


Recycling potentials of MSWI Bottom Ash

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EU long term ambition: legal framework

Waste Framework Directive 2008/98
Increase **energy recovery efficiency**

- Min. energy efficiency of MSWI required to become R1 installation
- Increase **recycling** rates of **materials**
- Introducing concept of "end of waste"
- Developing EoW criteria

=> modern "RECYCLING SOCIETY"

Bottom ash: amounts produced in EU

Country	Incinerated waste [million tonnes]	Bottom Ash [million tonnes]
Belgium (2010)	3.03	0.51
Czech Republic (2010)	0.51	0.16
Denmark (2008)	3.59	0.63
Finland (2009)	0.27	0.05
France (2008)	11.60	2.7
Germany (2010)	20.04	5.00
Hungary (2008)	0.40	0.09
Italy (2010)	4.71	1.27
Netherlands (2011)	7.2	1.6
Norway (2010)	1.35	0.25
Portugal (2011)	1.13	0.21
Spain (2011)	2.42	0.42
Sweden (2009)	4.50	0.74

Source: Amounts of bottom ash produced in Europe, CEWEP Country Reports 2010 and 2012

Bottom ash: recovery examples (1/2)

Country	Use as a secondary construction material
Austria	No intention to reuse except as landfill structure material
Belgium	Use of granulates in road construction, concrete products
Denmark	Road subbase and embankments, Filler for marine structures (dams, ports), Construction material for parking and small building foundations
France	80% of bottom ash recovered in road construction
Germany	Road subbase construction, recovery on landfills (roads, shaping) or storage in salt mines
Italy	Recovery in cement kilns, road construction, landfill construction

Bottom ash: recovery examples (2/2)

Country	Use as a secondary construction material
Netherlands	Road subbase and embankments, Noise barriers, Foundation material, Concrete products, Landfill prohibited
Portugal	Road construction, recovery on landfill sites (as construction layers)
Spain	Road construction, recovery on landfill sites (as construction layers)
Sweden	Reuse as landfill covering material
UK	55% reused as road material in 2011

Bottom ash: regional legislation for recycling
Comparison of leaching criteria

	Belgium Flanders (coming soon)		The Netherlands			France (EN 12457-2 mg/kg d.s.)	
	Shaped applications NEN 7345 (mg/m²)	Non-shaped applications CMA 2/II/A.9.1 (mg/kg d.s.)	Shaped applications NEN 7345 (mg/m²)	Non-shaped applications NEN 7373 (mg/kg d.s.)	IBC NEN 7373 (mg/kg d.s.)	Non-shaped covered by bitumen, coatings, …	Non-shaped covered by 30cm natural materials
As	27	0,80	260	0,90	2,0	0,60	0,60
Cd	1,1	0,03	3,8	0,04	0,06	0,05	0,05
Cr III	55	2,6	120	0,63	7,0	2	1
Cu	25	0,80	98	0,90	10	50	50
Hg	0,80	0,02	1,4	0,02	0,08	0,01	0,01
Pb	60	1,3	400	2,3	8,3	1,6	1,6
Ni	15	0,75	81	0,44	2,1	0,50	0,50
Zn	90	2,8	800	4,5	14	50	50
Sb	8	1	8,7	0,32	0,70	0,70	0,60
Ba	100	20	1.500	22	100	56	28
Co	35	0,5	60	0,54	2,4		
Mo	510	55	144	1,0	15	5,6	2,8
Se	2,5	2	4,8	0,15	3,0	0,10	0,10
Sn	10	1	50	0,40	2,3		
V	25	2,5	3.201	1,8	20		
Br	250	20	6.702	20	34		
Cl	20.000	1.000	1.100.002	616	8.800	10.000	5.000
F	500	55	25.002	55	1.500	60	30
SO_4	7.000	2.200	1.650.002	1730	20.000	10.000	5.000

Governments strive towards high quality

The Netherlands: Highlights of the 'Green Deal'

Make the 'IBC' (Encapsulate, Protect, Control) category obsolete:

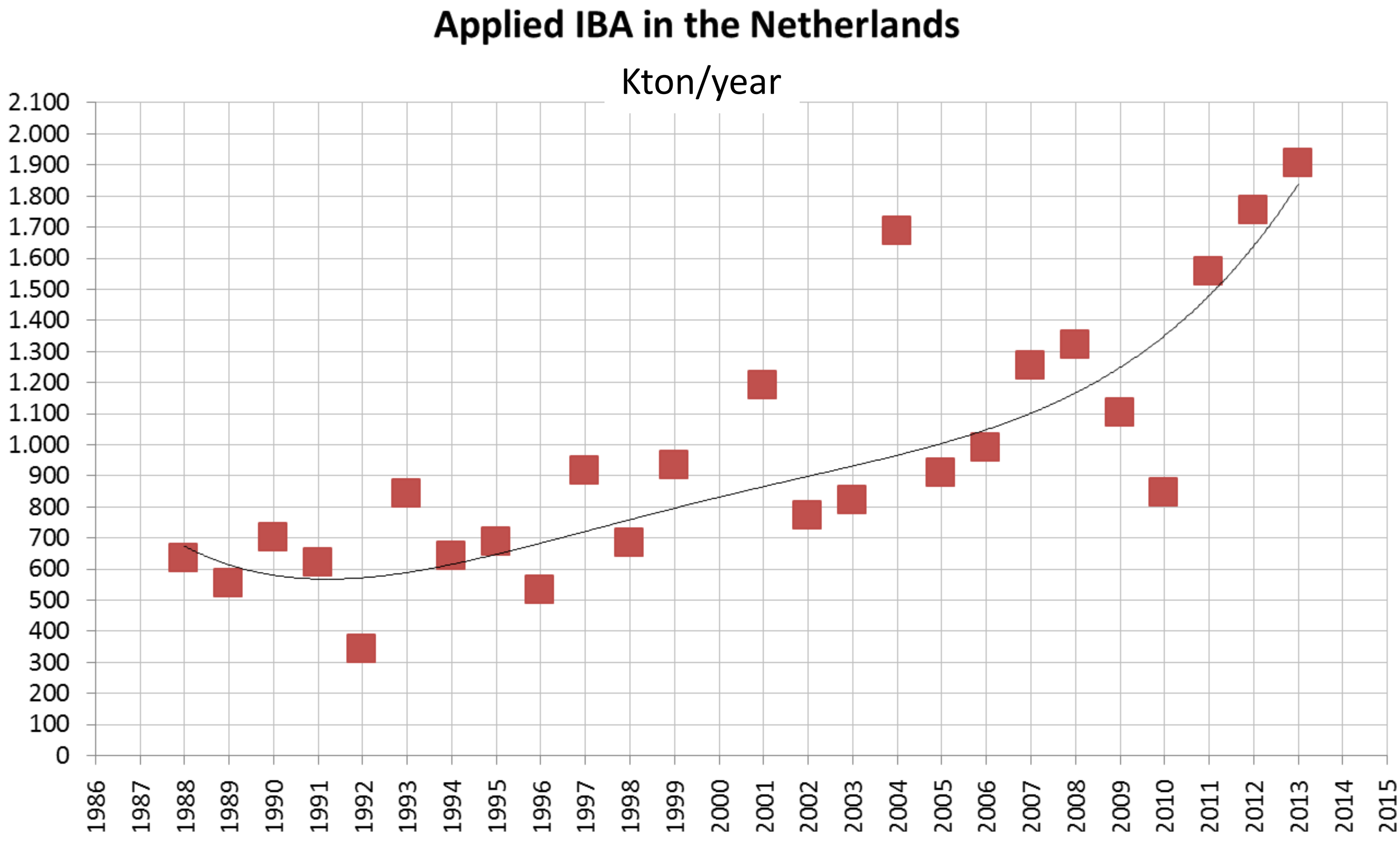
- By January 1st, 2017:
  50% of IBA has to find useful application, other than 'IBC'
- By 2020:
  100% of the IBA finds other applications than 'IBC'
- (Halfway: evaluation of the economical consequences)

Enhance the recycling of NF metals:

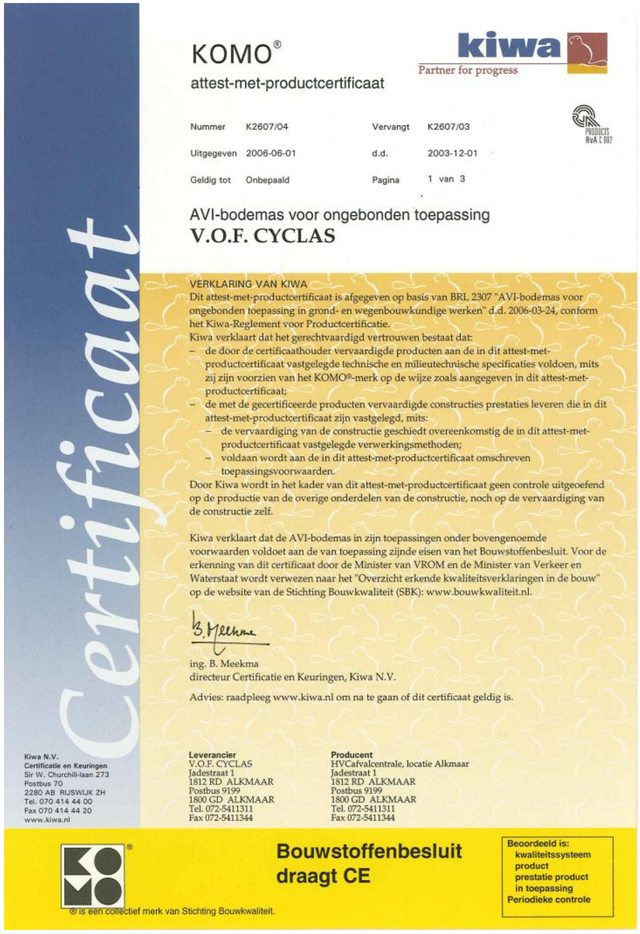
- By January 1st, 2017:
  75% recycling of non-ferrous metals fraction > 6 mm
- Before 2020:
  Set goals for the recycling of non-ferrous metals < 6 mm

➔ Clear regulation leads to technical choices and progress: the market evolves

Growth of useful application of bottom ash



Clear environmental and civil demands: allows certification: assured quality!



Certificaat

KOMO®
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Nummer	K2607/04	Vervangt	K2607/03
Uitgegeven	2006-06-01	d.d.	2003-12-01
Geldig tot	Onbepaald	Pagina	1 van 3

AVI-bodemas voor ongebonden toepassing
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Advies: raadpleeg www.kiwa.nl om na te gaan of dit certificaat geldig is.

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Beoordeeld is:
kwaliteitssysteem
product
prestatie product
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Periodieke controle

® is een collectief merk van Stichting Bouwkwaliteit.

Certification is institutionalized 'trust'
and refers to regulation:

i.e. clarity
for customer

Factory Production Control Certificate

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Number	K40089/02	Replaces	K40089/01
Issued	2006-01-01	First edition	2005-05-13
Valid until	no predetermined expiry date	Scope	NEN-EN 13242

CERTIFICATE OF FACTORY PRODUCTION CONTROL 0620 - CPD – K40089

Notified Body, Kiwa Certification has determined that

VOF CYCLAS

fulfills all provisions concerning the attestation of factory production control described in Annex ZA of the standard NEN-EN 13242 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction

Product:
Incinerator bottom ash for use in civil engineering work and road construction

Liability CYCLAS	Liability Kiwa Certification
Factory Production Control	Certification of FPC
Initial Type Testing Further testing of production samples	Surveillance of FPC

ing. B. Meekma
Director Certification and Inspection, Kiwa N.V.

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Publication of the certificate is allowed.
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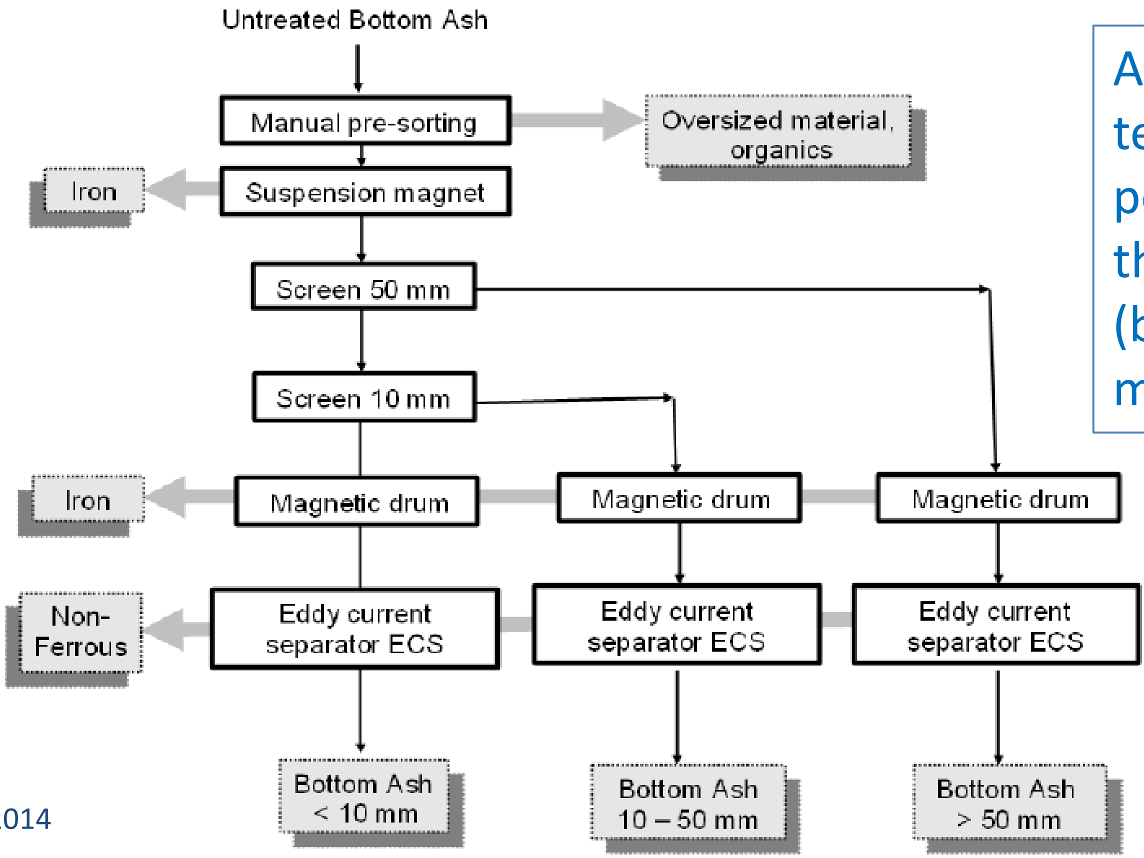
Bottom ash: treatment techniques

How to fullfill the new environmental targets ?

Bottom ash: treatment techniques 1/3

Conventional method (used in most of the WtE plants in Europe) bottom ash is removed from the grate by a wet discharge and follows a dry treatment process. In this approach the final goal is to achieve a high quality material that can be used as a secondary construction material in selected applications.



Application of this technology results in a positive business case: the yield of metals (both Fe and NF) makes it worthwhile

Bottom ash: treatment techniques 2/3

An innovative approach to bottom ash treatment removes the bottom ash from the grate by a wet discharge and follows a wet treatment process. The goal is to further improve the quality of the secondary construction material and recyclability of the metals (proven in Flanders (Belgium), Netherlands, Germany).

+ Washing / fractionating based on wet soil cleaning technology

+ Can remove salts from bottom ash

- Uses water/ needs water

- A sludge (< 63µm) fraction (10 - 15%) has to be landfilled. This contains heavy metals

Application of this technology may render a positive business case: depending of the yield of NF metals

Bottom ash: treatment techniques 3/3

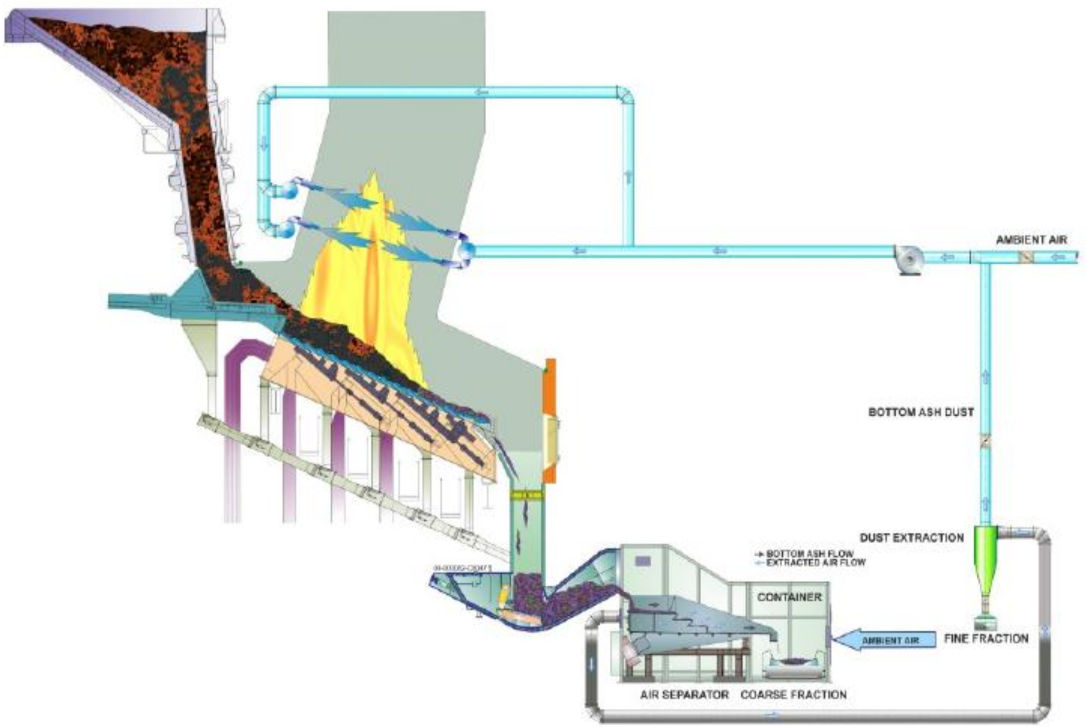
In two WtE plants in Switzerland (KEZO, Hinwill and SATOM, Monthey) bottom ash is removed from the grate by dry extraction and can follow a dry treatment process:

+ metal separation and metal quality

- higher leaching values for Sb, Br and Pb

- Risk

This technology finds application when the remaining IBA residue (after recovery of the fine metals) has to be landfilled anyway (reuse possibility not yet proven)



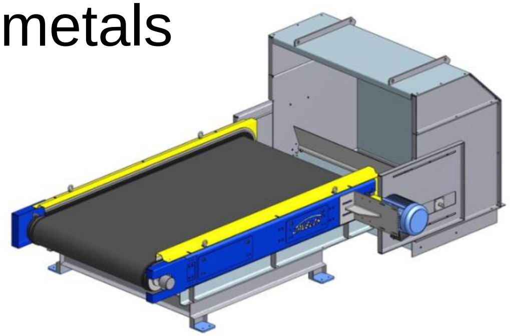
How to fullfill the new environmental targets ?

- CASE STUDIES:
  - INDAVER
  - HVC (Boskalis)

- Using a wet separation process to:
  - Convert process residues into useful **"secondary raw materials"**
  - Minimising the need for landfill space
  - Replacing raw 'primary' materials
  - Recover metals (fines, precious) as much as possible

Non-Ferrous recycling

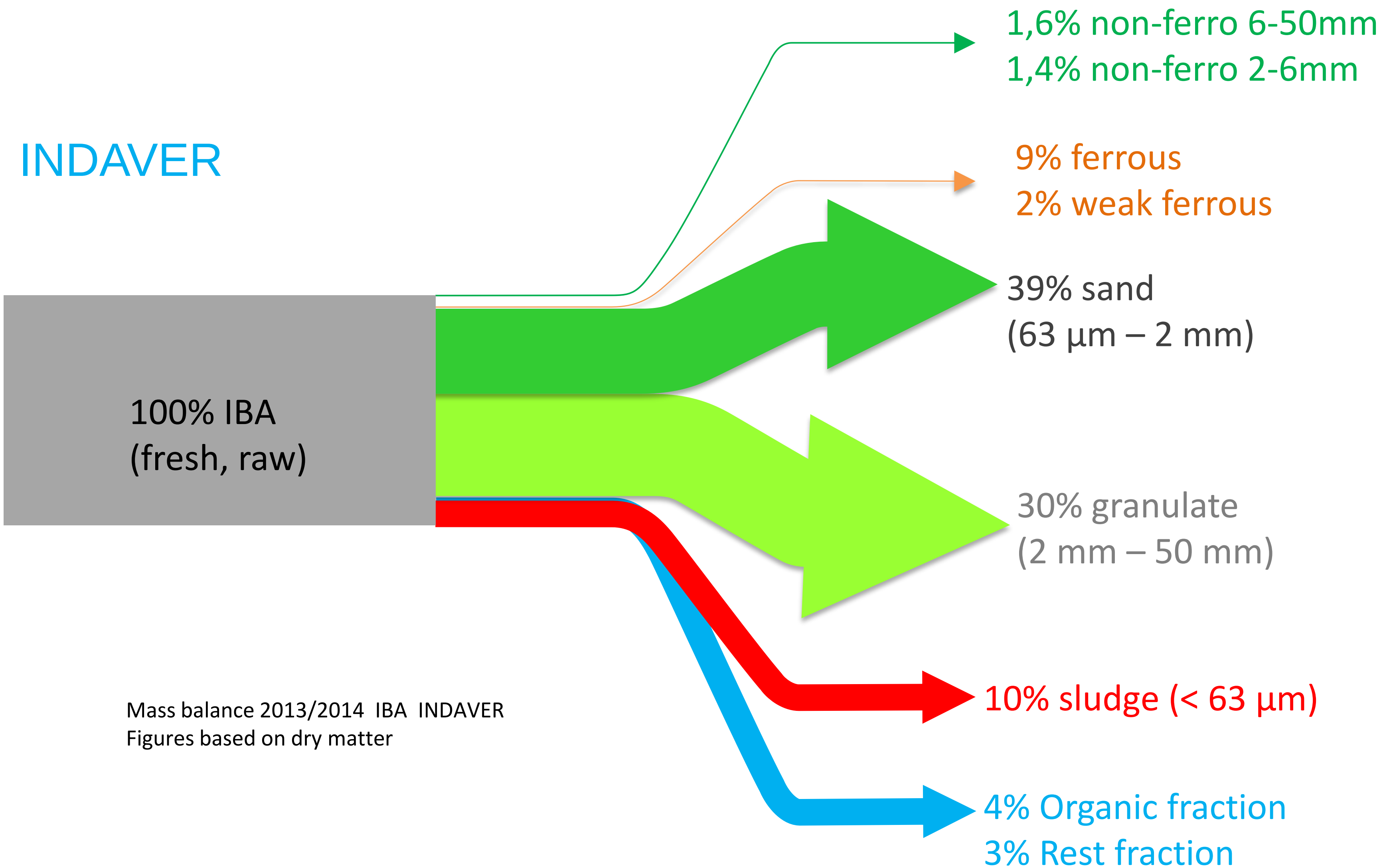
Enhancement of recycling of non-ferrous metals (75% of the NF > 6 mm) :



- **(Add-on) NF separation techniques**
  e.g. Enhanced Dry Recovery (InAshco) or Steinert, … as an add-on(s) to the classical dry treatment of IBA.
  Subsequently, the gravel fraction can be applied in concrete

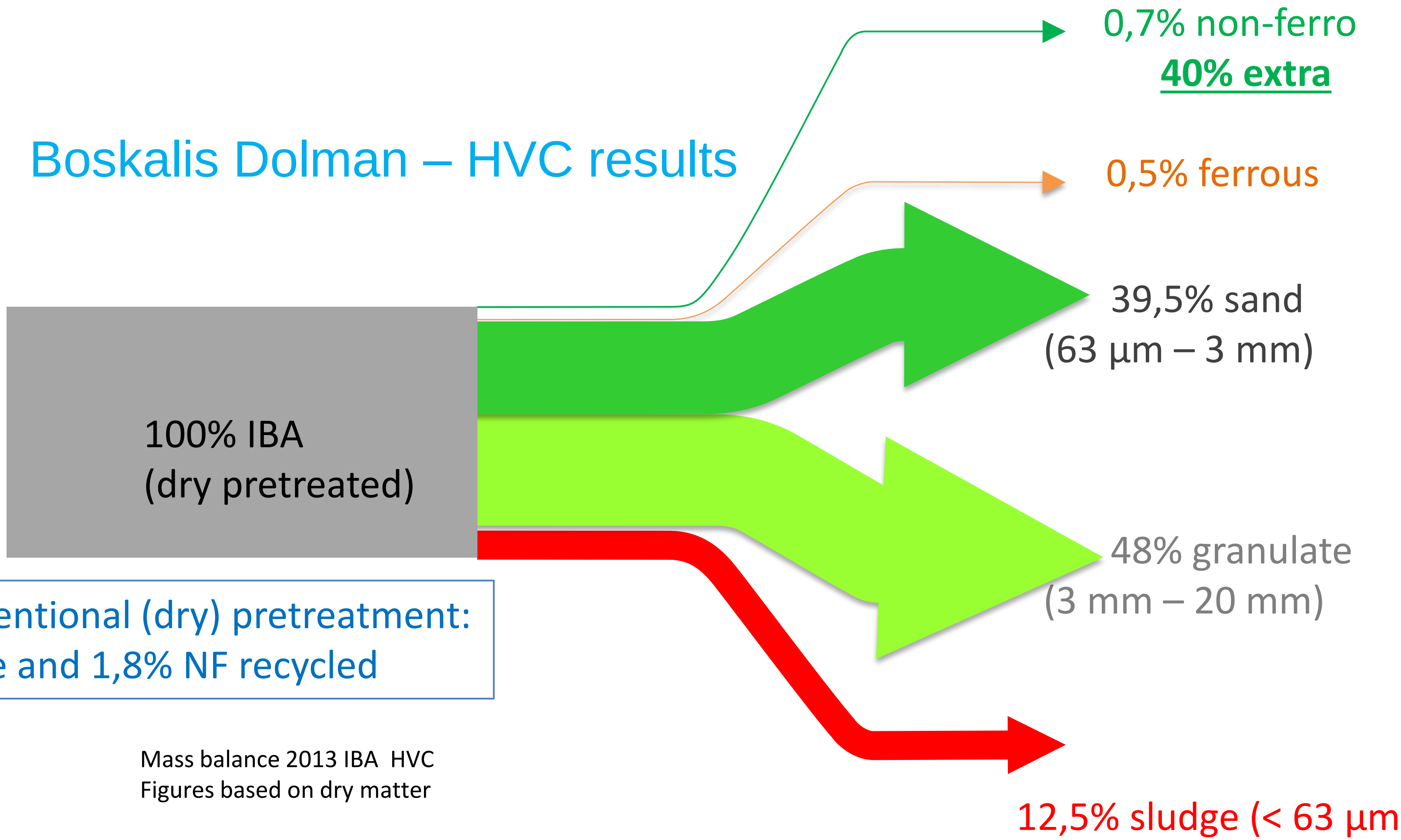
- **Improvement of the ballistics of NF particles**
  Washing / fractionating based on wet soil cleaning technology purifies the NF particles
  Subsequently, the washed IBA can be applied as a ‘normal’ building material

Wet treatment of bottom ashes: actual performance



Wet fractionating & washing

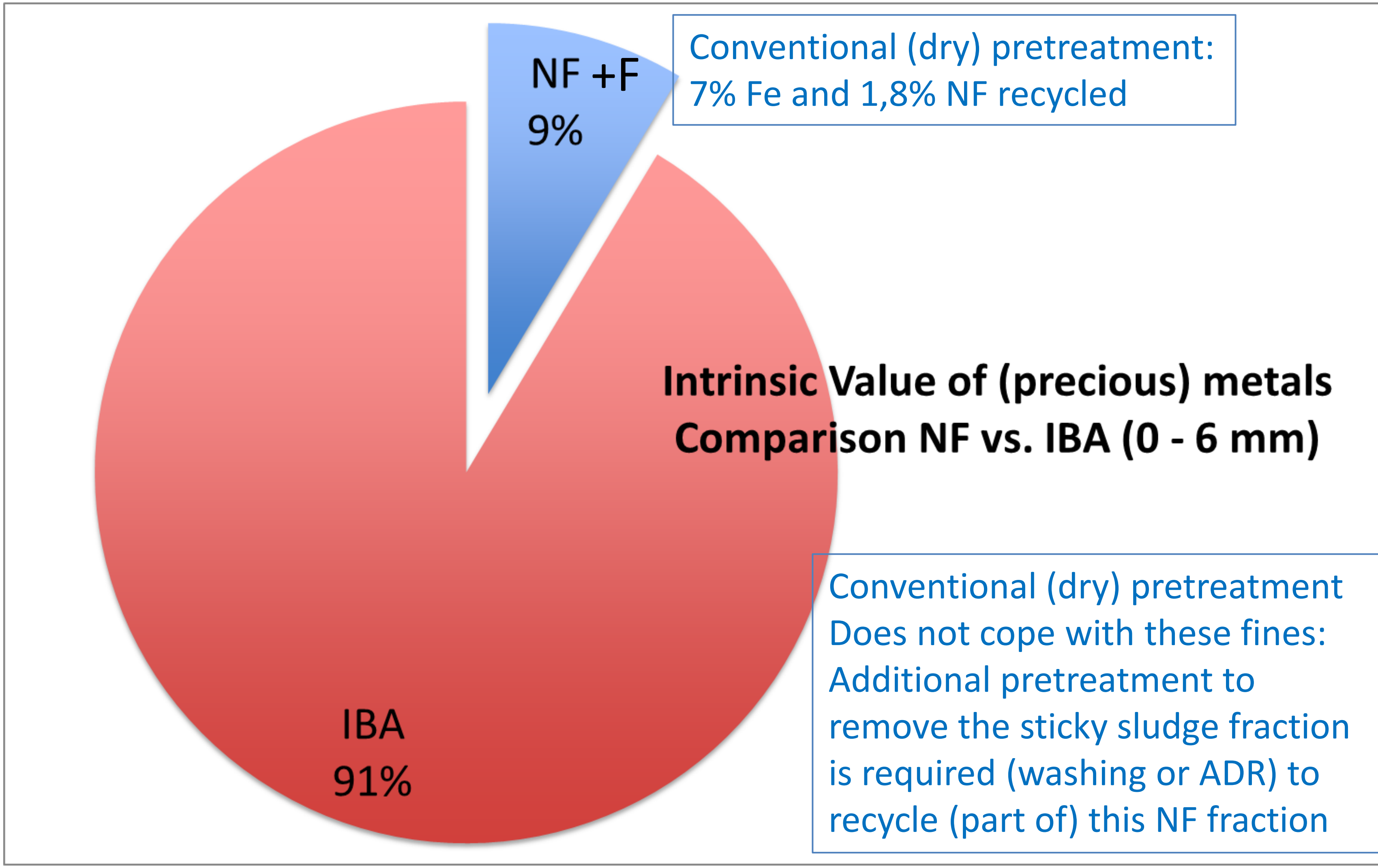
Boskalis Dolman – HVC results



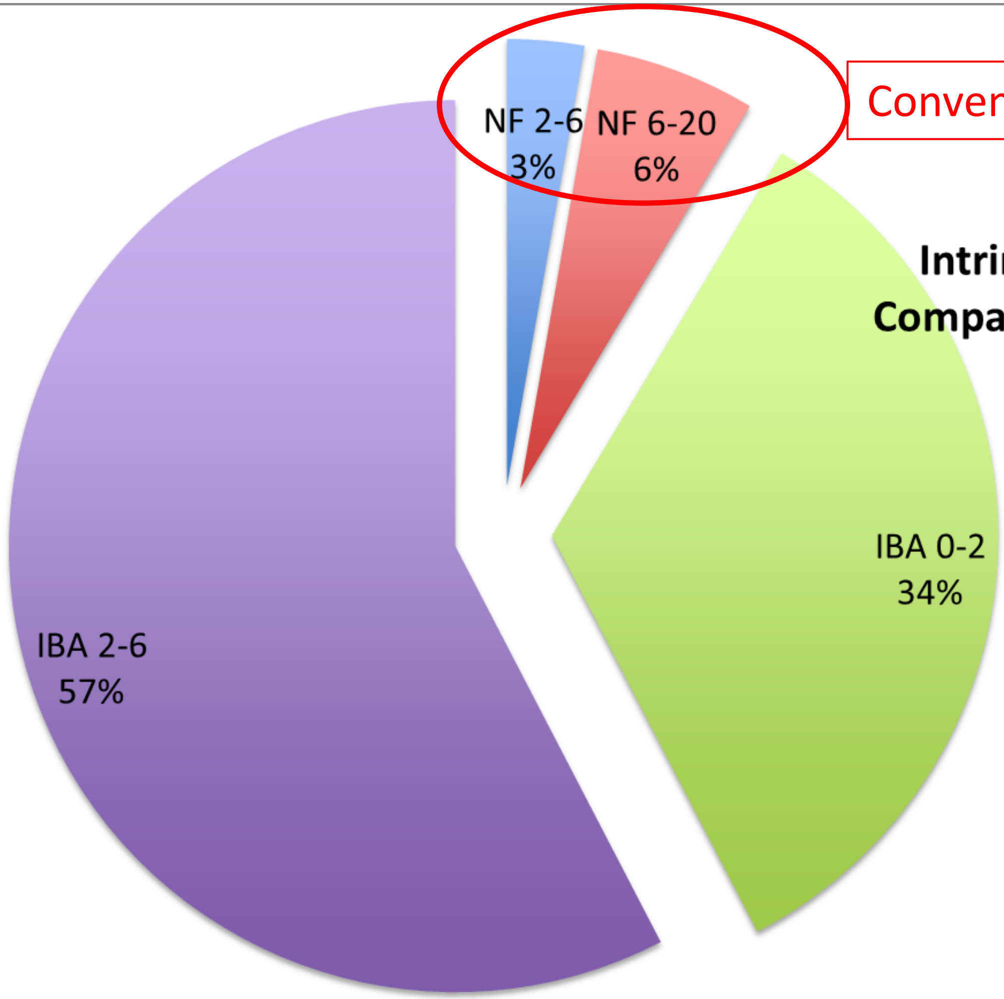
Conventional (dry) pretreatment:
7% Fe and 1,8% NF recycled

Mass balance 2013 IBA HVC
Figures based on dry matter

Maximum F+NF recycling…..

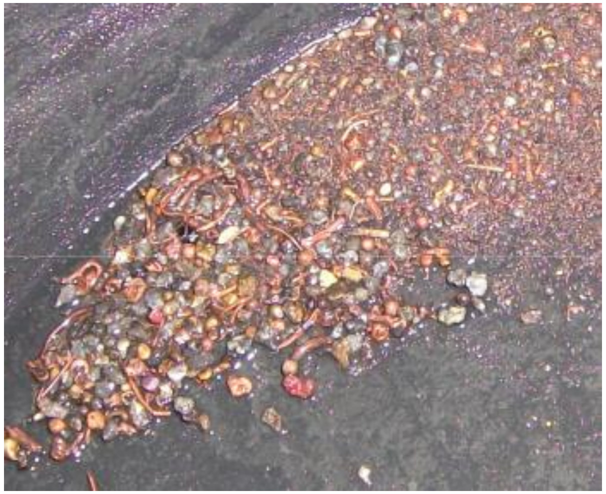


Overview of the analysis

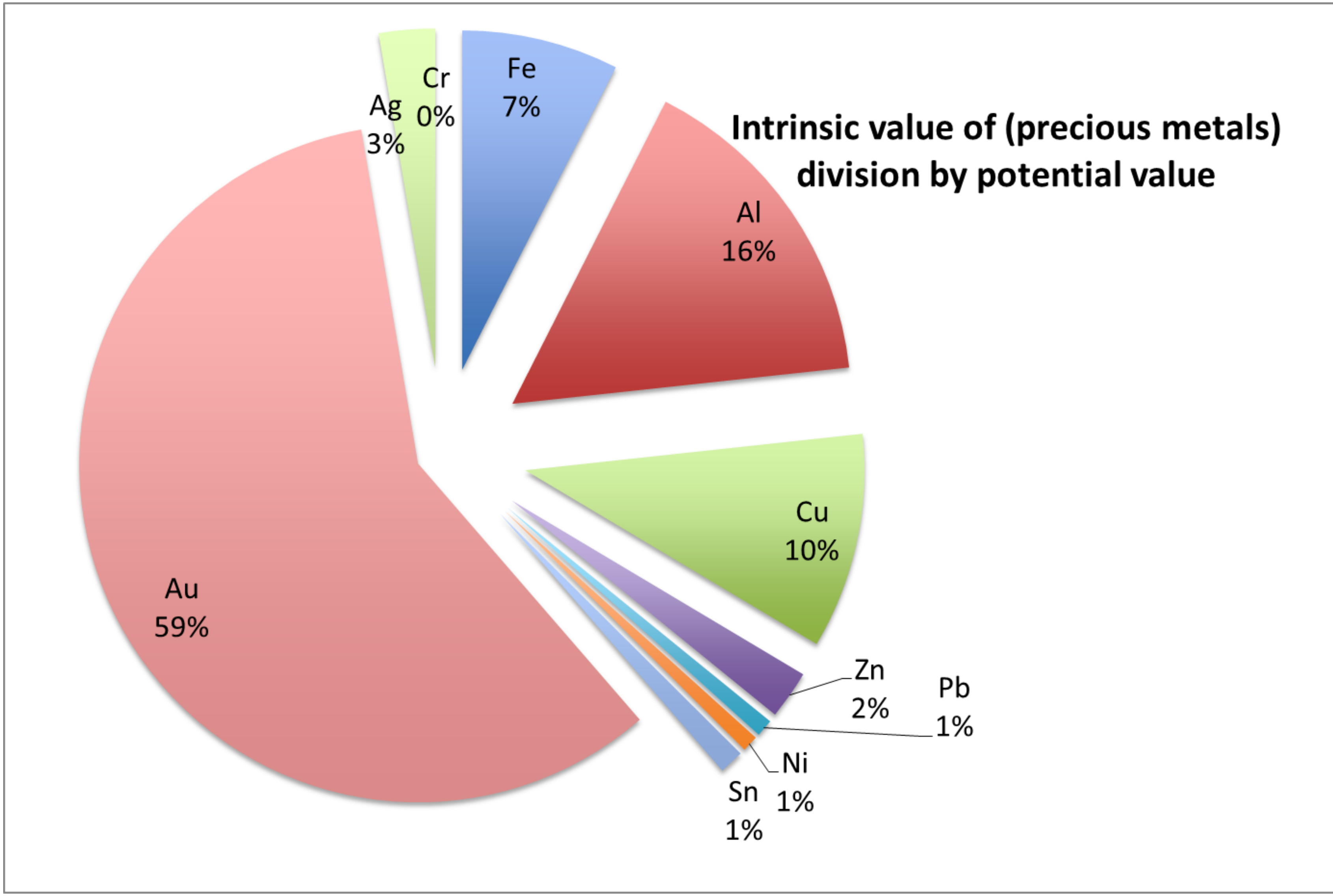


Conventional separation

Intrinsic value of (precious) metals
Comparison value of analyzed fractions



Precious metals



Restrictions: legal

- No harmonization on environmental standards between EU member states:
  - Application allowed or not
    (ranges from ban on landfill <-> ban on application)
  - Leaching conditions (which test method)
  - Parameter set: metals, organics, POP's, …
  - Limit values

- Result: uncertainty and, hence, risks are considered too high for entrepreneurs…

Restrictions: market

- Perception on the use of W-t-E granulates still negative
- At the moment low to negative prices for mineral fractions from bottom ash (competition of other secondary materials and/or IBC measures)
- Good market prices for ferrous / non ferrous necessary to keep facility economically feasible

Restrictions: socio - economical

- Need for further facilitating role of authorities e.g:
  - Act predictable and consistently
  - Legislate leaching behavior rather than composition
  - ‘Ease’ regulation towards technical achievable targets (but not in the extent that innovation is obsolete)
  - Award use of bottom ash in public works

- Promote application of bottom ash fractions in balance with the aim of protecting the environment

Concluding remarks

- A change in IBA treatment is imminent, driven by:
  - Environmental pressure on the quality of the mineral fraction (applied as building material)
  - The (intrinsic) value of the metals present in the IBA
- ‘Winning techniques’ make progress on both fronts: metal recycling can (in part) compensate the costs of quality improvement of the mineral fraction.