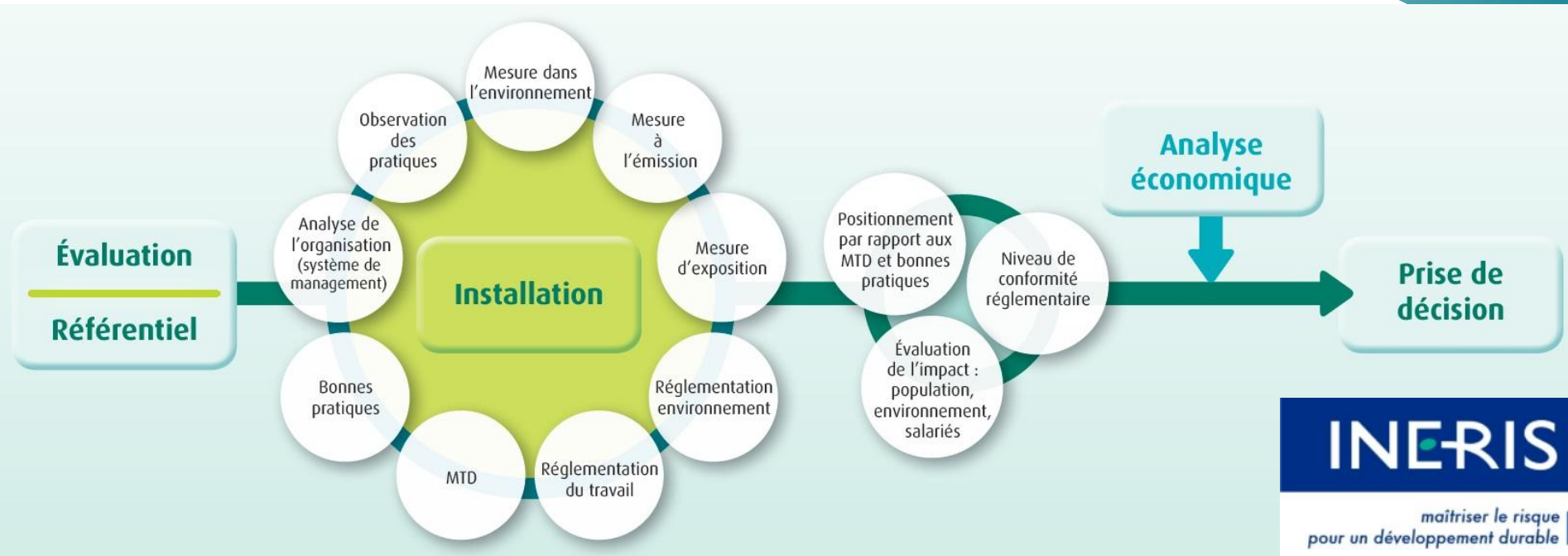
➔ **BAT-associated emission levels (BAT-AELs) are ranges of emission levels obtained under normal operating conditions using BAT or a combination of BAT, expressed under specified reference conditions and over a defined averaging period.**

BAT-AELs are installation-emission benchmarks under specified conditions. They are not ambient-air quality standards, occupational exposure limits or universal public-health thresholds.

STRIVING FOR THE ECO-COMPATIBILITY OF INDUSTRIAL SYSTEMS

1. **Optimization of production processes :**

   → MTD - Eco-design (of processes)
   → **Environmental Management System**
   → Environmental **evaluation** methods, multicriteria analysis, **decision** support tools



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STRIVING FOR THE ECO-COMPATIBILITY OF INDUSTRIAL SYSTEMS

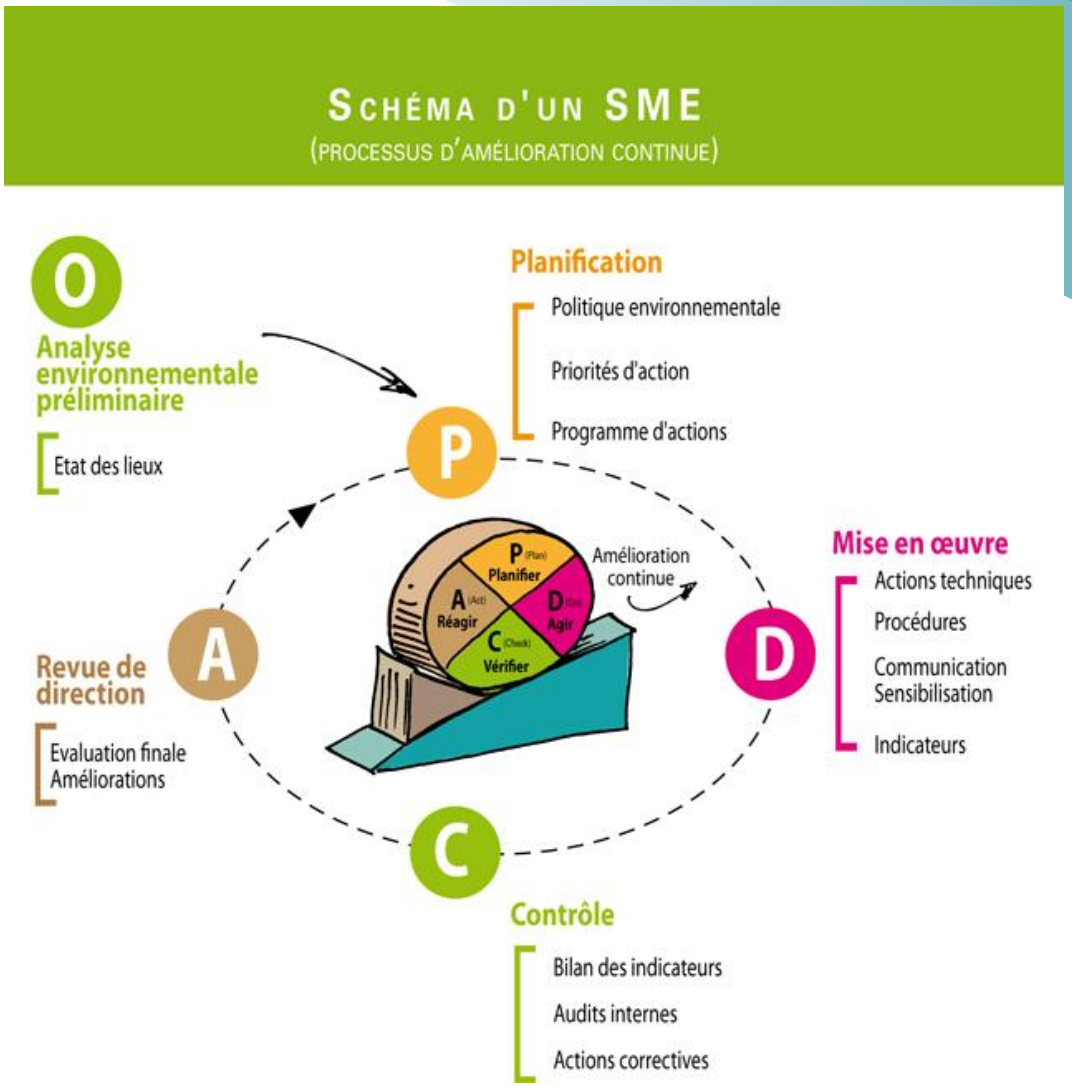
EMS — ENVIRONMENTAL MANAGEMENT SYSTEM.

Management tool aimed at organizing to reduce and control its environmental impacts and continuously improve environmental performance

The following ISO standards describe the SME :

- ISO 14001 specifies requirements for an environmental management system. ISO 14004 provides general guidance for implementation. Environmental auditing is addressed by the ISO 14010/14011/14012 family of standards.

STRIVING FOR THE ECO-COMPATIBILITY OF INDUSTRIAL SYSTEMS



STRIVING FOR THE ECO-COMPATIBILITY OF INDUSTRIAL SYSTEMS

EMS — ENVIRONMENTAL MANAGEMENT SYSTEM.

P:The environmental policy sets the general strategy of the entity and its level of commitment. During the planning stage, the assessment of regulatory non-compliances and the environmental analysis help determine the significant environmental aspects, from which the objectives and the program to achieve them are established.

D:The next step is the implementation and operation of the SME, with the definition of various responsibilities and the implementation of the different constituent actions of the SME.

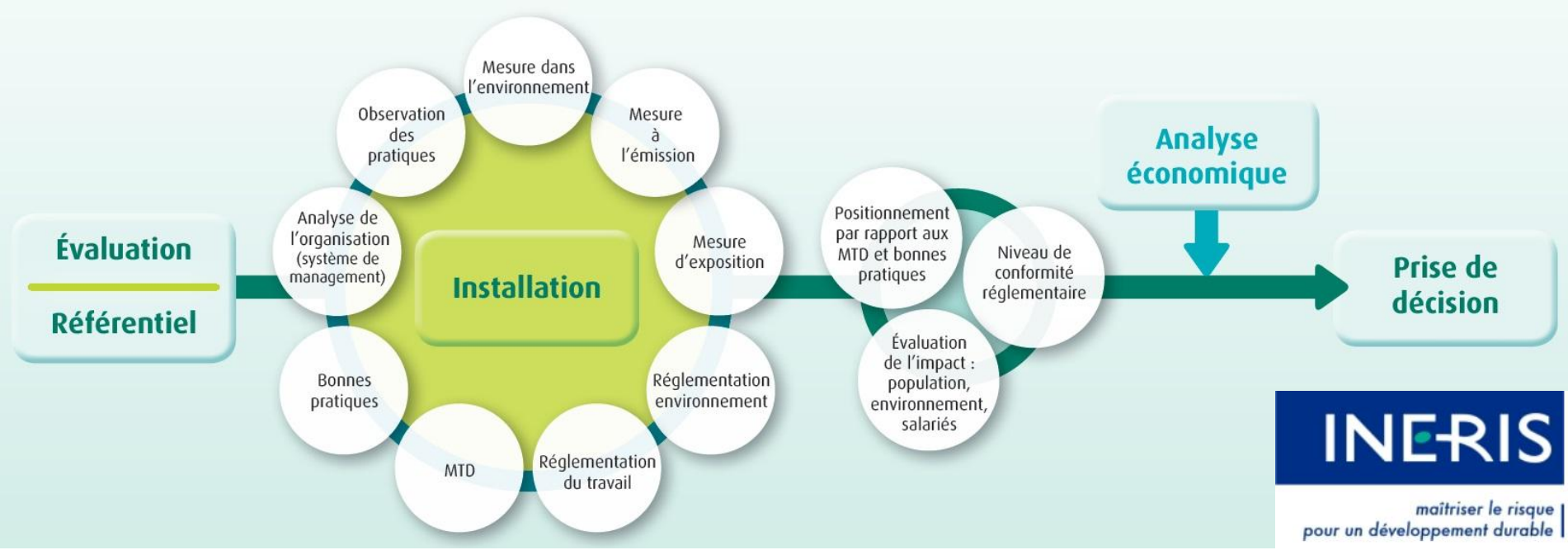
E:It is then important to monitor the actions to determine if their results align with the set objectives. If not, corrective actions should be implemented.

A:Finally, during the management review, an assessment of the SME is carried out, which leads to the evolution of the environmental policy.

STRIVING FOR THE ECO-COMPATIBILITY OF INDUSTRIAL SYSTEMS

1. **Optimization of production processes :**

   → MTD - Eco-design (of processes)
   → Environmental Management System
   → **Environmental evaluation methods, multi-criteria analysis, decision support tools**



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STRIVING FOR THE ECO-COMPATIBILITY OF INDUSTRIAL SYSTEMS

ENVIRONMENTAL EVALUATION METHODS, MULTI-CRITERIA ANALYSIS, DECISION SUPPORT TOOLS

These methods also enable the **eco-design** of processes and products.

The objective of making anthroposystems 'ecocompatible' by controlling environmental impacts involves being able to **identify and quantify these impacts, and to prioritize them if necessary.**

Similarly, in order to promote (or design) the least “penalizing” systems, environmental assessment methods must **enable products or systems to be compared on the basis of all their impacts** => Global assessment

GLOBAL ENVIRONMENTAL EVALUATION METHODS

LCA

Life Cycle Assessment (LCA) evaluates the potential environmental impacts of a product, service or system throughout its life cycle, from raw-material extraction and production to use and end-of-life.



LCA is framed by the ISO 14040 and ISO 14044 standards.

VIDEO | BAT



Best Available Techniques: Insights from the Cement Production and Wa...

1 vues · Il y a 5 jours

YouTube › OECD Chemical Safety and Biosafety

Watch — waste incineration only.

Start at 55:00; stop around 1:20:00 (25 min).

While watching, note:

- **key pollutants and environmental issues;**
- **process-integrated vs end-of-pipe BAT;**
- **what further data an LCA would need.**

Replay: https://youtu.be/5Ut348i-MMs?t=3300

BAT and LCA: two complementary questions

One addresses installation-level performance; the other compares the environmental consequences of a defined system.

BAT — installation and regulation

- Scope: an installation, a process, and its operating conditions.
- Question: which techniques prevent or reduce emissions and resource use?
- References: BREFs, BAT conclusions, BAT-AELs, and permit conditions.
- Role: set performance benchmarks and guide pollution prevention and control.

LCA — life-cycle comparison

- Scope: a system, a functional unit, and clearly defined boundaries.
- Question: which waste-management scenario has the better overall environmental profile?
- Considers several impact categories and relevant upstream / downstream stages.
- Role: compare options, test assumptions, and identify burden shifting.

LCA does not replace legal compliance; BAT alone does not rank every life-cycle scenario.

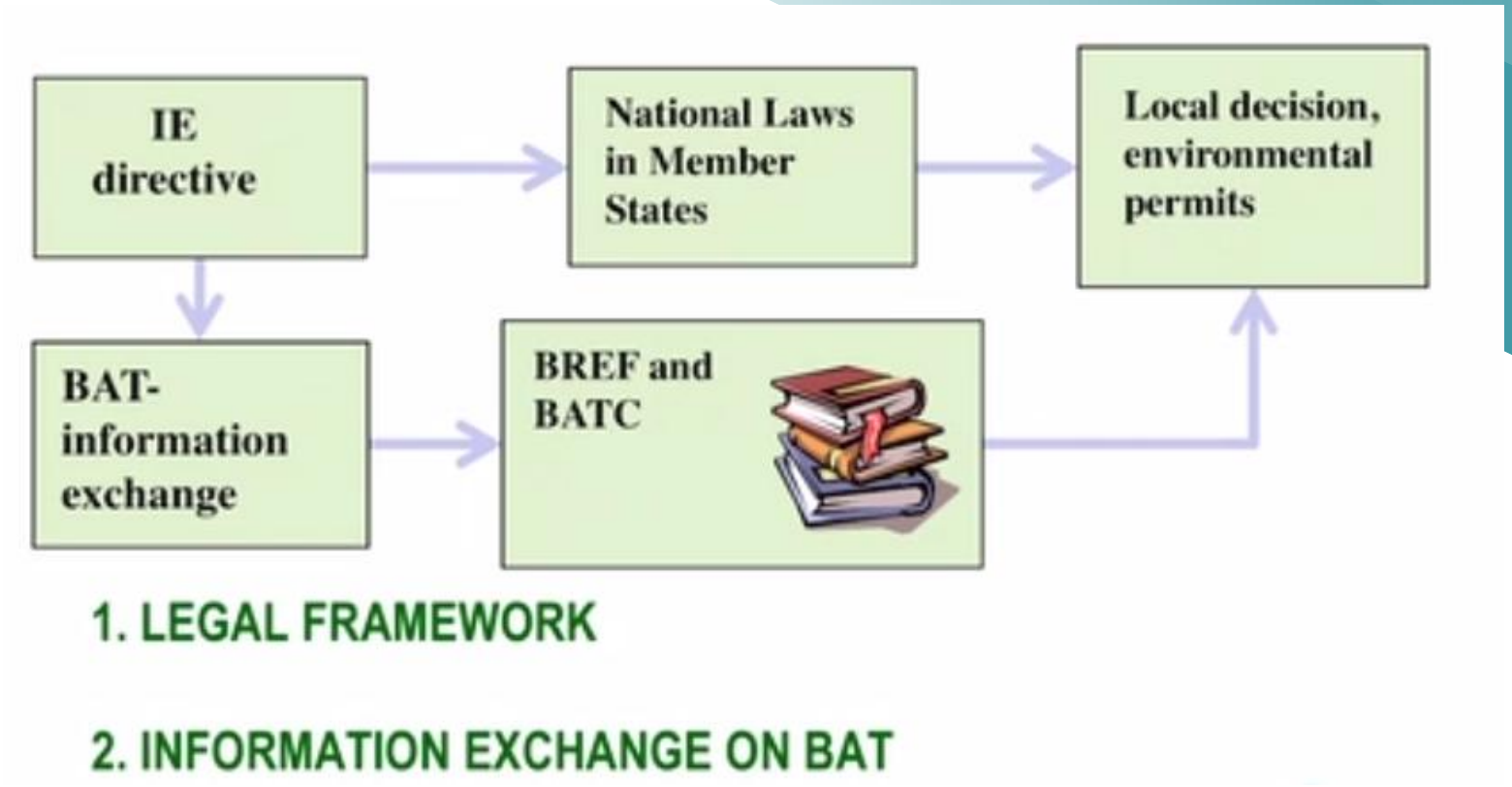
OVERALL CONCLUSION

Waste management is a complex subject, combining technical, regulatory, financial and social aspects, but one in which the stakes are extremely high for local authorities.

Beyond simple disposal, waste management represents an opportunity to develop a circular economy in our territories, through a local approach that enables the development of new activities and the creation of jobs.

APPENDIX

REGULATIONS





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THANK YOU FOR YOUR ATTENTION