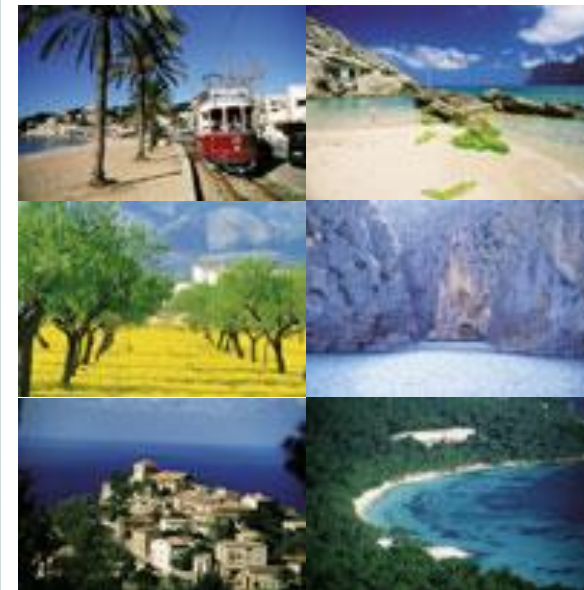




Recovery of Bottom Ash on an Island

Amalia Cerdà, TIRME S.A.

MALLORCA



GENERAL ASPECTS

- Extension of the island: 3.640 Km²
- Population Census : 869.858 inhabitants(2014)
- Density of population: \approx 240 inhabitants/Km²
- Municipal waste generation: 2,03 Kg/inhab/day

REMARKABLE FACTS

- Demographic density: double than Spanish average
- Annual tourism input supposes almost 10 million visitors
- Economy based on service sector, with a contribution of ca. 80 % to the GNP (Gross National Product), being the most important economic sector the tourism
- High seasonality in waste production

Disposal of refuse from C&D waste



Outdoor composting plants



Sorting Plant
Anaerobic
Digestion
Indoor Composting



Solar drying plant
for sewage sludge



Waste to Energy



Bottom ash
treatment



Landfill for
hazardous waste



1

2

3

4

2

5

1

3



Transfer Stations



Indoor Composting Plant



16 June 2016, Rotterdam



Energy Congress 2016



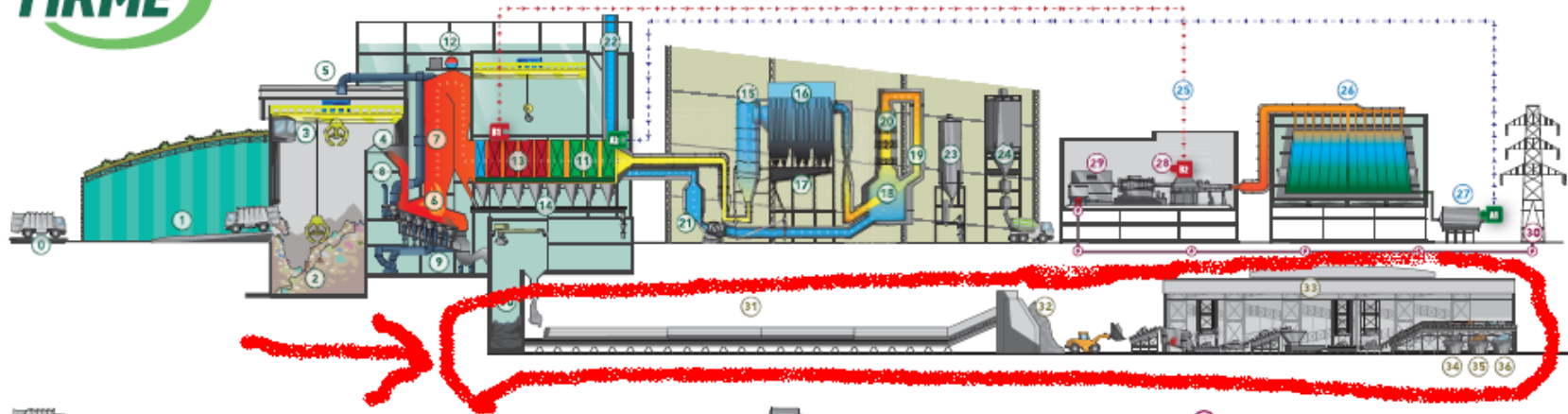
IBA treatment plant

Waste to Energy



Process and facilities

Waste to Energy facility & Bottom Ash Treatment Plant



TRATAMIENTO DE RESIDUOS

RECEPCIÓN

- 0 BÁSCULA
- 1 PLATAFORMA DE DESCARGA
- 2 FOSO
- 3 PUENTE-GRÚA

HORNO-CALDERA

- 4 TOLVA DE ALIMENTACIÓN
- 5 AIRE PRIMARIO
- 6 PARRILLA
- 7 QUEMADORES ALIQUILARES
- 8 AIRE SECUNDARIO
- 9 DESESCORADOR
- 10 FOSO DE ESCORIAS
- 11 ECONOMIZADORES
- 12 EVAPORADORES Y CALDERÍN
- 13 SOBRECALENTADORES
- 14 GOLPEO Y TRANSPORTE DE CENIZAS

CALDERA

TRATAMIENTO DE GASES

- 15 REACTOR SEMISECO
- 16 FILTRO DE MANGAS
- 17 RECIRCULACIÓN
- 18 INTERCAMBIADOR GAS > GAS
- 19 INTERCAMBIADOR GAS > VAPOR
- 20 SCR DeNOx
- 21 VENTILADOR DE TIRO
- 22 CHIMENEA
- 23 SILOS DE REACTIVOS
- 24 PLANTA DE CEMENTACIÓN

CICLO AGUA-VAPOR

- 25 VAPOR SOBRECALENTADO
- 26 AEROCONDENSADOR
- 27 AGUA DE ALIMENTACIÓN

TRATAMIENTO DE ESCORIAS

- 31 CINTAS DE TRANSPORTE
- 32 TROJES DE RECEPCIÓN
- 33 SELECCIÓN Y TRATAMIENTO: CRIBAS, PRESNA, MOLINO, SEPARADORES FÉRRICOS, SEPARADORES FOCAULT.

GENERACIÓN DE ENERGÍA

- 28 TURBINA DE VAPOR
- 29 GENERADOR
- 30 ENERGÍA ELÉCTRICA A LA RED

- 34 ARIDOS
- 35 METALES FÉRRICOS
- 36 METALES NO FÉRRICOS

Waste to Energy:

- INPUT: 600.000 tons/year of MSW
- OUTPUT: 125.000 tons/year of Bottom Ash

IBA Treatment Plant:

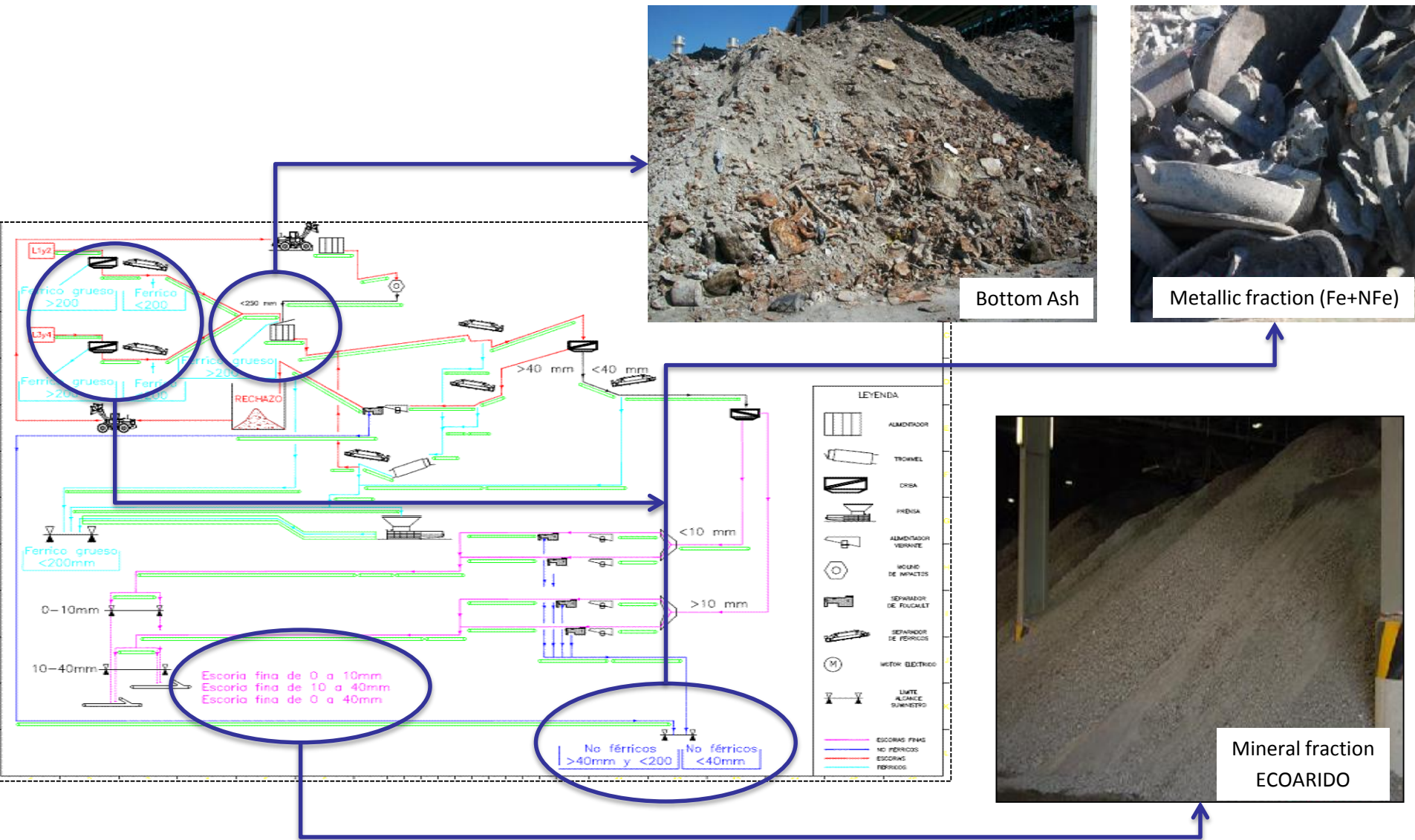
- 10.000 tons/year of metallic fraction
- 115.000 tons/year of mineral fraction



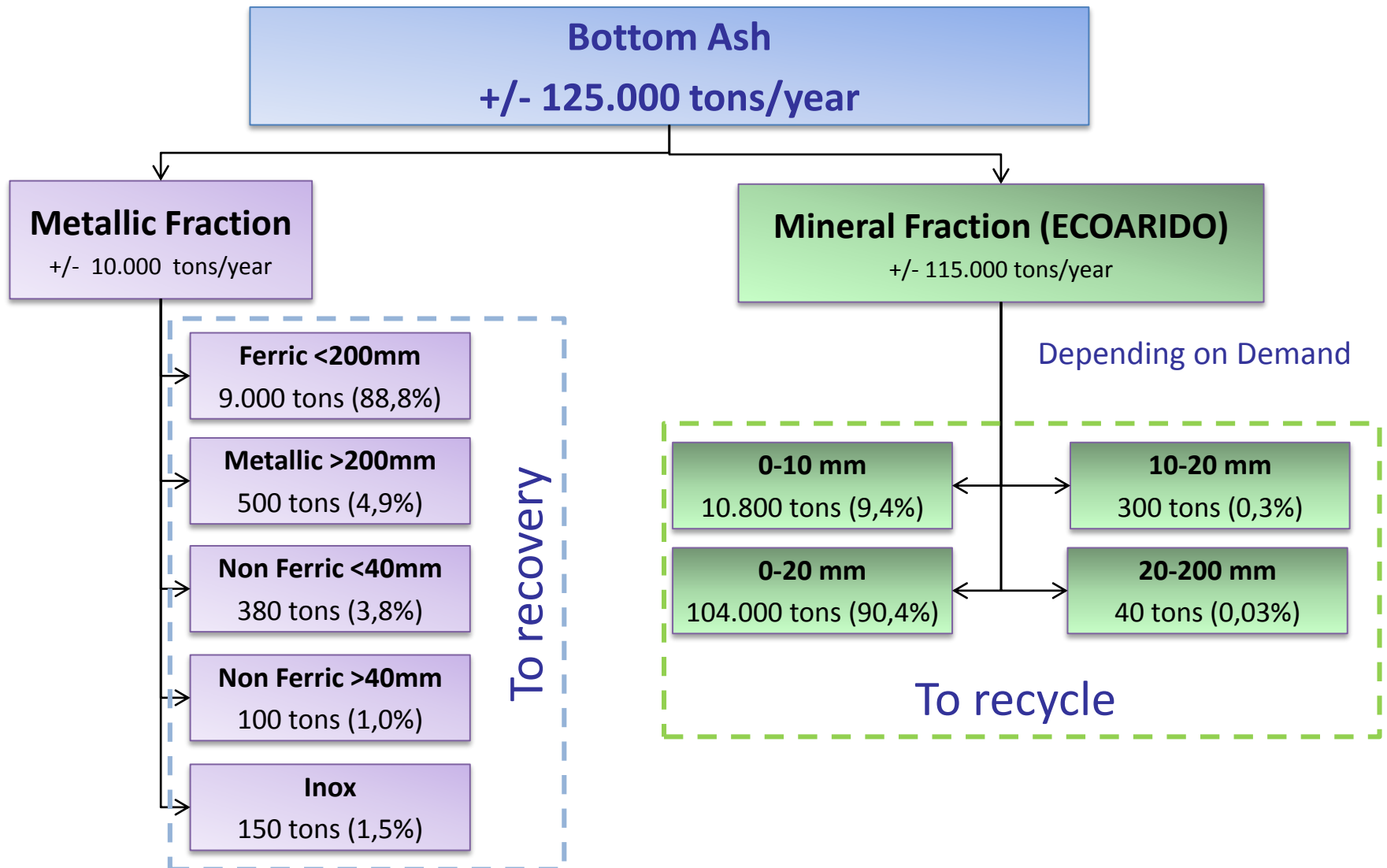
16 June 2016, Rotterdam

8th CEWEP Waste-to-Energy Congress 2016

Process and facility



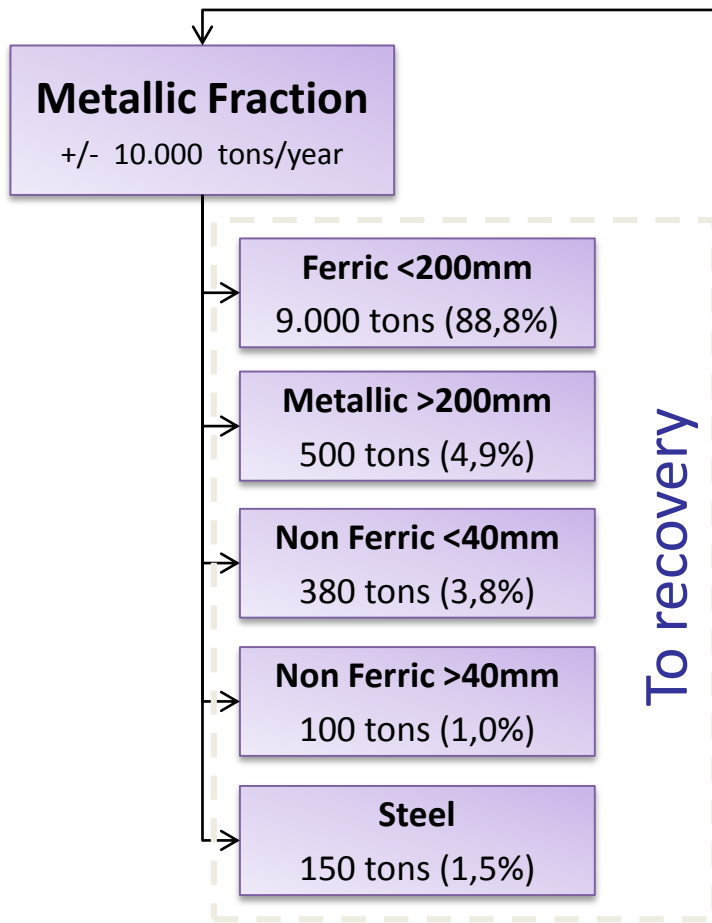
Mass Balance



Metallic fraction to recovery



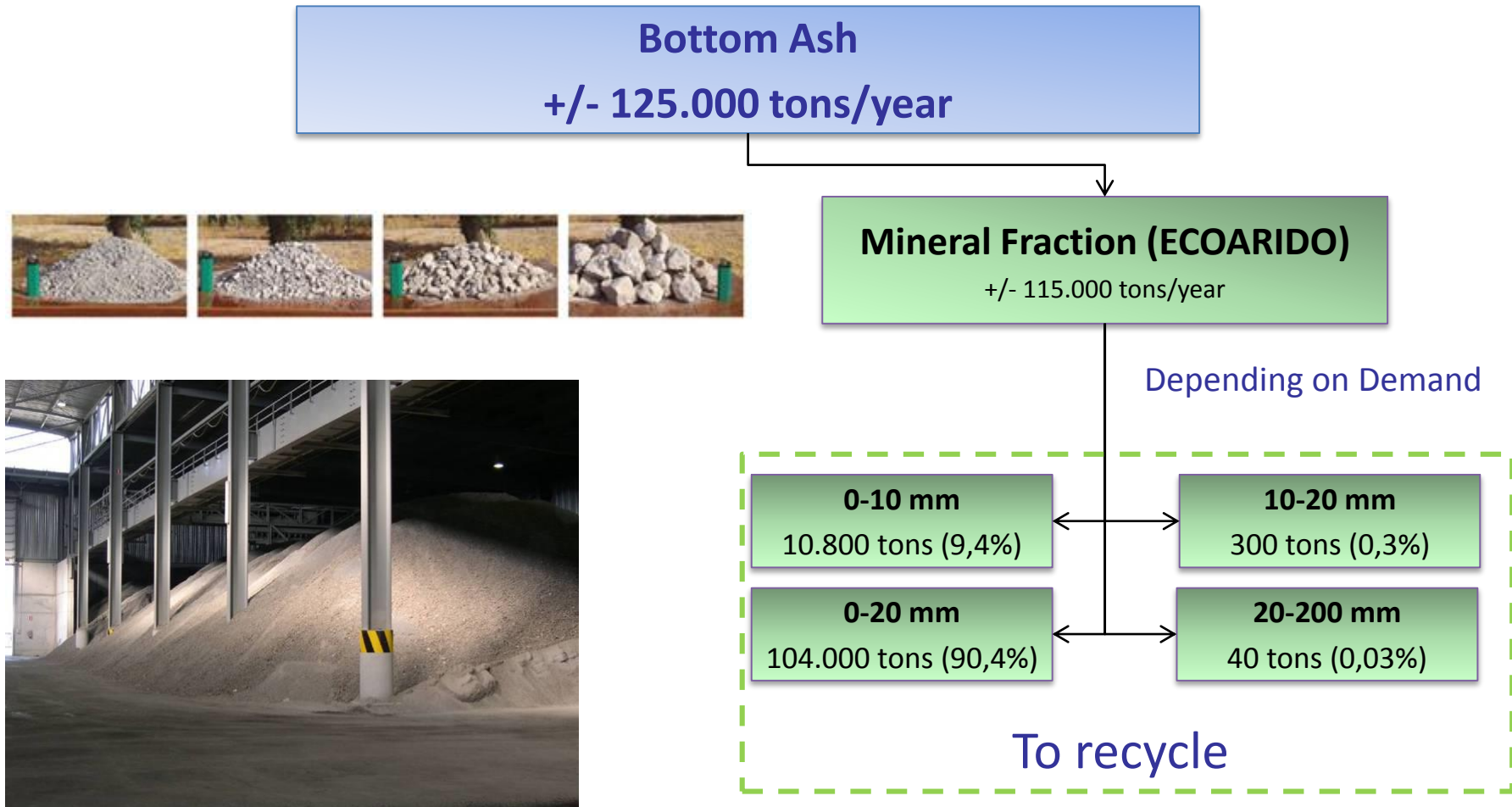
Bottom Ash
+/- 125.000 tons/year



- ▶ Delivered to authorized scrap metal recycler, awarded through public tender
- ▶ Monthly price of the different metallic fractions referred to an international index (EUROFER Scrap Price Index) showing market trends
- ▶ In the case of iron, a discount rapping is applied (according to the quality of scrap) based on monthly characterizations

MATERIAL	Average Annual Prices		Fluctuation
	2015	2014	
Ferric <200mm	33,08	70,42	- 53%
Metallic >200mm	33,08	70,42	- 53%
Non Ferric <40mm	890,54	864,64	3%
Non Ferric >40mm	722,44	811,86	- 11%
Steel	964,04	857,88	12%

Mineral fraction to recycling





ECOÁRIDO CERTIFICADO



FRACCIONES Y USOS PRINCIPALES



FRACCIÓN 0/10: Fabricación de cementos Ecológicos / Prefabricados / Lecho y cubrición de tuberías

FRACCIÓN 0/20: Bacheo y arreglo de caminos y explanadas / Suelo Cemento y Estabilizado / Pantallas, diques y rellenos

FRACCIÓN 10/20: Fabricación de hormigones compactos / Relleno de zanjas / Drenajes.

FRACCIÓN 20/200: Rellenos / Trasdoses / Drenajes.

BUENOS PARA TI Y PARA EL MEDIO AMBIENTE



Utilizando ECOÁRIDOS certificados sustituimos a los áridos naturales evitando su extracción de canteras, mantenemos nuestro entorno y contribuimos a reducir las emisiones de CO2.

PRIMERAS CONCLUSIONES DEL ESTUDIO CEDEX



Comportamiento mecánico del ECOÁRIDO en el suelo estabilizado con cemento: Módulo de elasticidad 15 a 20% superior al de los áridos naturales y mayor resistencia a la fatiga.

CONTROLES AMBIENTALES Y DE CALIDAD



Para garantizar el cumplimiento de las exigencias ambientales nuestro Ecoárido es sometido a rigurosos ensayos anuales realizados por entidades externas acreditadas, concluyendo que el Ecoárido no es ni tóxico ni peligroso.

EJEMPLOS DE USO. OBRA PÚBLICA Y PRIVADA



TIRME

www.orgullososdeloquehacemos.com

f t g+ s

TIRME - Ctra. de Sóller, km B.2 - 07120 Palma de Mallorca
Tel. +34 971 435 050 www.tirme.com

CE conformity marking of ECOARIDO

- ▶ Bottom ash ageing (carbonation) before use: min. 8 weeks
- ▶ Since May 2011 CE conformity marking of ECOARIDO. Renewed annually through inspection by accredited body (2012-2016).

- ☐ *Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction according to EN 13242*
- ☐ *Aggregates for concrete according to EN 12620*

- ▶ Size classification according to intended uses



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Applus⁺



CERTIFICADO DEL CONTROL DE PRODUCCIÓN EN FÁBRICA

En cumplimiento con la Directiva 89/106/CEE del Consejo de las Comunidades Europeas de 21 de diciembre de 1988 relativa a la aproximación de las disposiciones legales, reglamentarias y administrativas de los Estados Miembros sobre los productos de la construcción (Directiva de Productos de Construcción-CPD), modificada por la Directiva 93/68/CEE del Consejo de las Comunidades Europeas de 22 de julio de 1993, se ha verificado que el producto de construcción

- ÁRIDOS PARA CAPAS GRANULARES Y CAPAS TRATADAS CON CONGLOMERANTES HIDRÁULICOS PARA SU USO EN CAPAS ESTRUCTURALES DE FIRMES: 0/10, 0/20, 10/20
- ÁRIDOS PARA HORMIGÓN: 0/10, 10/20

Suministrado al mercado por:

TIRME S.A.
CARRETERA DE SÓLLER KM 8.2
07120 PALMA DE MALLORCA

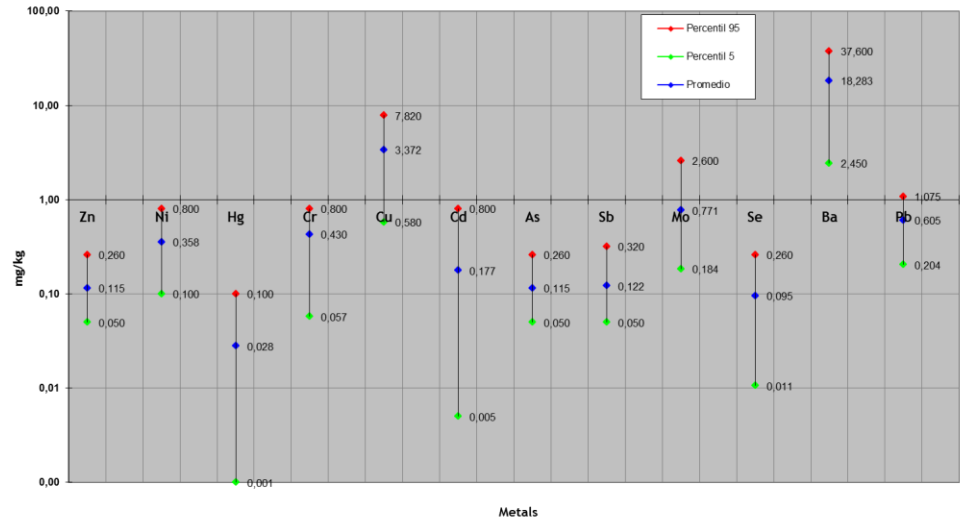
Y fabricado en:

PLANTA TRATAMIENTO DE ESCORIAS
CARRETERA DE SÓLLER KM 8.2
07120 PALMA DE MALLORCA

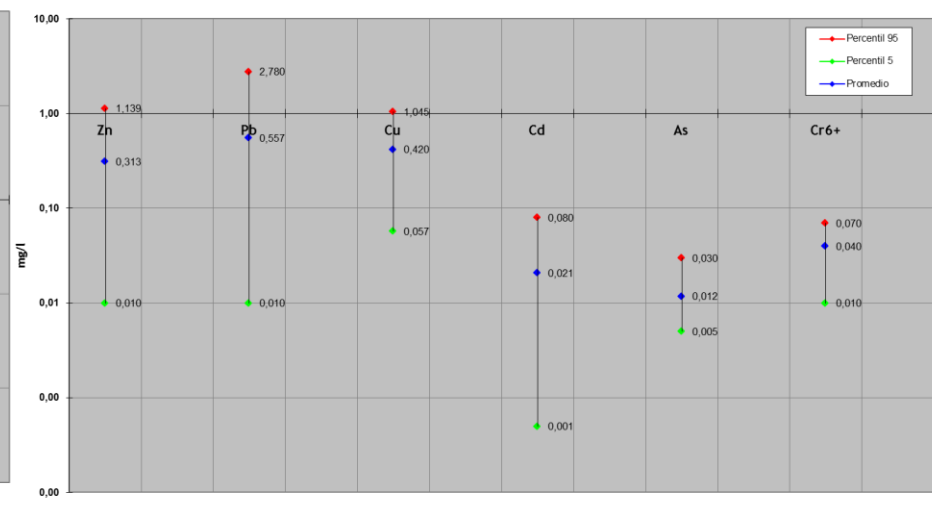


Environmental monitoring and control

LEACHING TEST RESULTS (UNE EN 12457-P4)
(logarithmic scale)



LEACHING TEST RESULTS (DIN 38414)
(Logarithmic scale)



LEACHATE AND SOLID MATRIX	Dioxins and Furans (PCDD/Fs)	Annually
	Metals (Cr, Cu, Mn, Ni, Pb, Zn, As, Cd, Hg, Sn, Sb, Cr ⁶⁺ , Al, Ca, V, Mo, Se, Ba), anions (F ⁻ , Cl ⁻ , SO ₄ ²⁻), pH conductivity	Every 3 months
	Toxicity and Hazardous Characterization under national waste legislation	Annually
	Other POPs	Periodically

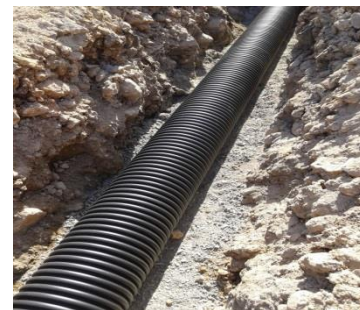
Main uses of ECOARIDO

Embankment dam /
ridge / landfill sealing
and closure



Precast concrete

Subbase and base
layers of roads



Bed and covering for
ducts and pipes

Roller compacted
concrete (RCC)



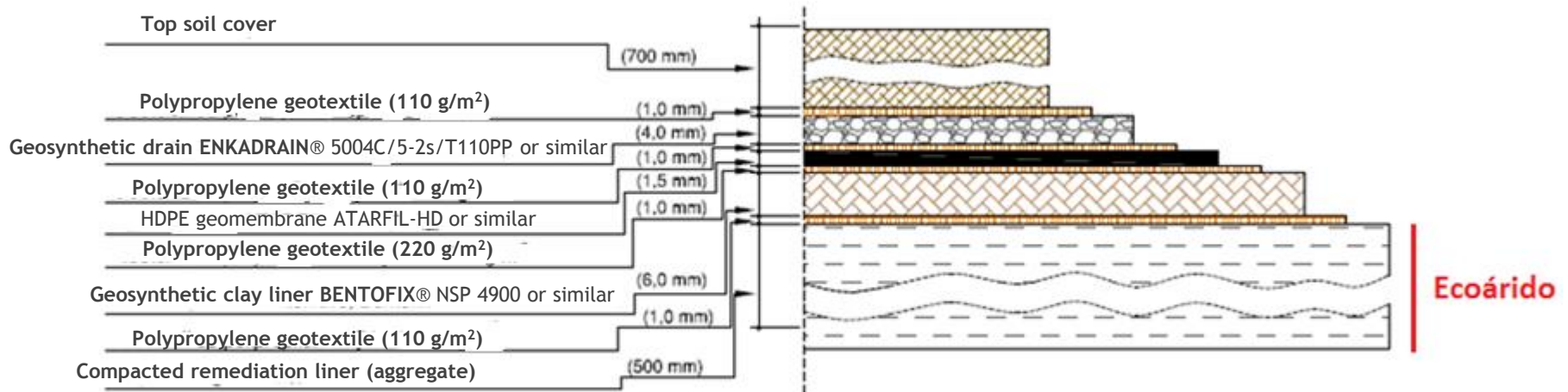
Filler material for
trenches, drainages and
Extrados

Cement production
(Clinker)



Noise Barriers

MINERAL-IBA. Uses: Embankment dam / ridge / landfill sealing and closure



MINERAL-IBA. Uses: Subbase and base layers of roads

Stabilized soil

Soil-cement



MINERAL-IBA. Uses: Cement stabilized layers

- ▶ Stabilized layers for coronation of esplanades, underneath asphalt pavements.
- ▶ **Stabilized soil**: 3% cement; 85% bottom ash; 12% water.



MINERAL-IBA. Uses: Soil-cement base

Soil-cement used as pavement base for roads, with a bituminous surface placed on the soil-cement to complete the pavement. It's placed with conventional asphalt paving equipment.



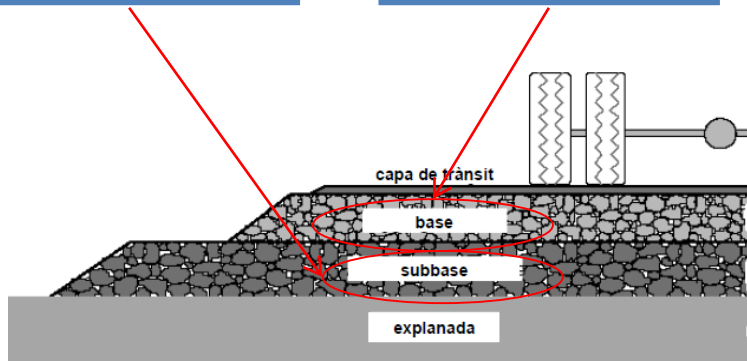
Soil-cement: 4% cement; 84% bottom ash; 12% water

MINERAL-IBA. Uses: Subbase and base layers of roads

Base/Sub-base layers of roads

Stabilized soil for embankment

Soil-cement under asphaltic layer



According to Spanish Road construction Normative and Guidelines (PG3)



Road Layers

Layer:	Material:	(cm)
Transit	Asphalt layer	15
Intermediate-Base	Soil-cement	25
Subbase	Stabilized soil	30
Esplanade	Selected soil	30

Note: In red, layers made with BOTTOM ASH

Ordered within 2014: **82.000 tn**

MINERAL-IBA. Uses: Subbase and base layers of roads



PG3 Compliant

Características técnicas		Características físicas	
Grav. vol. (20°C)	1,45	Grav. vol. (20°C)	1,45
Grav. real (20°C)	1,45	Grav. real (20°C)	1,45
Grav. real (15°C)	1,45	Grav. real (15°C)	1,45
Grav. real (10°C)	1,45	Grav. real (10°C)	1,45
Grav. real (5°C)	1,45	Grav. real (5°C)	1,45
Grav. real (0°C)	1,45	Grav. real (0°C)	1,45
Grav. real (-5°C)	1,45	Grav. real (-5°C)	1,45
Grav. real (-10°C)	1,45	Grav. real (-10°C)	1,45
Grav. real (-15°C)	1,45	Grav. real (-15°C)	1,45
Grav. real (-20°C)	1,45	Grav. real (-20°C)	1,45
Grav. real (-25°C)	1,45	Grav. real (-25°C)	1,45
Grav. real (-30°C)	1,45	Grav. real (-30°C)	1,45
Grav. real (-35°C)	1,45	Grav. real (-35°C)	1,45
Grav. real (-40°C)	1,45	Grav. real (-40°C)	1,45
Grav. real (-45°C)	1,45	Grav. real (-45°C)	1,45
Grav. real (-50°C)	1,45	Grav. real (-50°C)	1,45
Grav. real (-55°C)	1,45	Grav. real (-55°C)	1,45
Grav. real (-60°C)	1,45	Grav. real (-60°C)	1,45
Grav. real (-65°C)	1,45	Grav. real (-65°C)	1,45
Grav. real (-70°C)	1,45	Grav. real (-70°C)	1,45
Grav. real (-75°C)	1,45	Grav. real (-75°C)	1,45
Grav. real (-80°C)	1,45	Grav. real (-80°C)	1,45
Grav. real (-85°C)	1,45	Grav. real (-85°C)	1,45
Grav. real (-90°C)	1,45	Grav. real (-90°C)	1,45
Grav. real (-95°C)	1,45	Grav. real (-95°C)	1,45
Grav. real (-100°C)	1,45	Grav. real (-100°C)	1,45
Grav. real (-105°C)	1,45	Grav. real (-105°C)	1,45
Grav. real (-110°C)	1,45	Grav. real (-110°C)	1,45
Grav. real (-115°C)	1,45	Grav. real (-115°C)	1,45
Grav. real (-120°C)	1,45	Grav. real (-120°C)	1,45
Grav. real (-125°C)	1,45	Grav. real (-125°C)	1,45
Grav. real (-130°C)	1,45	Grav. real (-130°C)	1,45
Grav. real (-135°C)	1,45	Grav. real (-135°C)	1,45
Grav. real (-140°C)	1,45	Grav. real (-140°C)	1,45
Grav. real (-145°C)	1,45	Grav. real (-145°C)	1,45
Grav. real (-150°C)	1,45	Grav. real (-150°C)	1,45
Grav. real (-155°C)	1,45	Grav. real (-155°C)	1,45
Grav. real (-160°C)	1,45	Grav. real (-160°C)	1,45
Grav. real (-165°C)	1,45	Grav. real (-165°C)	1,45
Grav. real (-170°C)	1,45	Grav. real (-170°C)	1,45
Grav. real (-175°C)	1,45	Grav. real (-175°C)	1,45
Grav. real (-180°C)	1,45	Grav. real (-180°C)	1,45
Grav. real (-185°C)	1,45	Grav. real (-185°C)	1,45
Grav. real (-190°C)	1,45	Grav. real (-190°C)	1,45
Grav. real (-195°C)	1,45	Grav. real (-195°C)	1,45
Grav. real (-200°C)	1,45	Grav. real (-200°C)	1,45



MINERAL-IBA. R&D – CEDEX Study

Centre for Public Works
Studies and Experimentation -
Ministry of Development



GOBIERNO
DE ESPAÑA

MINISTERIO
DE FOMENTO

MINISTERIO
DE AGRICULTURA,
ALIMENTACIÓN Y
MEDIO AMBIENTE



Study of the structural behavior of the main roadway constructed between Son Ferriol and Inca Road (Ma-13A), made with IBA.

- **4 sections:**
 - Control (without IBA)
 - Stabilized layer with IBA
 - Soil-Cement layer with IBA
 - Stabilized layer + Soil-Cement layer with IBA
- **36 sensors:** Measurement of temperature, tensions/compressions, deformations (H/V), humidity,...
 - Temp of the bituminous mixture
 - Vertical stress at the bottom layer of soil-cement
 - Horizontal def. at the bottom layer of soil-cement
 - Vertical def. at the layer of selected soil
 - Humidity, temperature and selected soil layer suction
- **Time schedule:** 12 months (3 reports: 0-6-12)
- **Budget:** 75.000 €
- **Intermediate results:** October 2015
- **Final Results:** July 2016

Esquema de instrumentación

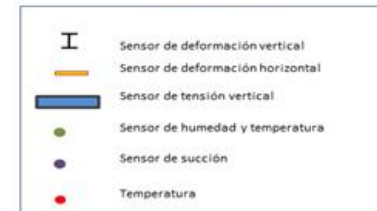
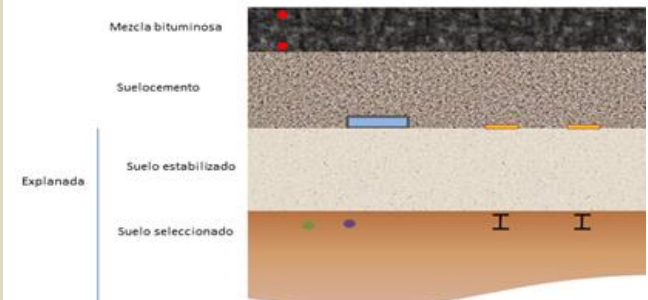


Foto 12. Útil de instalación de los sensores de deformación vertical LVDT

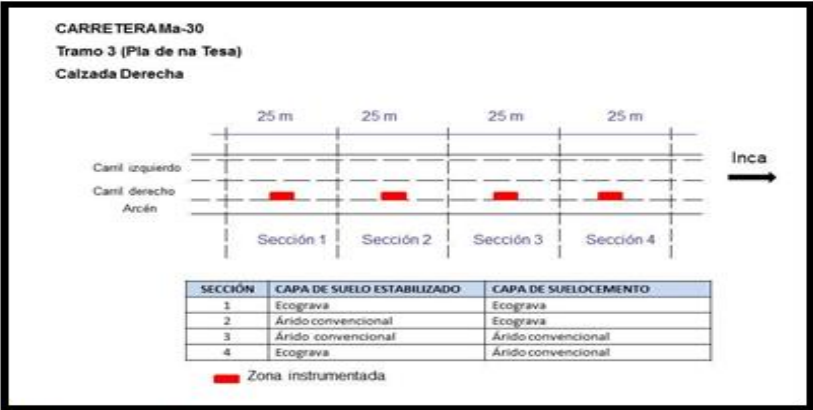
MINERAL-IBA. R&D – CEDEX Study

Intermediate results: October 2015

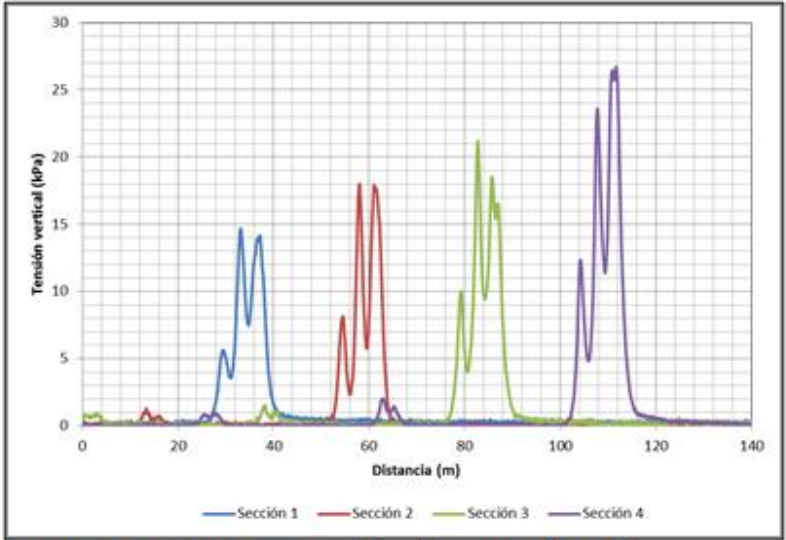
- ▶ The behaviour of the different sections with IBA are into the regular behaviour of conventional materials (According to PG3 Normative)
- ▶ Although Soil-cement section with IBA is below conventional section, the evolution over time is narrowing the gap.



Foto 3.1. Medida con el deflectómetro de impacto en la Sección 2



Experimental section



Vertical stress in the selected soil layer when driving a heavy truck on test sections

MINERAL-IBA. Uses: Roller compacted concrete (RCC)

Roller compacted concrete (RCC)

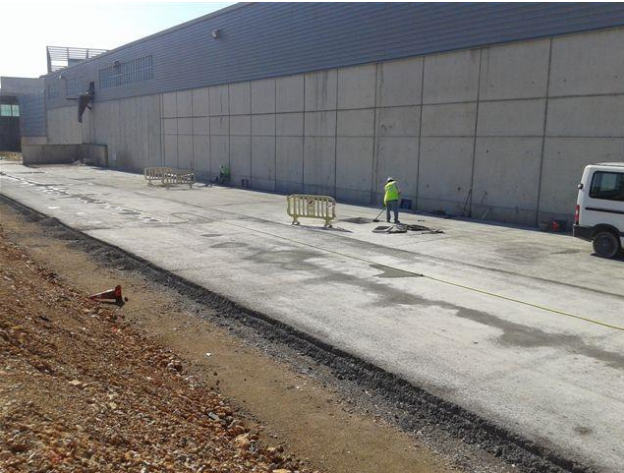
RCC is a special blend of concrete that has essentially the same ingredients as conventional concrete but in different ratios. It has lower cementitious materials content (cement and pozzolan) and less water, making it much drier and essentially having no slump. RCC is placed in a manner similar to paving.

Advantages:

- Low maintenance
- Lifespan much higher than other conventional paving
- Open to traffic in the short term.
- Excellent performance in streets, highways and rural roads for low speed and in car parks, industrial areas, storage meadows, parks, etc.
- It's a more environmentally friendly pavement:
 - ✓ Lower energy consumption (temperature)
 - ✓ Less artificial lighting
 - ✓ Use of local materials
 - ✓ Reuse of secondary aggregates



MINERAL-IBA. Uses: Roller compacted concrete (RCC)



Recipe used:

80% Natural aggregate, 20% IBA (0-20 mm) and a proportion of cement and water.

MINERAL-IBA. Uses: Cement production

Cement production (Clinker)

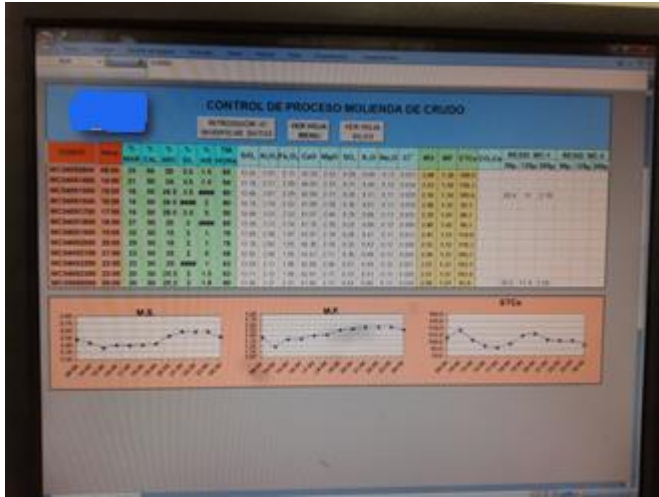
Use of IBA as aggregate filler (among others) in the pre-homogenization of raw material prior to processing in Clinker in the manufacturing process of certain conventional Portland. Approx. 10.000 tons/year of bottom ash.



MINERAL-IBA. Uses: Cement production



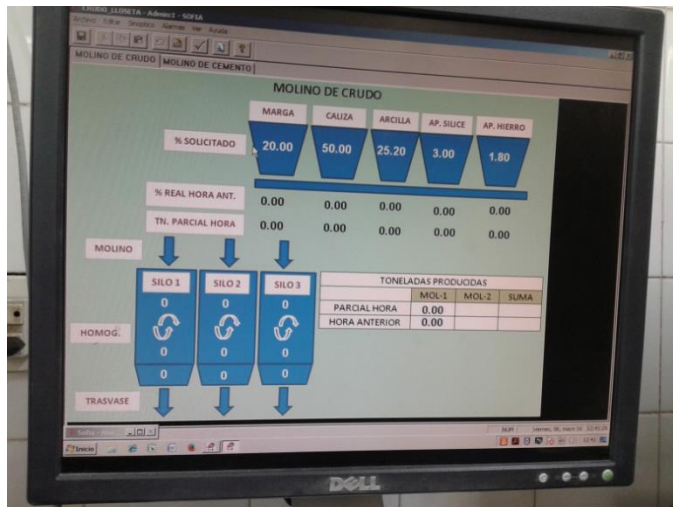
MINERAL-IBA. Uses: Cement production



ESPECIFICACIONES TÉCNICAS DE COMPRA

1. SULFATO:
 - SiO₂ max = 70 %
 - Al₂O₃ max = 10 %
 - Humedad max = 7 %
2. YESO:
 - SiO₂ max = 25 %
 - Humedad max = 5 %
3. CENizas VOLANTES:
 - P.F. max = 7.0 %
 - SiO₂ max max = 25 %
 - CaO max max = 10 %
4. CENizas DE PIRITA:
 - SiO₂ max = 4 %
 - Fa₂O₃ max = 75 %
 - Humedad max = 14 %
 - Cloruro max = 0.05 %
5. ARCILLA VIZCARRA:
 - CO₂ max = 50 %
6. SULFATO FERROSO:
 - Fa₂O₃ max = 18 %
 - H₂SO₄ max = 12 %
7. COKE:
 - S² max = 7.5 %
8. ESCORIA TIRME:
 - CaO max = 30 %
 - Fa₂O₃ max = 5.0 %
 - Cloruro max = 1.5 %

	MARGA	CALIZA	ARCILLA POPIA	ARCILLA VILL	AP. SILICE	ESC. TIRME	CEN TIRME	SIL. HIERRO	CRUDO
%	35.68	45.00	5.00	9.68	1.99	1.50	0.00	1.15	100.00
M.S.	2.36	1.79	2.32	3.33	18.94	2.12	0.00	0.41	2.50
M.F.	2.06	1.33	3.29	3.28	3.60	0.62	0.00	0.04	1.50
S.C.	102.1	1259.9	18.3	16.1	0.1	14.1	0.0	2.4	99.0
Tn/año	142709	180000	20000	38734	7946	6000	0	4612	400000

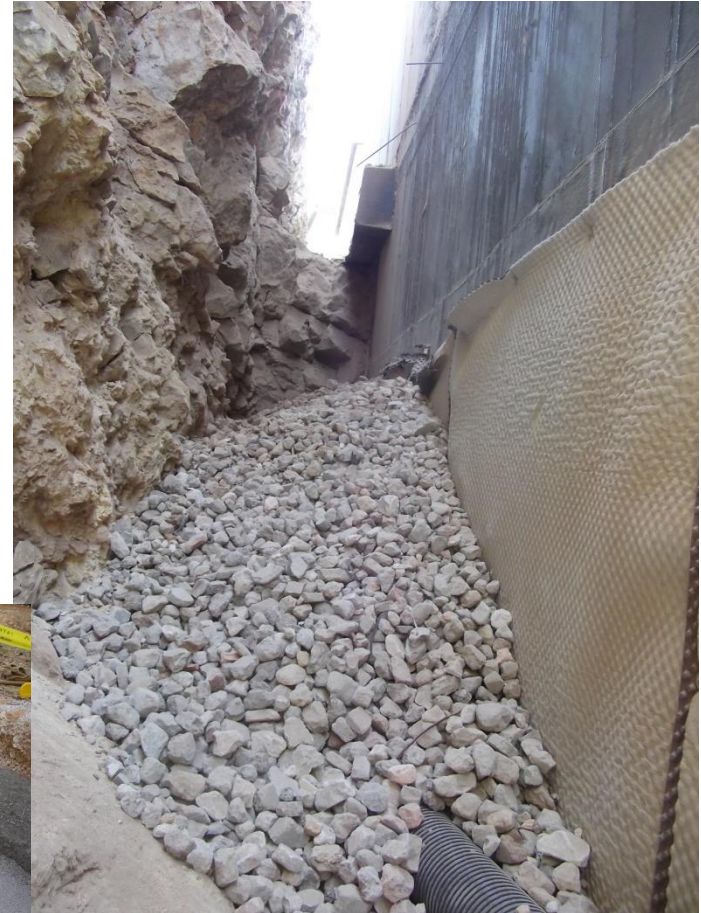


MINERAL-IBA. Uses: Precast concrete



Non-structural elements such as kerbs, paving stones, blocks for enclosures, etc.

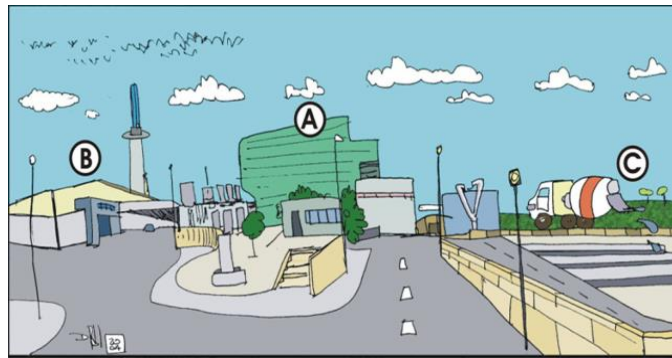
MINERAL-IBA. Uses: Filler material for trenches, drainages and Extrados



Gaining a commitment to stakeholders



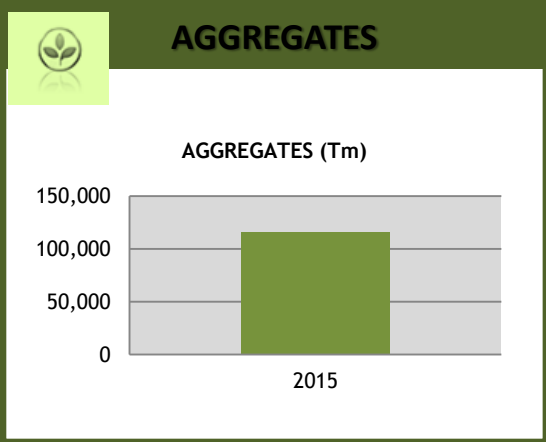
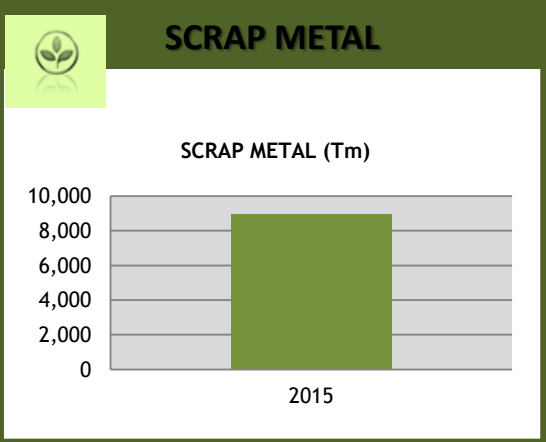
Let's hope it doesn't turn out that for seeking ways out, we ran out of ways in, eh?



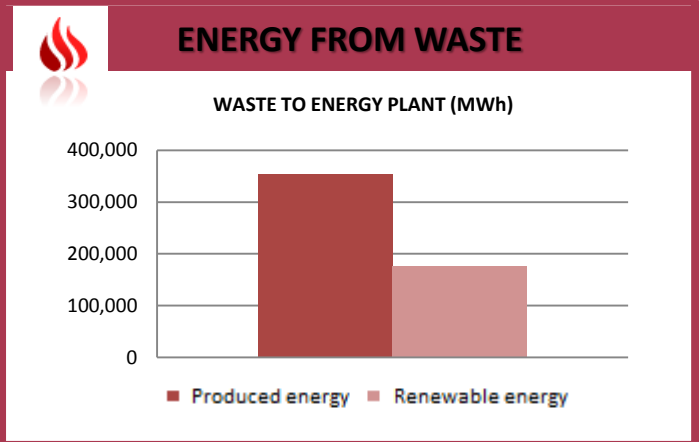
Energy recovery: 604.288 tons

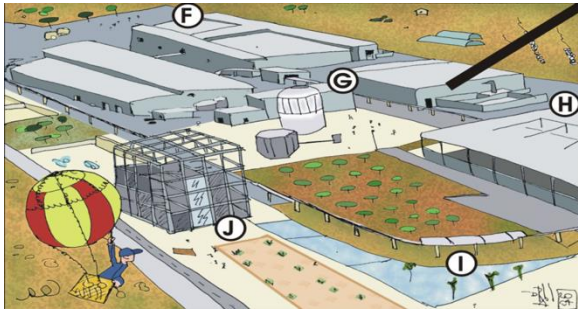
MSW AND SIMILAR WASTE	REFUSE FROM SORTING PLANTS	DRIED SLUDGE	C&D WASTE (REFUSE)	RDF
465.881	5.563	14.739	37.731	80.374

Material recovery and/or recycling: 134.717 tons



Energy recovery: 353.552 MWh





Material recovery and recycling: 135.359 tons

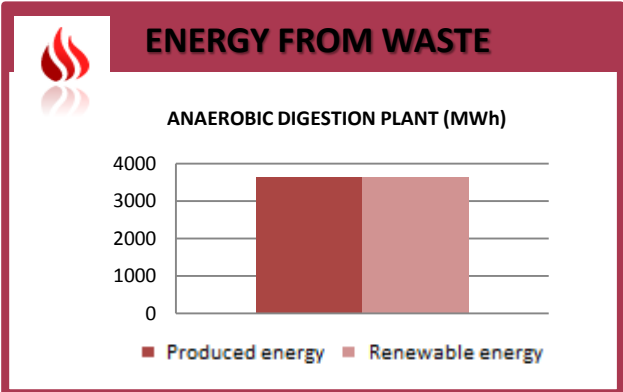
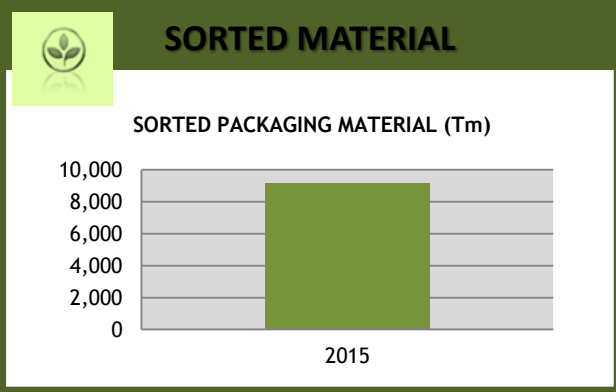
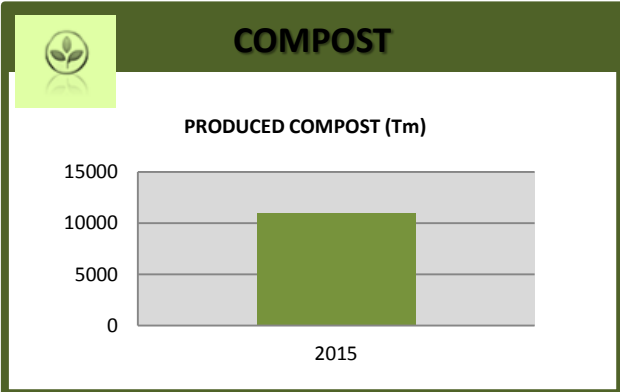
GLASS	PAPER & CARDBOARD	LIGHT PACKAGING MATERIAL	SOURCE-SEPARATED ORGANIC FRACTION	BULKING MATERIAL	SEWAGE SLUDGE
22.603	27.511	13.908	17.061	16.713	37.563

Material recovery: 64.022 tons

Biological treatment: 71.337 tons

Material recovery and/or recycling: 20.790 tons

Energy recovery: 3800 MWh



Since 2012 Zero landfilling



THANKS FOR YOUR ATTEMPTION

<http://www.tirme.com/>

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