Ornamental stone cutting processing and sludge production evaluation with the goal of ending waste.

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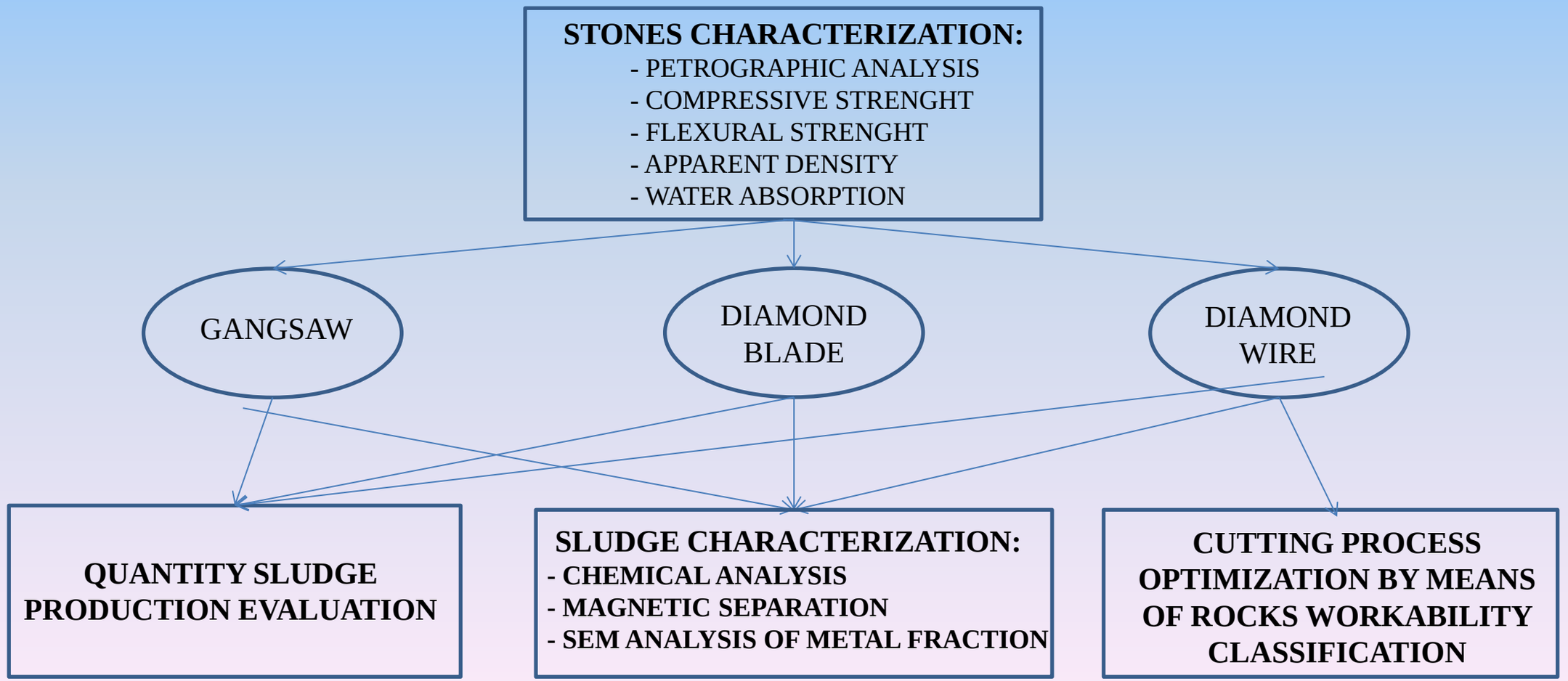
AIM OF THE RESEARCH:

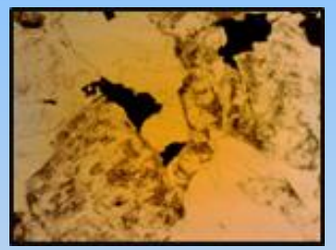
Identify the best cutting techniques for processing of stones in order to obtain a good efficiency process, optimize the recovery process, increase the economic advantages and evaluate the possible reuse of the sludge through a proactive waste management strategy.



STONE CHARACTERIZATION

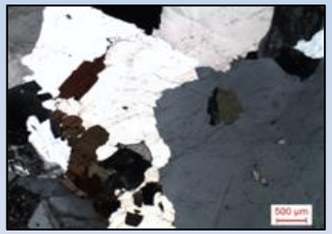
SERIZZO ANTIGORIO

GRIGIO PERLA



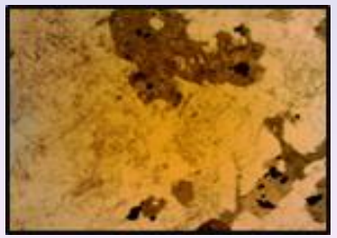
LUSERNA

MONTORFANO

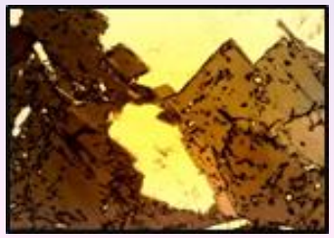


WHITE BEOLA

SIENITE



ROSA BETA

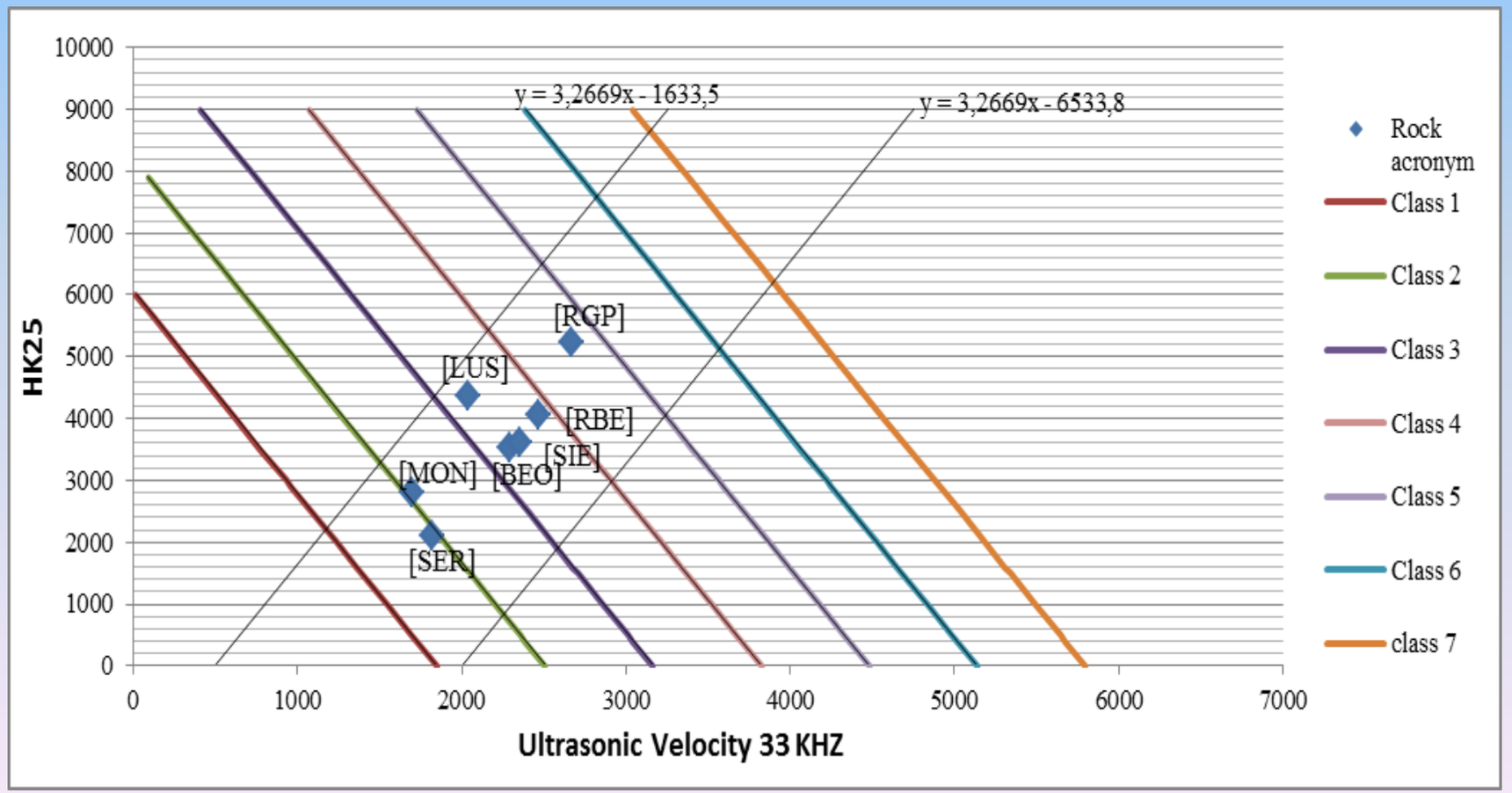


Samples code	Districts	Stones type	Main minerals composition	Cutting methodologies
MVG	Verbania	Serizzo	Quartz, Plagioclase, Ortoclase; Biotite; Muscovite; Epidote.	Gangsaw
DVM	Verbania	Beola, Serizzo, Granite	Quartz; Plagioclase, Ortoclase, Alkaline Feldspar; Biotite; Muscovite, Piroxen.	Gangsaw – Diamond blade – Diamond wire
TVD	Verbania	Serizzo, marble	Quartz, Plagioclase, Ortoclase; Biotite; Muscovite; Epidote; calcium carbonate.	Diamond blade
CVW	Verbania	Serizzo	Quartz, Plagioclase, Ortoclase; Biotite; Muscovite; Epidote	Diamond wire
GVM	Verbania	Beola, Granite, Serizzo, Luserna, Sienite	Quartz; Plagioclase, Ortoclase, Alkaline Feldspar; Biotite; Muscovite, Piroxen, White mica; Chlorite	Gangsaw - Diamond blade - Diamond wire
PTD	Torino	Gneiss	Quartz; Plagioclase; Alkaline Feldspar; White mica; Chlorite; Epidote	Diamond blade
CTD	Torino	Granite	Quartz; Plagioclase, Orthoclase, Biotite.	Diamond blade
TTW	Torino	Diorite, Sienite, Granite, Luserna, Serizzo, Beola	Quartz; Plagioclase, Ortoclase, Alkaline Feldspar; Biotite; Muscovite, Piroxen, White mica; Chlorite	Diamond wire
MCG	Cuneo	Luserna stone	Quartz; Plagioclase; Alkaline Feldspar; White mica; Chlorite; Epidote.	Gangsaw
MCD	Cuneo	Luserna stone	Quartz; Plagioclase; Alkaline Feldspar; White mica; Chlorite; Epidote	Diamond blade

ROCKS WORKABILITY CLASSIFICATION FOR CUTTING OPTIMIZATION

UPV + KNOOP

Prediction of stone - diamond wire interaction: crucial for the extractive sector, both to improve the productivity and efficiency of quarry work and to avoid dangerous and expensive endeavours of cutting when an unknown stone has to be introduced in the plant



ROCK ACRONYM	IWC	OBTAINED CLASS
SER	2	1/2
MON	3	2
LUS	3	3
BEO	3	3
RBE	3	3
SIE	3	3
RGP	4	4

Based on the research carried out with the European EASE R3 project, reference: ”Diamond-wire cutting: a methodology to evaluate stone workability” Zichella et. al., 2017

EASE-R3

QUANTITY SLUDGE PRODUCTION EVALUATION

Block dimension [m]	1.5*3*2		
Block length [m]	2		
Rock specific weight [t/m³]	2.7		
m² for one slab [m²]	4.5		
Slab thickness [cm]	2	3	4
Slab volume [m³]	0.09	0.135	0.18
Slab weight [t]	0.243	0.364	0.486

Starting data considered for the calculation of lost materials.

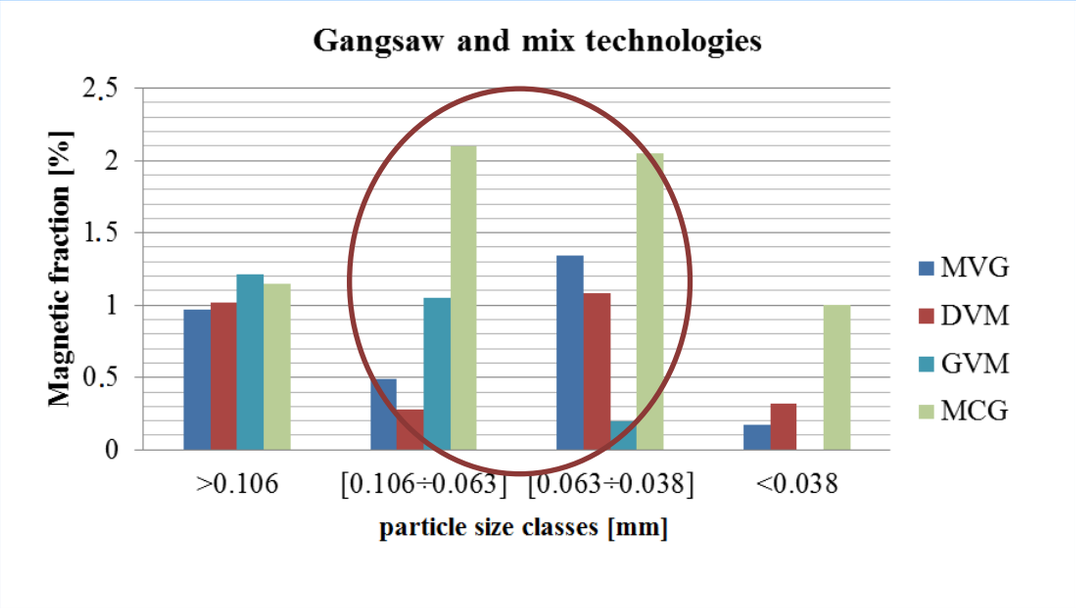
	SLABS 2 cm	SLABS 3 cm	SLABS 4 cm
GANGSAW lost material [%]	30	22	17
GANGSAW Number of slabs for block	70	52	41
GIANT DIAMOND BLADE lost material [%]	43	34	28
GIANT DIAMOND BLADE Number of slabs for block	57	44	36
DIAMOND WIRE lost material [%]	29	22	17
DIAMOND WIRE Number of slabs for block	71	52	41

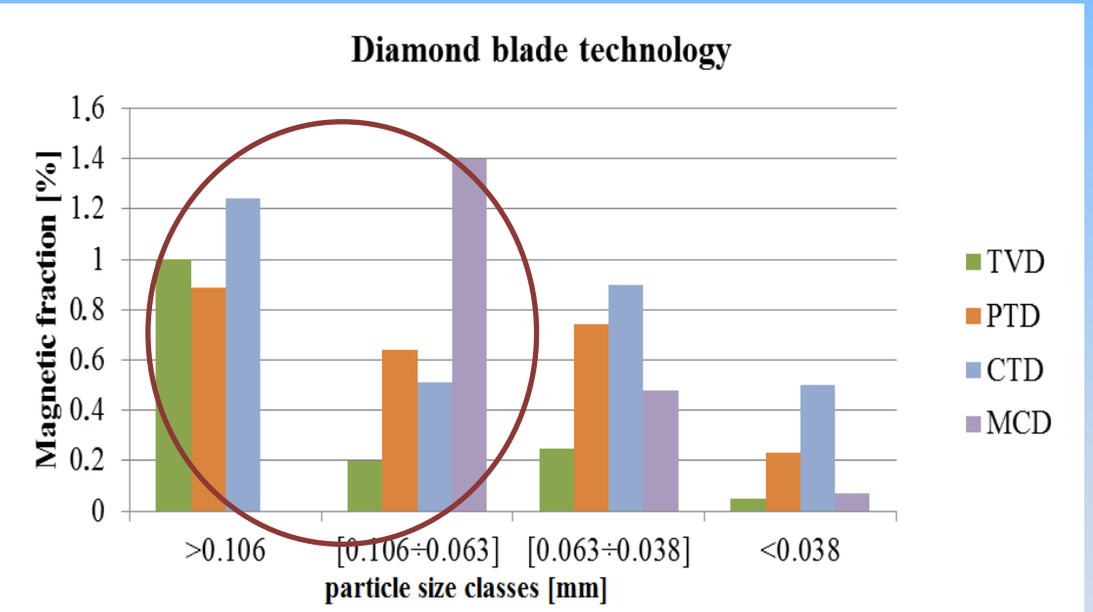
	STARTING DATA			
		SLABS 2cm	SLABS 3 cm	SLABS 4cm
GANGSAW	blade segment thickness [mm]	4.8		
	grit diameter [mm]	0.4		
	cutting width + blade distance[mm]	28.4	38.4	48.4
GIANT DIAMOND BLADE	disk diameter [mm]	3500		
	segment thickness [mm]	14,2		
	cutting width + slab thickness [mm]	35.2	45.2	55.2
DIAMOND WIRE	beads diameter [mm]	7.3		
	cutting width + slabs thickness[mm]	28.3	38.3	48.3

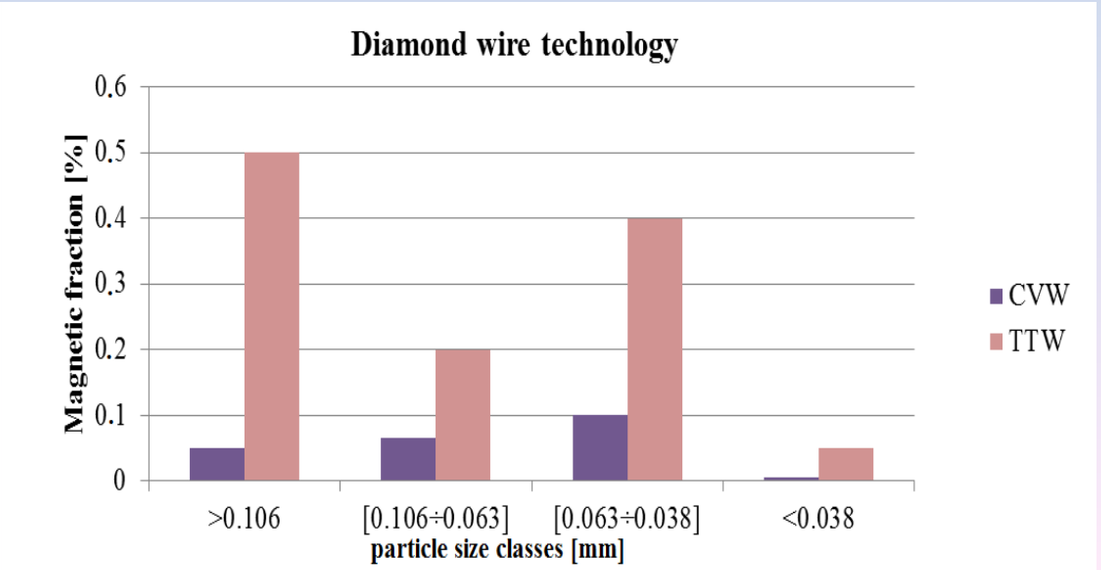
Diamond wire produces an amount of waste, similar to the gangsaw technology. However, diamond wire technology offers many advantages compared to gangsaw. One of the advantages of multiwire respect gangsaw is the down feed speed. Multiwire speed is more than four times compared to gangsaw speed. This aspect is linked to a higher production of slabs for the diamond wire. Furthermore, this type of technology uses tools that are more wear resistant than gangsaw.

SLUDGE CHARACTERIZATION

Magnetic separation







- Gangsaw and diamond blade technologies have a high percentage of metals concentration (magnetic fraction) respect diamond wire;
- The type of stone cut and its workability affects the wear of the tools and therefore the concentration of metals in the sludge (percentage of concentration of metals present in the sludge is higher in the case of stones more difficultly workable);

- Gangsaw and mix technologies magnetic distribution trend of magnetic fraction is higher for particle size class ranges [0.106÷0.063] and [0.063÷0.038].
- Diamond blade and diamond wire magnetic distribution trend is higher for particle size classes > 0.038 mm.
- The lowest class of 0.038 mm, for all technologies, is the class with the lowest concentration of magnetic fraction. In case of separation as a pre-treatment, it could have a good efficiency, due to the packing effect for the too fine material.

CONCLUSION

- *Sludge quantity evaluation*: feasibility of possible recovery depend on quantity of secondary raw material involved.
- *Rocks workability classification:* inexpensive and simple method to predict cuttability prior to cutting, and to predict the wear of tools and consequent production of sludge with less content of metals.
- *Magnetic separation*: → as characterization for a correct future recovery
  → as pre-treatment to decrease metals content

ECONOMIC EVALUATION

		small company	medium company
	sludge production [t/year]	1,800	7,800
waste as inert	landfill disposal cost [€/year]	23,400	101,400
	transport cost [€/year]	21,600	93,600
	total cost sludge management [€/year]	45,000	195,000
	company turnover [€/year]	466,560	2,021.76
	cost incidence of sludge management [%]	10	10
waste as special non-hazardous waste	landfill disposal cost [€/year]	144,000	624,000
	transport cost [€/year]	21,600	93,600
	total cost sludge management [€/year]	165,600	717,600
	company turnover [€/year]	466,560	2,021.76
	cost incidence of sludge management [%]	35	35

Thank you for the attention !!!

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WEB SITE.: http://areeweb.polito.it/rawmaterials/index_en.html