

An approach to the economic and environmental sustainable management in hazardous waste stabilization and disposal



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INTRODUCTION: CISMA AMBIENTE S.P.A.

Cisma Ambiente s.p.a. is a waste management society, which includes a waste treatment plant and a *non-hazardous waste landfill*, located in the heavily industrialized area of Priolo-Mellili-Augusta (Sicily), where the presence of massive industrial activities requires a sustainable management of industrial wastes coming from the different companies.



CISMAMBIENTE S.P.A.

❖ Hazardous and non-hazardous waste landfill
(Volume > 500.000 m³)

❖ Chemical-physical treatment plant
for hazardous and non-hazardous wastes.
(Area of 14000 m²)

❖ Deposit (covered deposit > 15000 m³)

❖ Laboratory for analysis and tests

❖ Authorizations (D1, D9, D13, D14, D15,
R3, R4, R5, R8, R11, R12, R13)



CISMAMBIENTE S.P.A.



CISMAMBIENTE S.P.A.: THE TREATMENT PLANT



CISMAMBIENTE S.P.A.: MATURATION BAYS



CISMAMBIENTE S.P.A.: TRANSPORT'S VEHICLES



CISMAMBIENTE S.P.A.: THE LANDFILL BAY

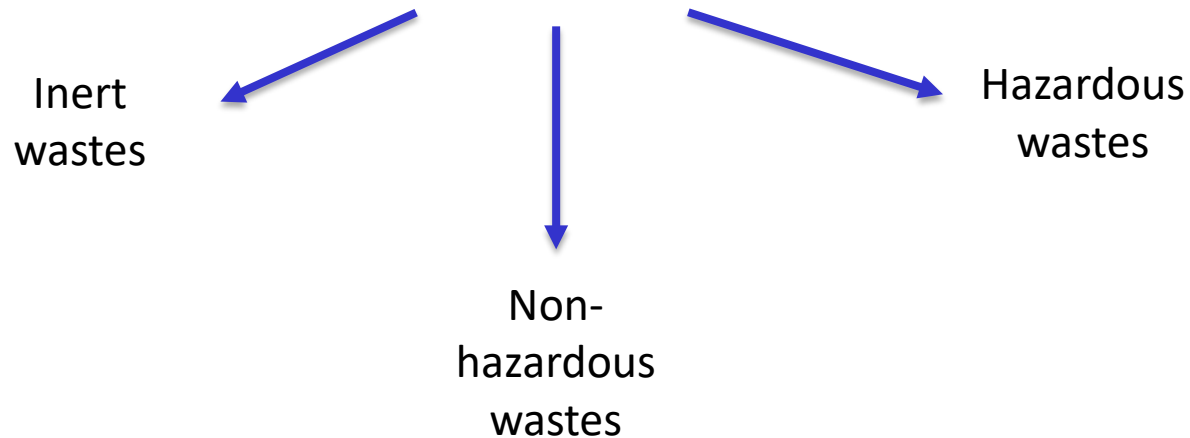


CISMAMBIENTE S.P.A.: THE LABORATORY



WASTE MANAGEMENT & DISPOSAL

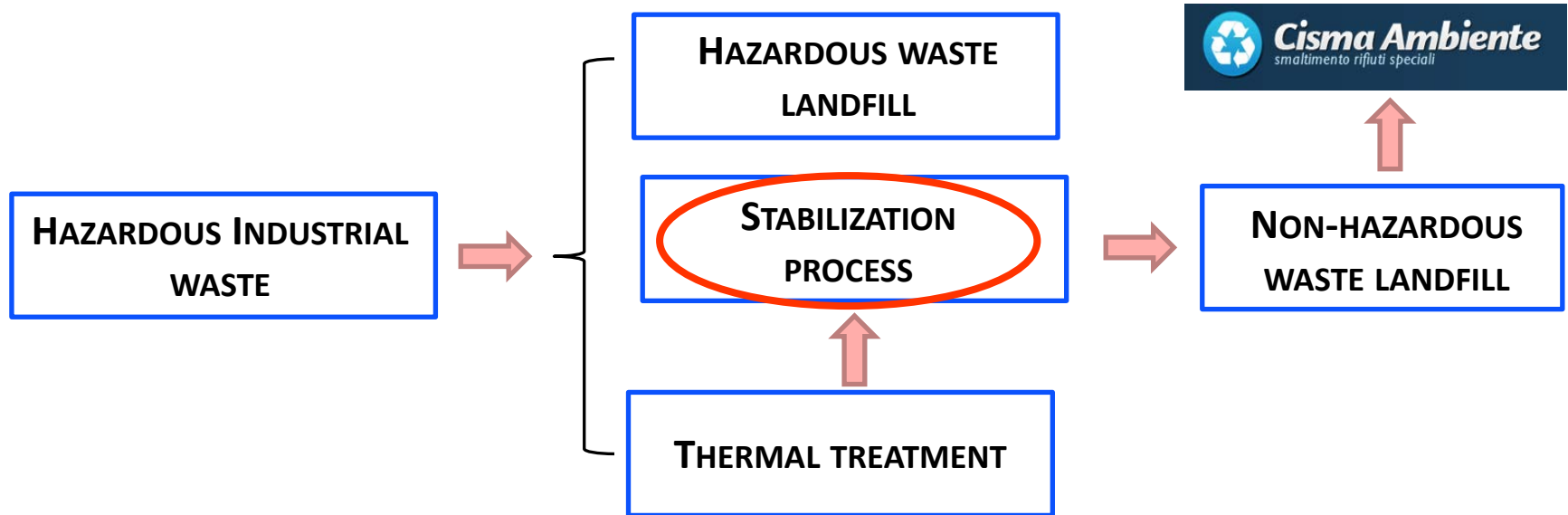
According to EU directives 1999/31 and 2003/33, wastes can be classified in:



In Italy DM 27/09/2010, updated the 24/06/2015, defines the criteria for the eligibility of wastes at landfills and it considers 3 types of landfills:

- Inert wastes (Art.5)
- Non-hazardous wastes (Art.6)
- Hazardous wastes (Art.8)

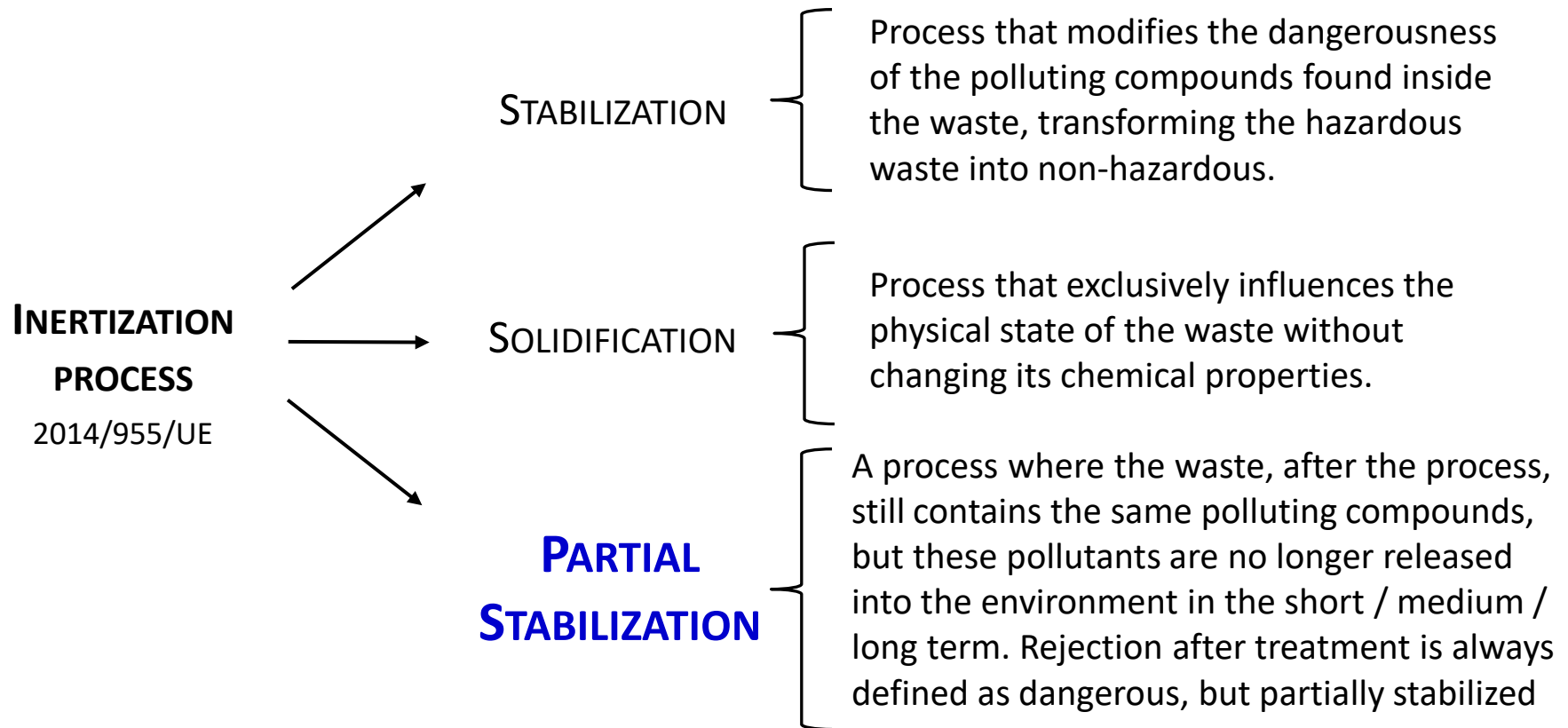
WASTE MANAGEMENT & DISPOSAL



Landfill for non-hazardous waste may be used for “*stable, non-reactive hazardous waste*” (e.g. solidified, vitrified), with leaching behaviour equivalent to those of the *non-hazardous wastes*



INERTIZATION PROCESSES



- All of these processes involve mixing the contaminated waste with binders or other **chemical reagents**
- The additives used can be both inorganic and organic in nature and can also consist of other wastes.

WASTE MANAGEMENT & DISPOSAL

“Stable, non-reactive waste” means that the leaching behavior of the waste will not change adversely in the long-term, under landfill design conditions:

- in the waste (for example, by biodegradation)
- under the effect of long-term landfilling conditions (for example water, air, temperature, mechanical constraints)
- reaction with other wastes (including waste products such as leachate and gas)



DILUTION REQUIREMENTS FOR LANDFILL DISPOSAL OF NON-HAZARDOUS WASTES

- There is only one very specific regulatory prohibition (article 6, co. 2, of Legislative Decree, 36/2003) with regards to dilution or mixing the waste for the sole purpose of making it compliant with the criteria for admissibility to landfills. This prohibition is fulfilled by preventing that the mixing of a waste with other substances will lead to the reduction of contaminant's concentration in the eluate (and therefore will lead to a better compatibility with law limits), only by "mere dilution" .

~~DILUTION~~

MIXING, DILUTION AND MICRO-MIXES

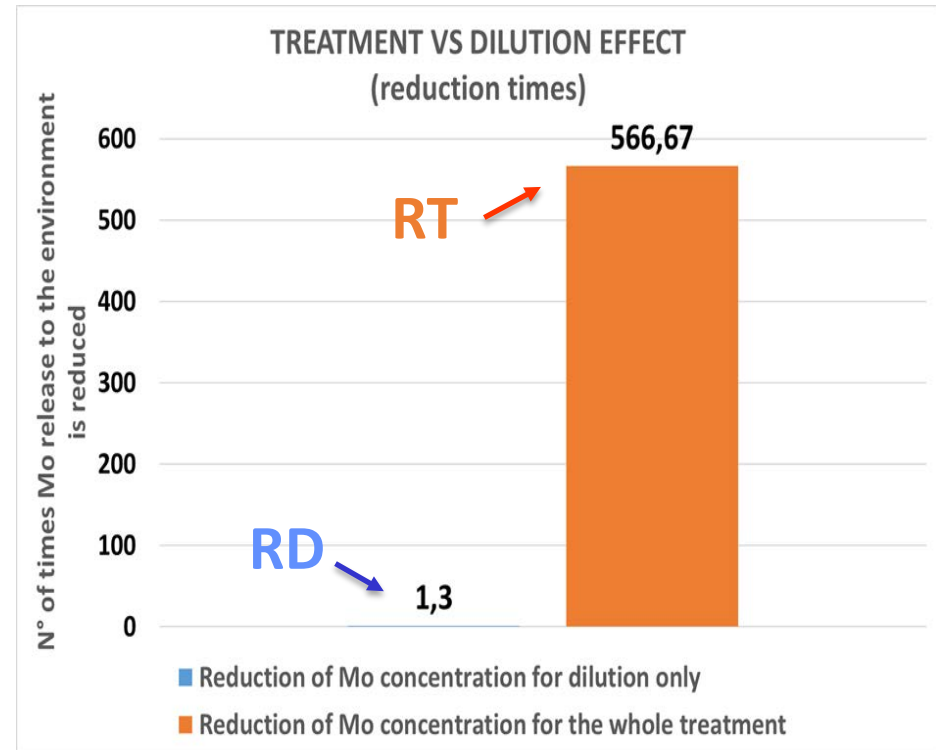


Dilution or not
dilution??



CISMA'S PURPOSE TO REGULATE DILUTION CONTRIBUTION

For compliance with the law (prohibition of diluting or mixing wastes for the sole purpose of making it compliant with the criteria for admissibility in landfill), it must therefore be verified that the dilution carried out in the treatment (obviously unavoidable) and measured by **RDIL** is not such as to guarantee compliance with the landfill eligibility criteria **alone** but vice versa additional chemical-physical treatment must guarantee the reduction of the hazardous characteristics of the waste (reducing the availability of contaminants to transfer to the environment).



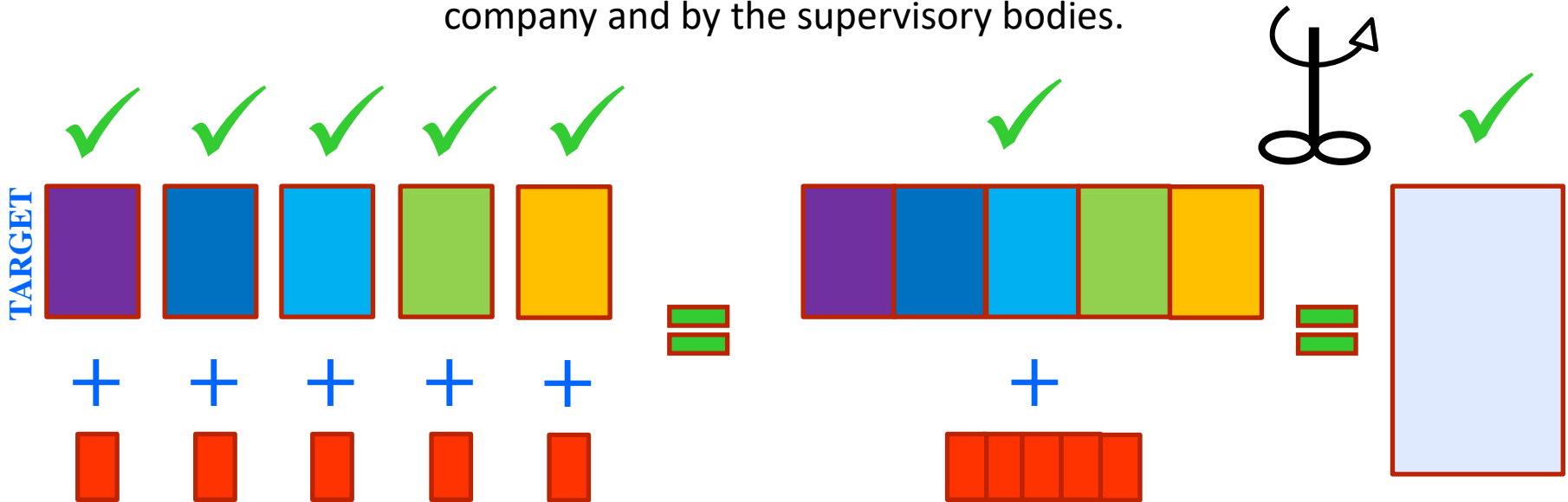
$$\text{RDIL} = \text{RT} / \text{RD} > 1$$

MACRO-MIXES OF HAZARDOUS WASTES WITH LEACHING TEST

COMPLIANT WITH LAW LIMITS

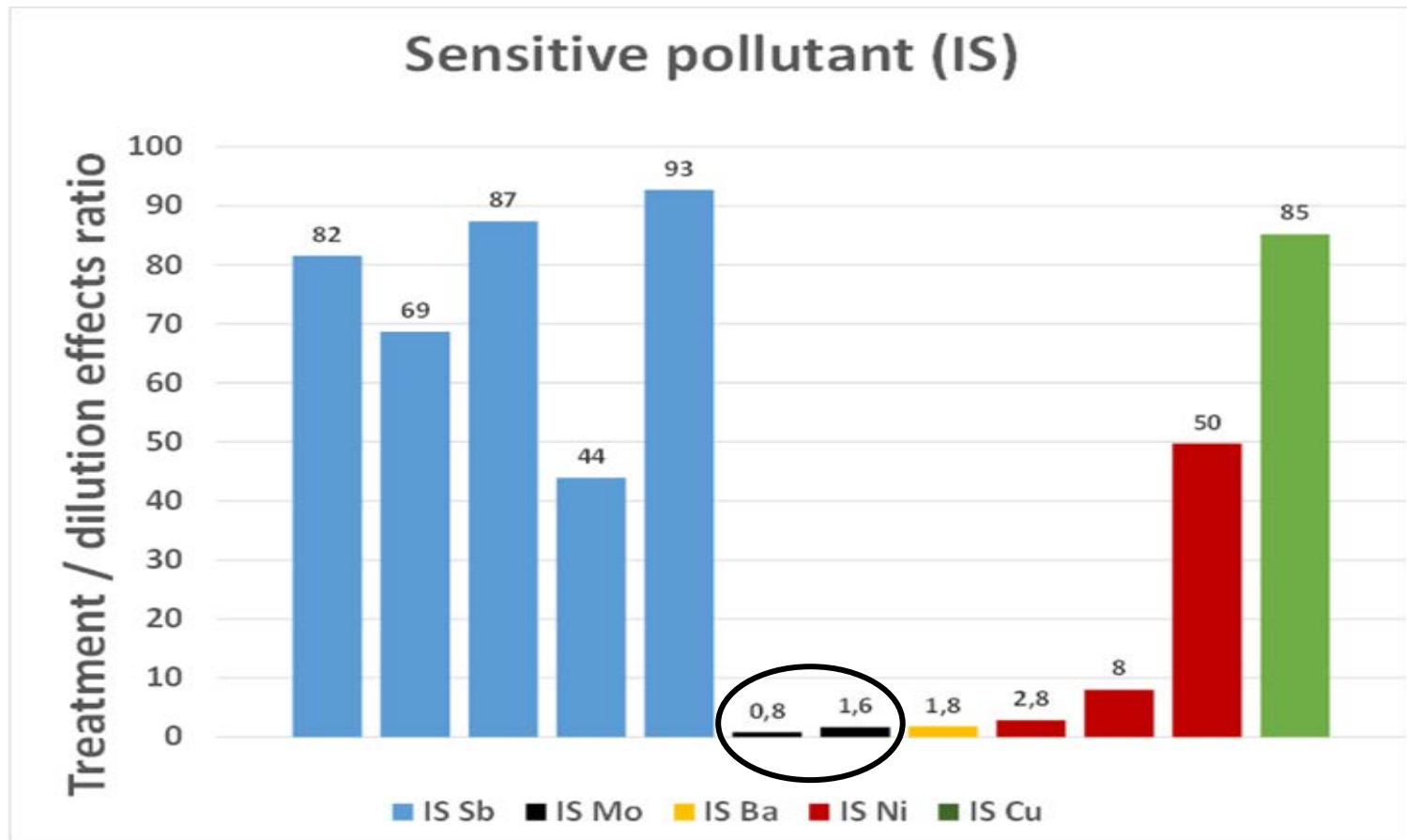
Basically, by acting in this way, one proceeds in an absolutely equivalent manner to process each waste individually, with the identified combination of reagents (having previously ascertained its effectiveness on the worst case).

The pre-homogenization of all waste and reagents therefore becomes only a necessary industrial practice to reach the necessary volumes for a single daily process, having as a further positive consequence that of being able to obtain a result (stabilized or partially stabilized waste) more homogeneous and therefore more easily verifiable. by the company and by the supervisory bodies.



SENSITIVE POLLUTANTS

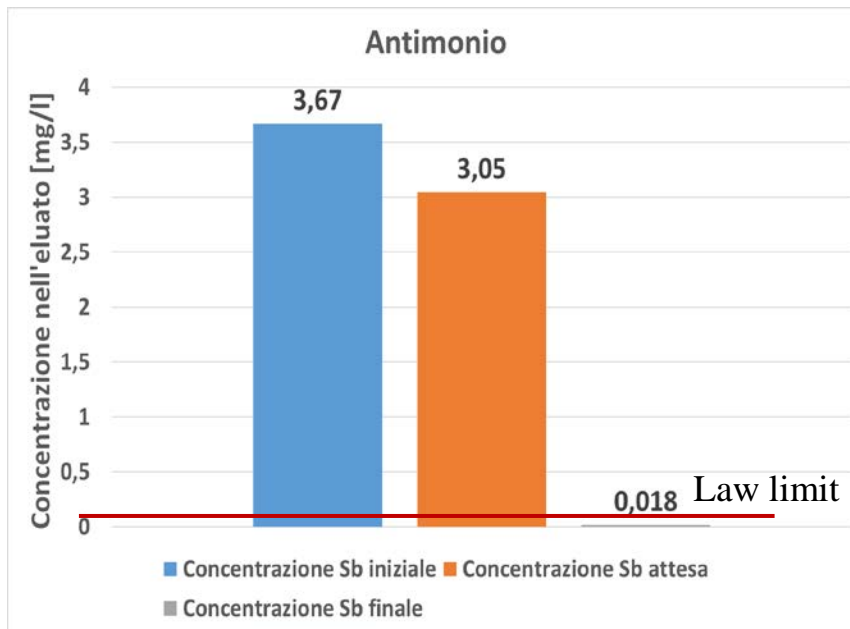
Efficacy of the treatment for different pollutants
(waste treated with calcium oxide and cement)



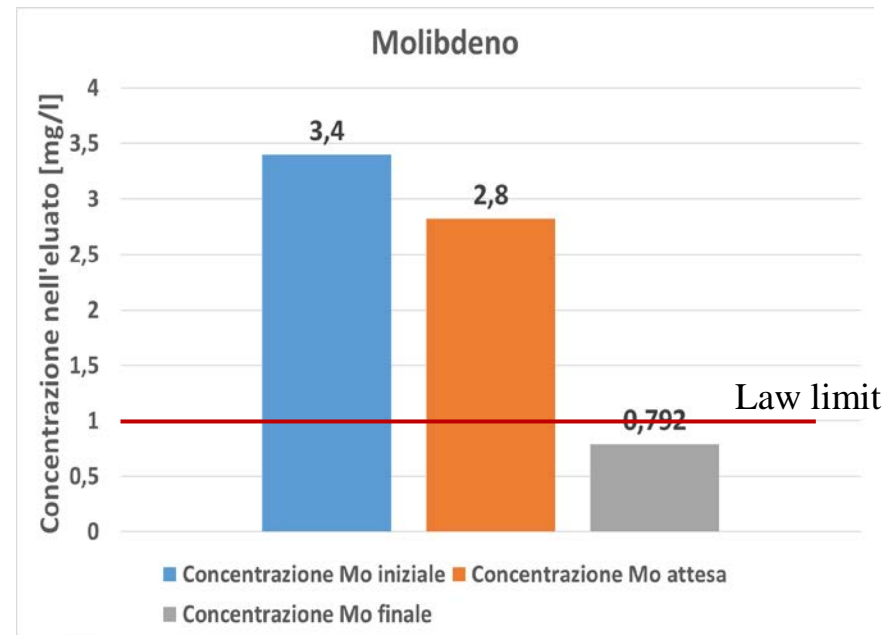
EXAMPLE OF WASTE TREATMENT WITH TWO TARGET CONTAMINANTS

Having verified for both cases the preponderance of the treatment with respect to the mere dilution it can be affirmed that the whole treatment was efficient because both contaminant's releases are below their own law limits

ANTIMONY: EFFICIENT

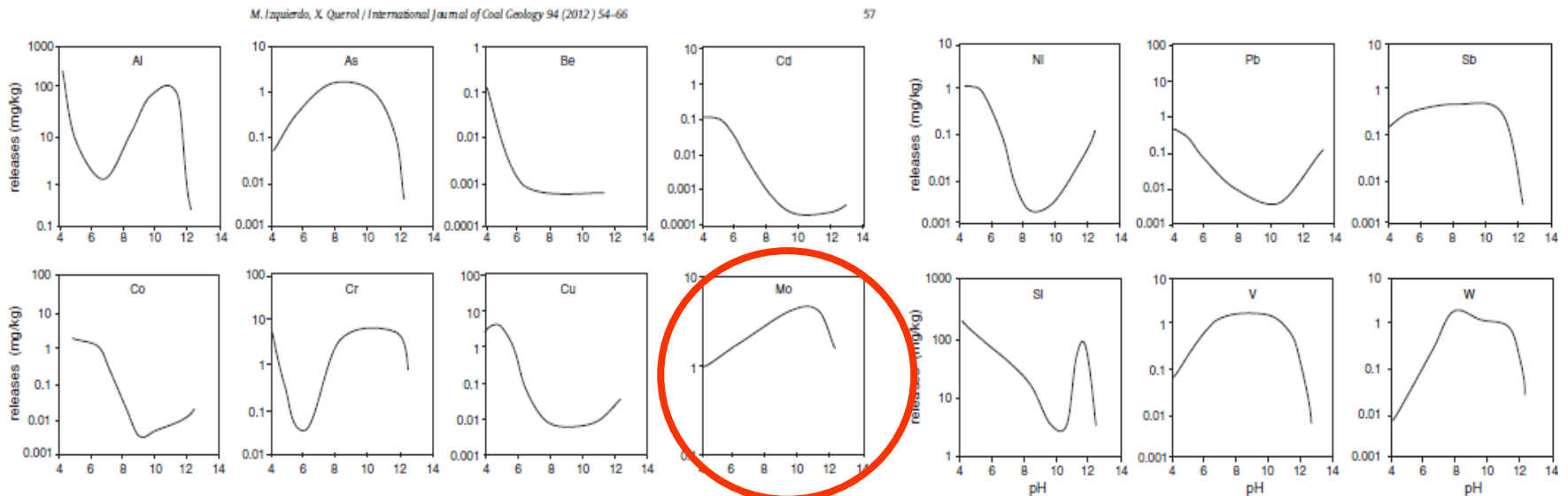


MOLIBDENUM: EFFICIENT

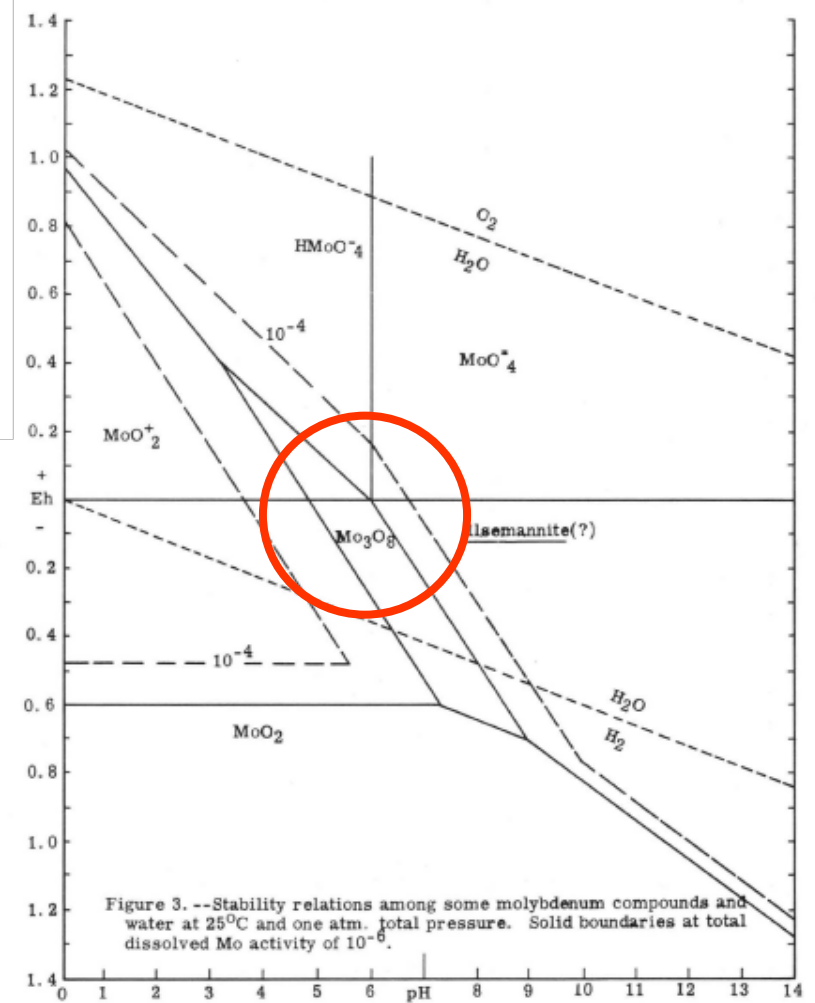
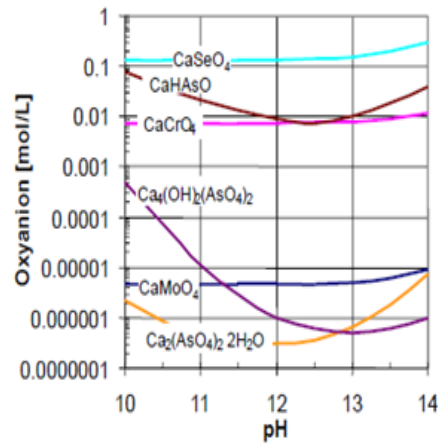
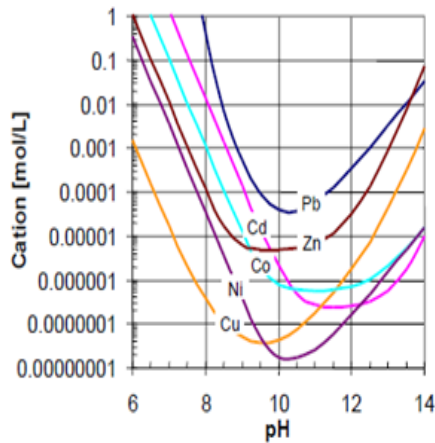
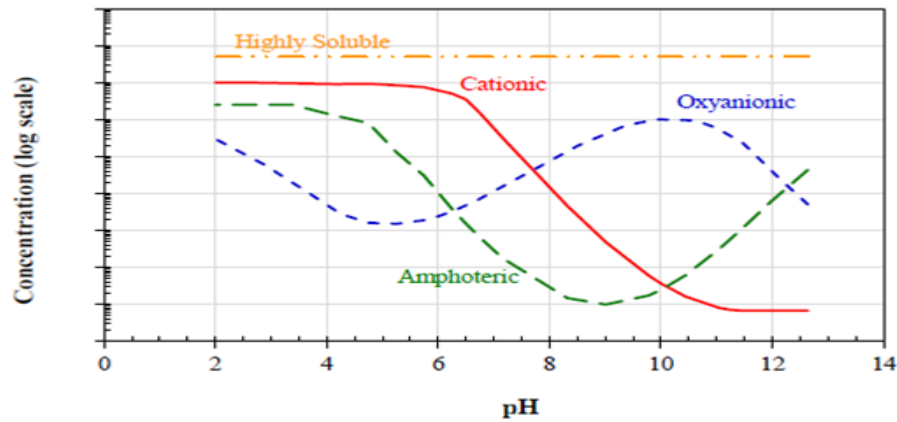


MOLYBDENUM













Molybdenum-containing hazardous solid waste is a special category of waste that requires specific attention as the Molybdenum leaching behaviour **totally differs** from that of most of the metals contained in hazardous solid waste.



MOLYBDENUM



EXAMPLE: FLY ASH TREATMENT WITH FeSO_4 AND H_2SO_4

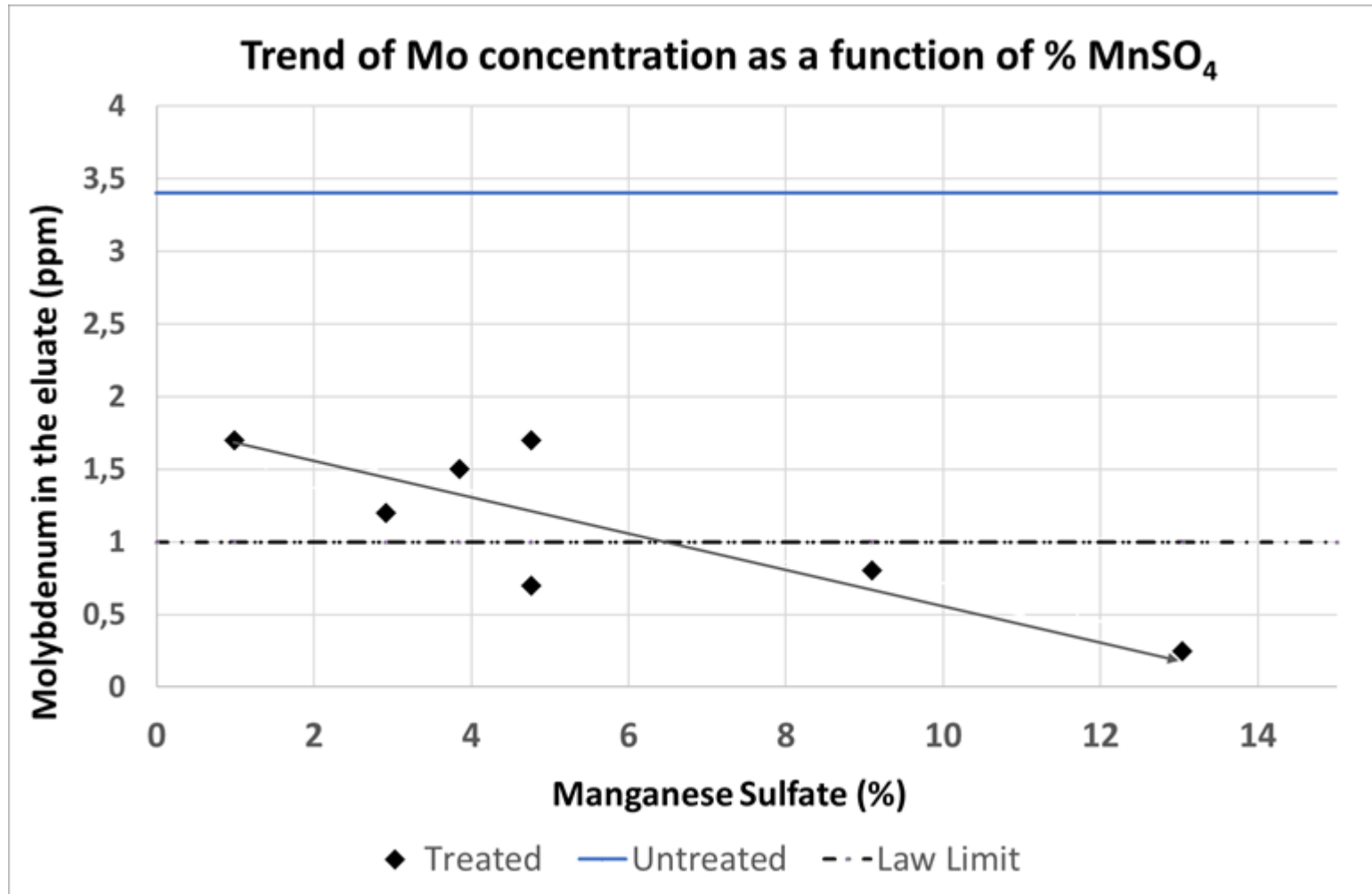
Pollutant	Initial conc. (ppm)	Final conc. (ppm)	Law limit	Behavior
Cr	3,06	0,009	1	
Mo	9,1	0,9	1	
Pb	1,23	0	1	
Ni	0,001	1,24	1	
Zn	0,37	42,1	5	
Cd	0,001	0,45	0,02	
Hg	0	0,015	0,005	
Cu	0,01	0	5	
As	0,032	0	0,2	
Se	0,65	0,177	0,05	
Sb	0,036	0,026	0,07	
Ba	0,093	0,025	10	

EXPERIMENTAL APPROACH: METHODS

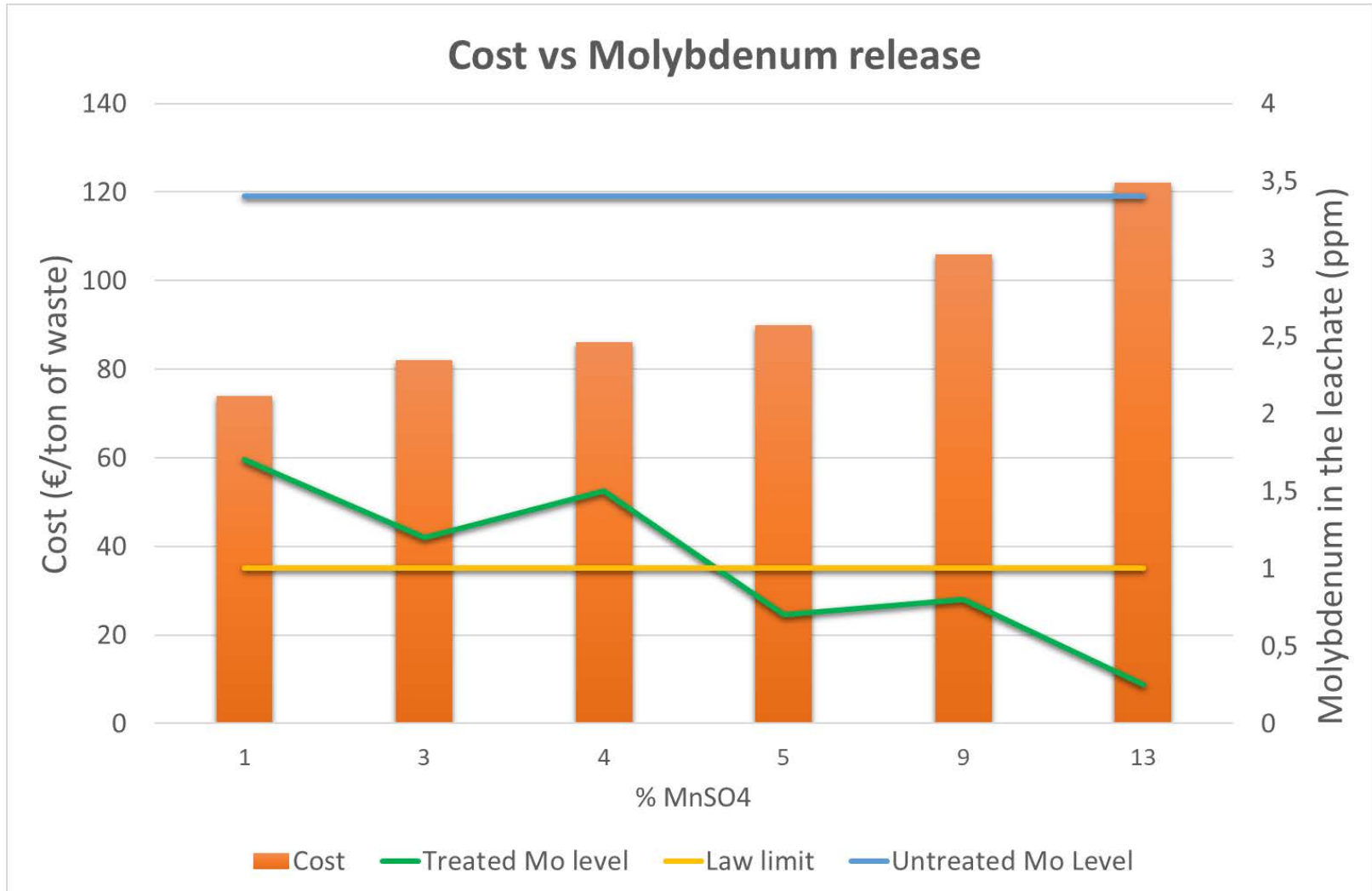
Experiments performed on a **bottom ash** coming from an **incineration plant** (Gespi Incineration plant) :

Waste	Reagent	(%)	Cost of reagent
Bottom ash	Manganese sulfate	1-13%	400 €/ton
Bottom ash	Ferrous sulfate	5-25%	270 €/ton

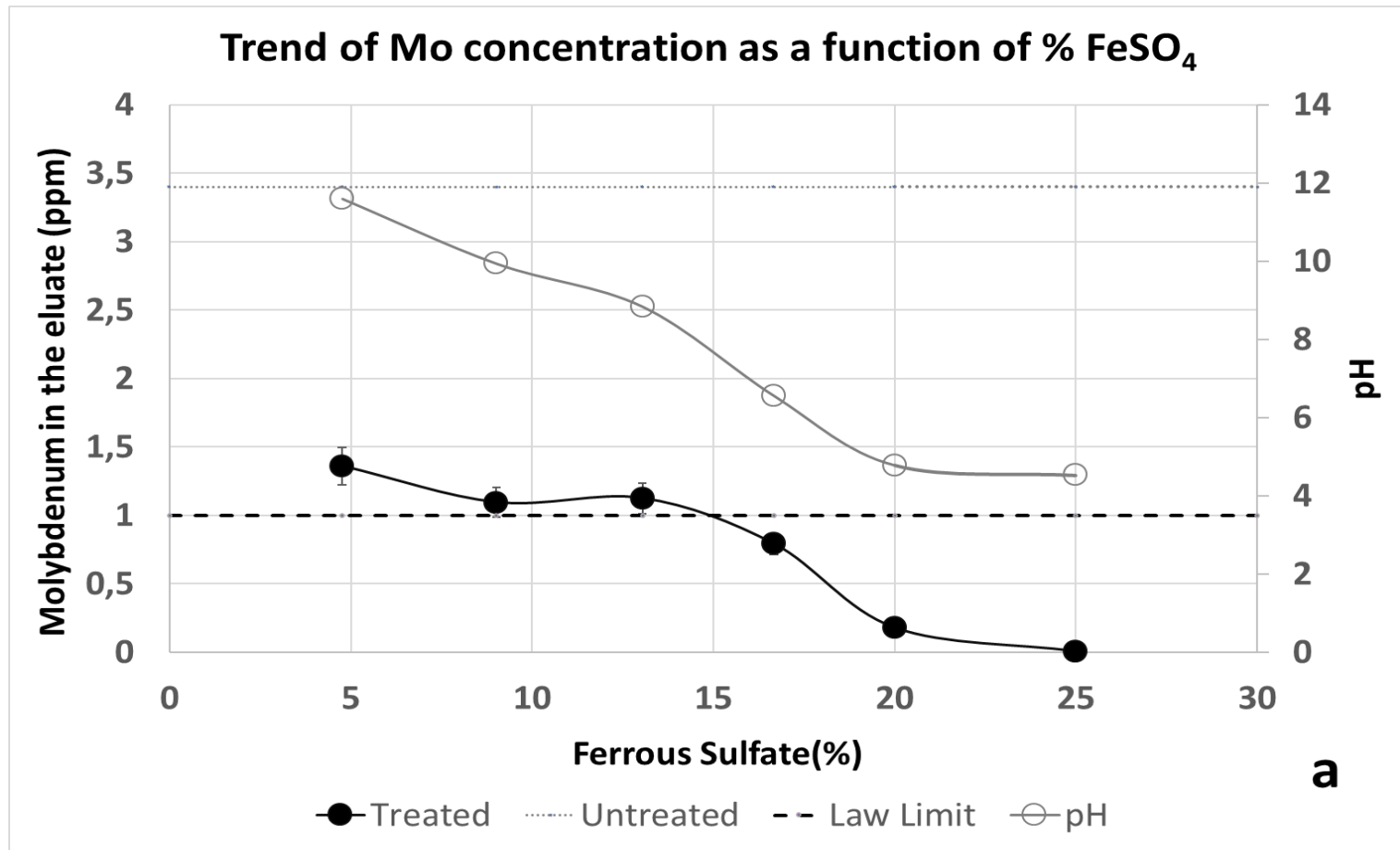
RESULTS: BOTTOM ASH TREATMENT WITH MnSO_4



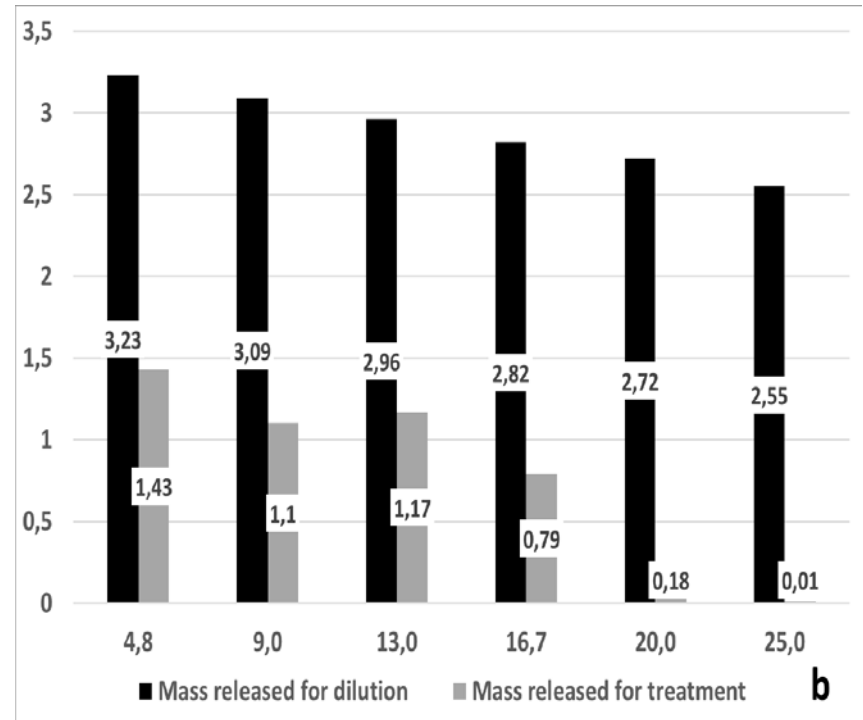
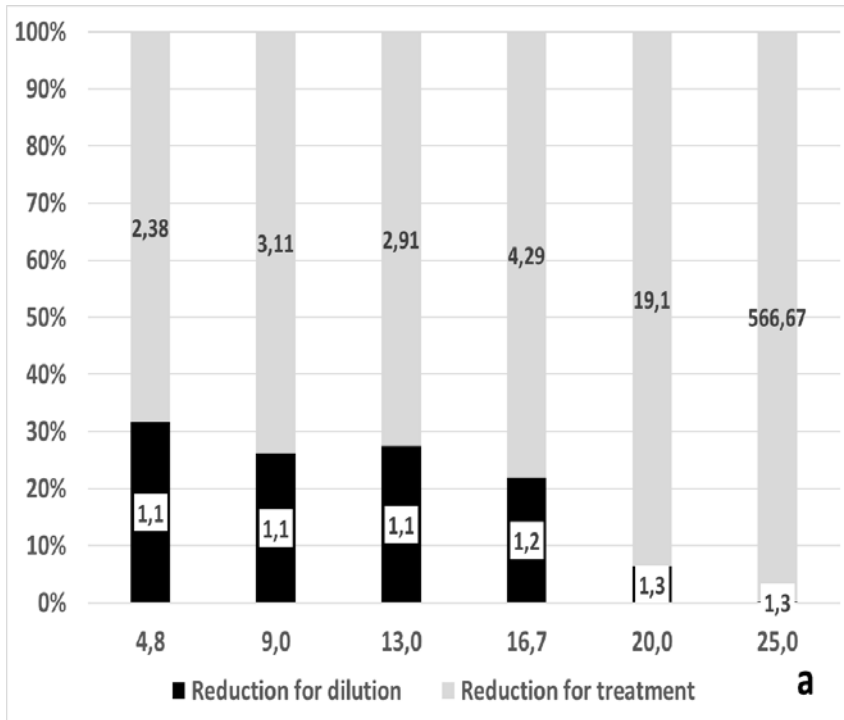
RESULTS: BOTTOM ASH TREATMENT WITH $MnSO_4$



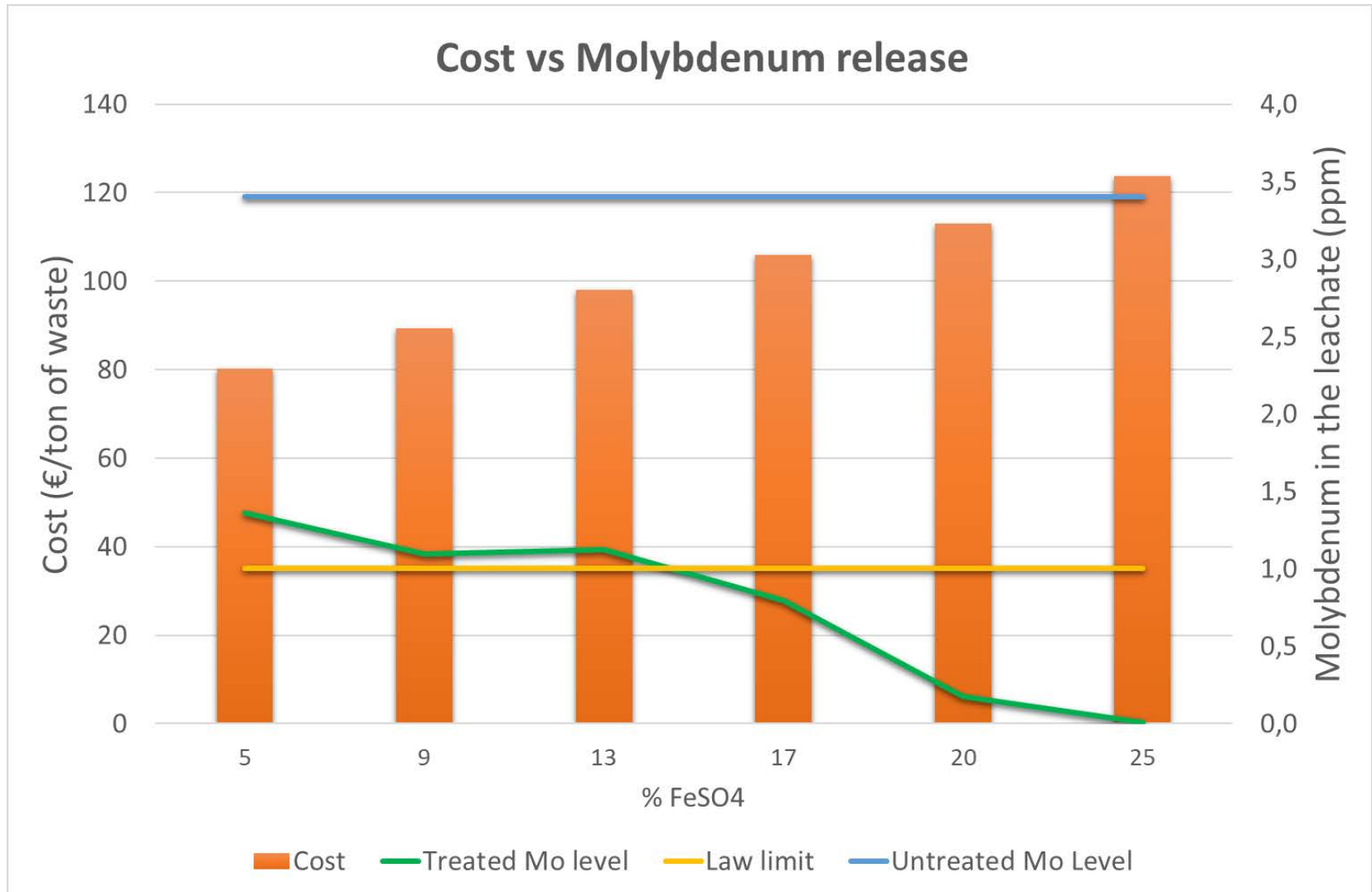
RESULTS: BOTTOM ASH TREATMENT WITH FeSO_4



RESULTS: BOTTOM ASH TREATMENT WITH FeSO_4

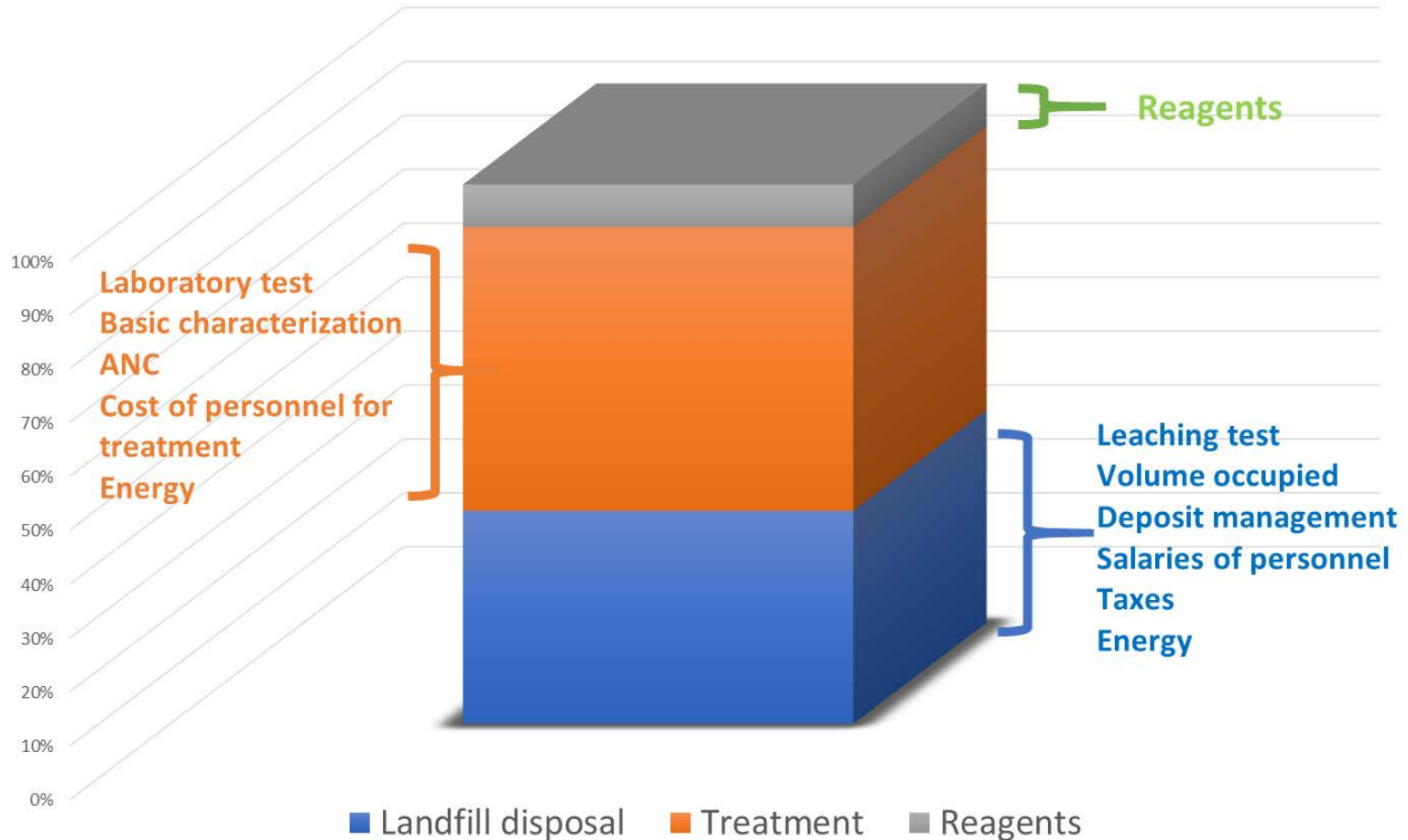


RESULTS: BOTTOM ASH TREATMENT WITH FeSO_4



Costs of the Treated Mix

Distribution of cost



Study of different Costs and Gain

Landfill value and waste density

TOTAL COST OF REALIZATION	8,8 M	€
VOLUME	539.000	m ³
DISTRIBUTED COST	16,46	€/m ³

Distributed cost over volume	16,46	€/m ³
Average waste density	1,2	Ton/m ³
Cost over ton	13,7	€/ton



Study of different Costs and Gain

Eco Taxes

Cost	6,24	€/ton
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Study of different Costs and Gain

Analysis



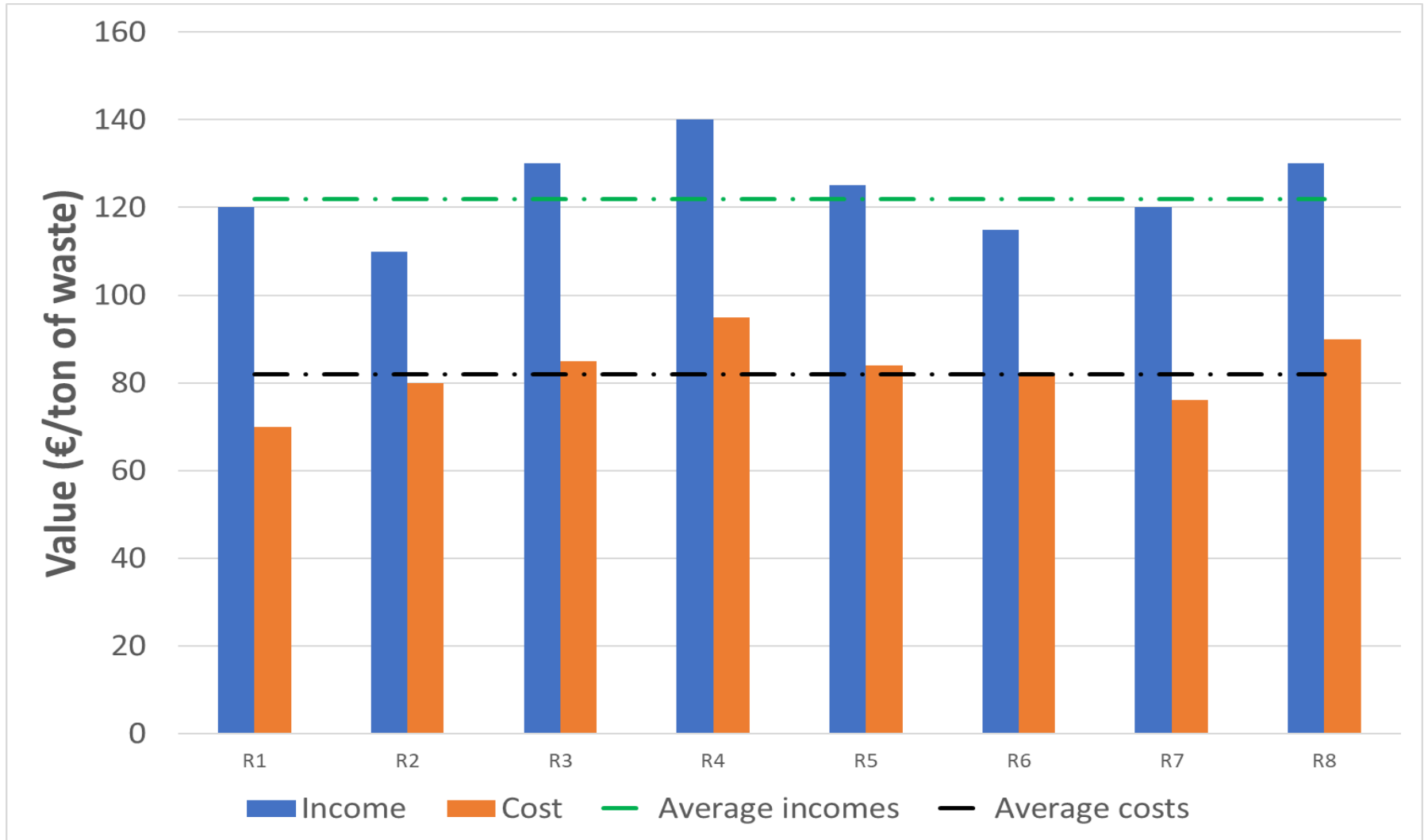
Basic characterization and ANC	500
ANC Test	250
Geotechnical tests	200
Leaching Test	250
Combined laboratories Test	300

Energy

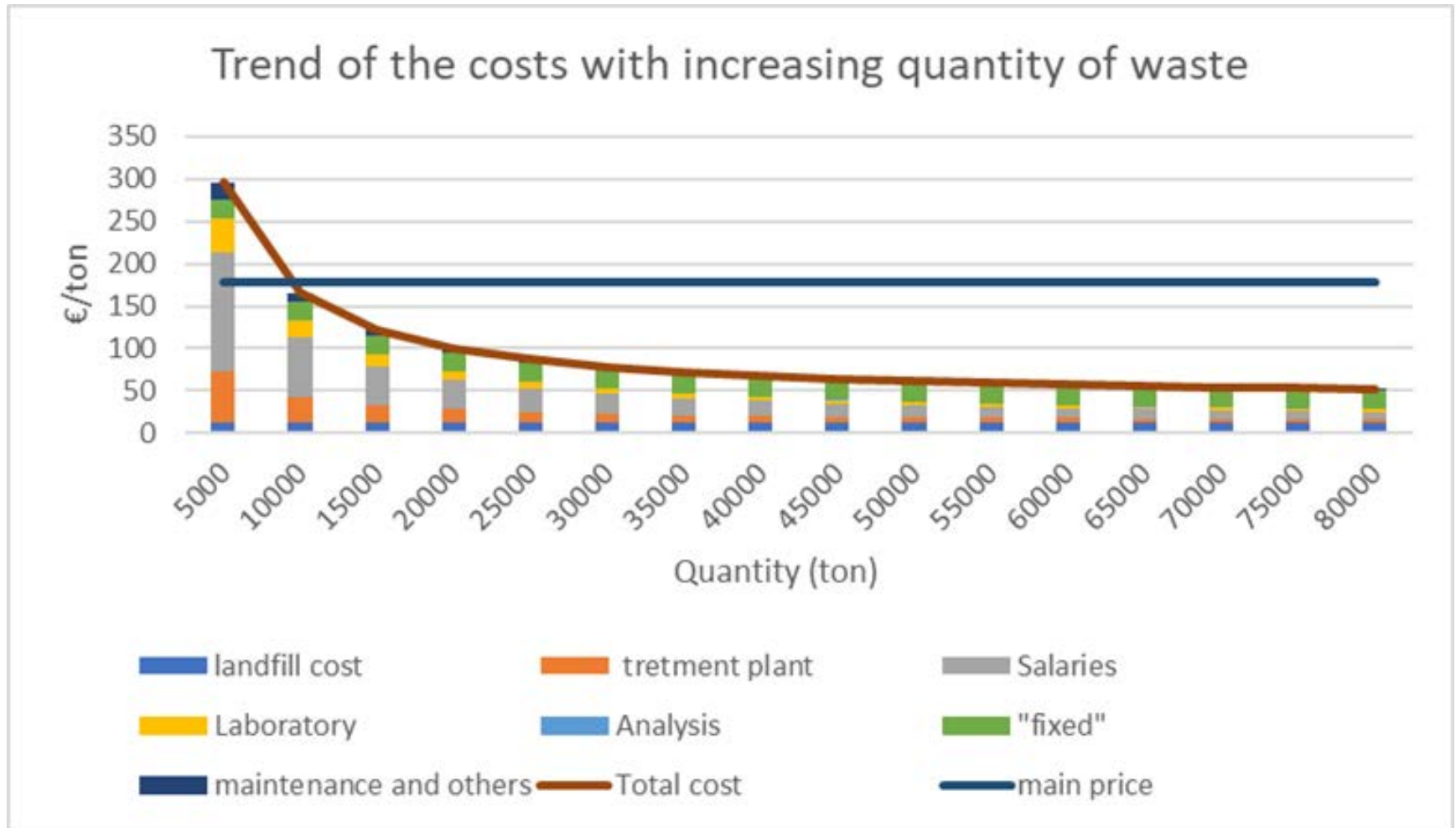


Construction cost of treatment plant	4,1 M	€
Annual amortization quote	300.000	€/year
Energetic cost	0,96	€/ton

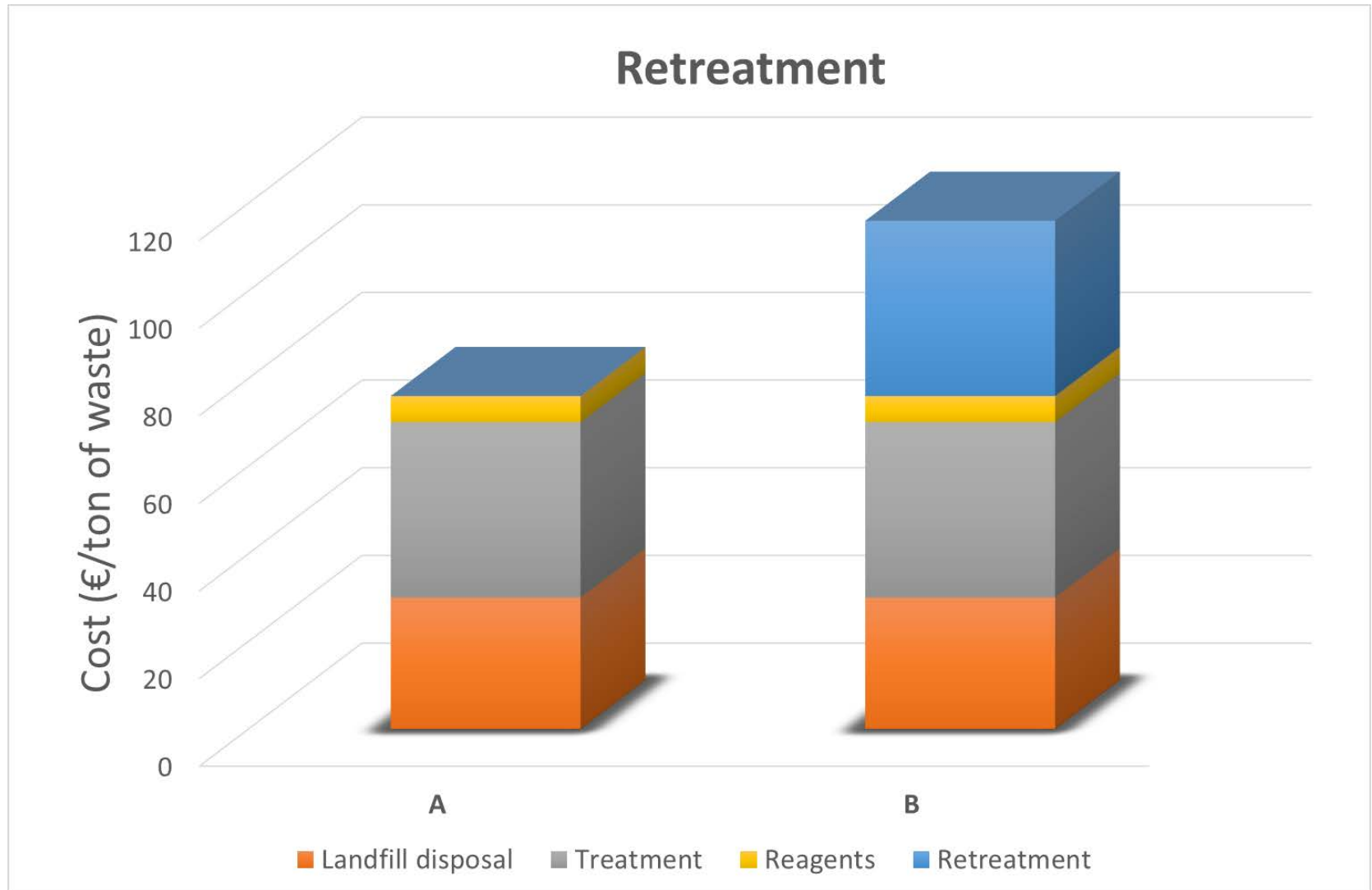
Profit



The importance of quantity in a waste treatment plant



The importance of retreatment in a waste treatment plant



Conclusion

We are working to develop a tool useful for matching every waste with a specific product class:

- **Combining both the analytic and economical aspects of any waste waiting for an approval for landfill processing.**
- **Analytical characteristics such as target contaminants, concentration of contaminants, pH, ANC and CBR will define the kind of process or treatment that the waste must withstand, while..**
- **Economical aspects such as treatment cost, landfilling cost, quantities, profits and possible reworkings will be evaluated and will determine the proper risks/benefits ratio**
- **The combination of these aspects will result in a fundamental tool for the waste treatment plant for providing a competitive, realistic, economically and environmentally acceptable price for the considered waste.**
- **Thus, helping not only the company in being more competitive but also improving its ability to select the best path for every incoming waste that has to be subjected to a partial stabilization process.**