# Bottom Ash Treatment – „State-of-the-art“ in Germany

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# Agenda

- Metal in Wate
- Bottom Ashes
- Methods
- Results
  - Inputs
  - State-of-the-art of bottom ash treatment in Germany
  - Metal qualities
- Conclusions

# Bottom ashes

- Long tradition in waste incineration: first plant on the European continent Hamburg 1896
- About **24 Mio Mg/a** of waste is **incinerated** in Germany
- About **5 Mio Mg/a of MSWI bottom ashes**
- Recovery of **metals**
- Utilization of **mineral material**
- **Lack of data** on current recovery rates, especially nf metals, state-of-the-art

# Metal recovery from bottom ashes from waste incineration – evaluation of the resource efficiency

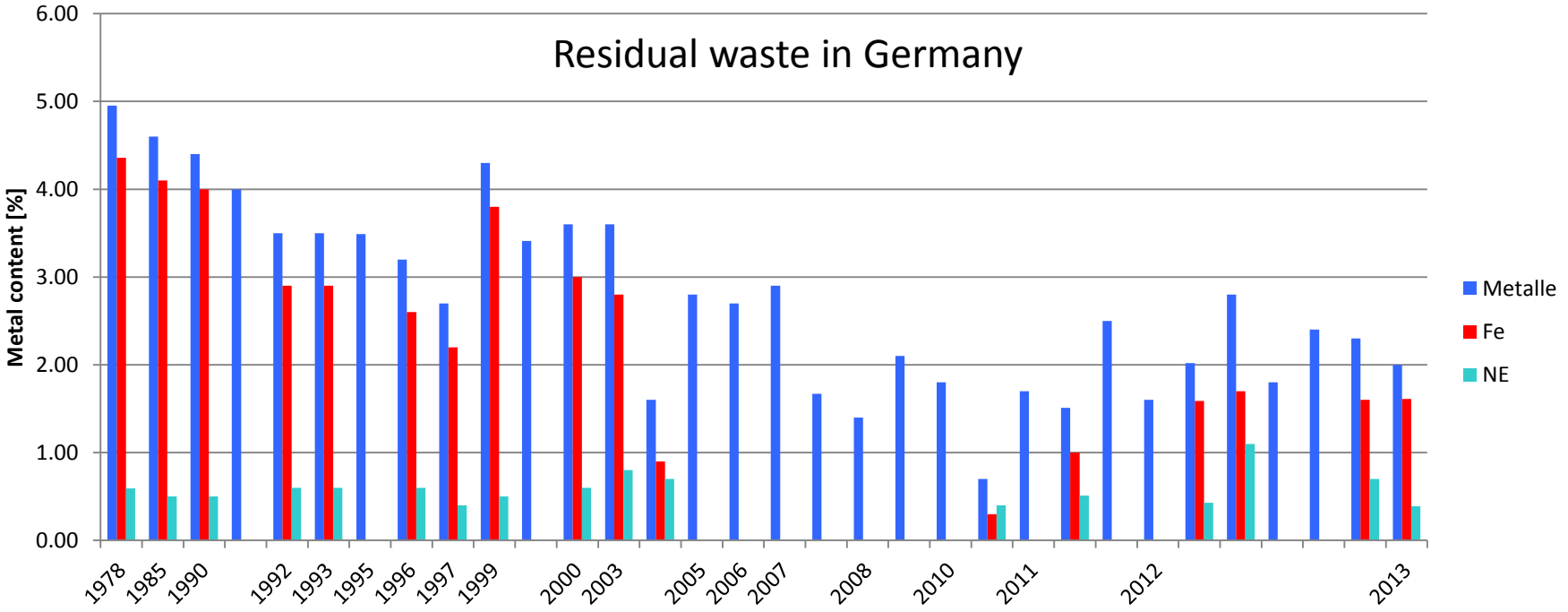
- **Resource potential bottom ashes** – waste composition
- **Resource effiency state-of-the-art** bottom ash treatment and mechanical waste treatment
- **Estimation of the quality of metals**
- **Evaluation of the resource effiency**

# Climate protection potential Metal recovery

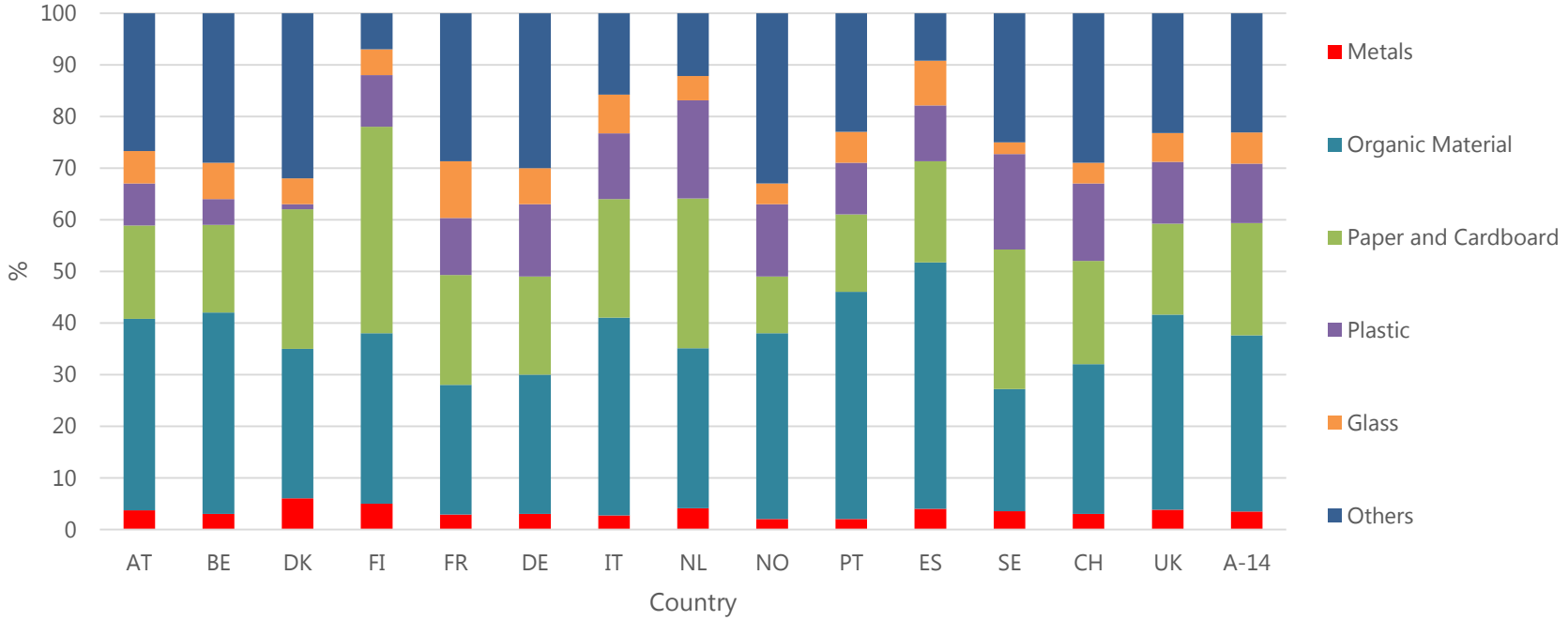
| Material | kg CO2 Eq/Mg |
|---|---|
| Iron | 945 |
| Copper | 2106 |
| Aluminum | 9307 |
| Stainless steal | 3096 |
| “metal mix BA" (80% Fe, 12% Al, 4% Cu, 4% VA) | 2081 |

# Metal Potential in Waste

# Resource potential



# MSW Composition in Europe



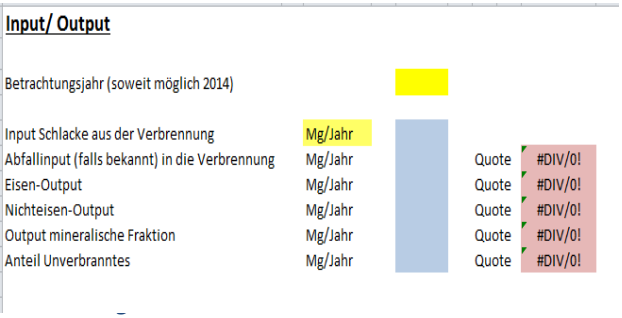

*MSW Composition of the researched Countries (%)*

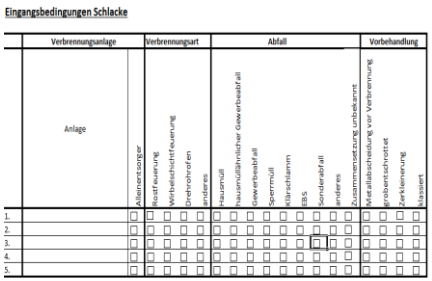
| | A-14 | Median | MIN | MAX | σ |
|---|---|---|---|---|---|
| Organic Material | 34.1 | 34.5 | 23.7 | 47.7 | 6.83 |
| Paper and Cardboard | 21.8 | 19.8 | 11 | 40 | 6.93 |
| Plastic | 11.5 | 11.5 | 1 | 19 | 1.05 |
| **Metals** | **3.5** | **3.25** | **2** | **6** | **1.05** |
| Glass | 6 | 5.8 | 2.3 | 11 | 2.11 |
| Others | 23.1 | 25.85 | 7 | 33 | 8.31 |

# Methodology

- Questionnaires to all German bottom ash treatment plants
- Cooperation with IGAM (German association of bottom treatment plants)
- Cooperation with ITAD (German association of waste incineration plants)
- Cross-check possibility
- → **24 questionnaires from bottom ash treatment plants**
- → **→ 25 answers from incineration plant**

**4,2 Mio. Mg**



# Methodology

Aspects of the questionaire:

- Input/ Output
- Origin of bottom ashes
- Technique of treatment of bottom ash
- Quality and characteristics of different metals

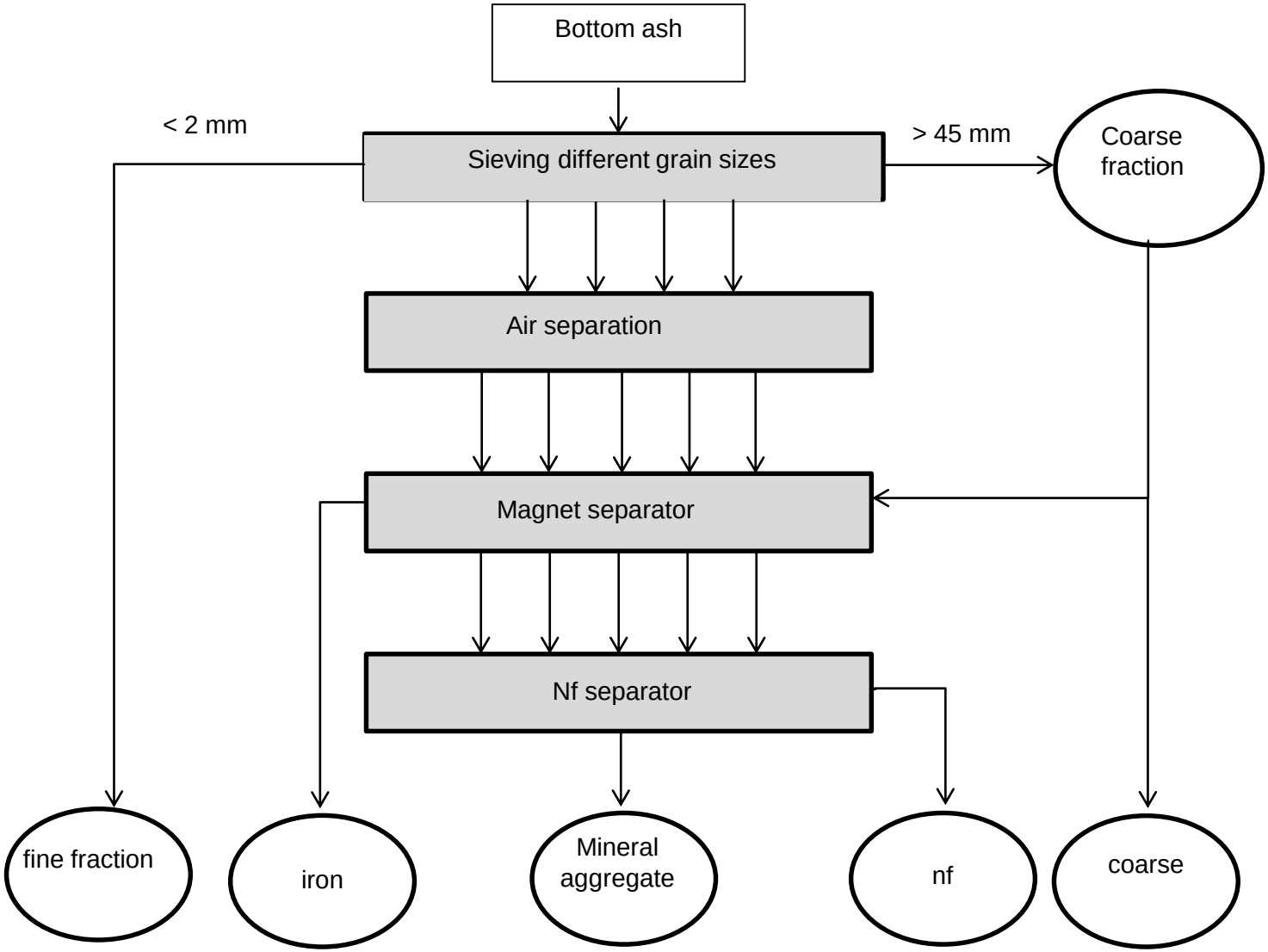
**Input/ Output**

| | | | | |
|---|---|---|---|---|
| Betrachtungsjahr (soweit möglich 2014) | | | | |
| Input Schlacke aus der Verbrennung | Mg/Jahr | | | |
| Abfallinput (falls bekannt) in die Verbrennung | Mg/Jahr | | Quote | #DIV/0! |
| Eisen-Output | Mg/Jahr | | Quote | #DIV/0! |
| Nichteisen-Output | Mg/Jahr | | Quote | #DIV/0! |
| Output mineralische Fraktion | Mg/Jahr | | Quote | #DIV/0! |
| Anteil Unverbranntes | Mg/Jahr | | Quote | #DIV/0! |

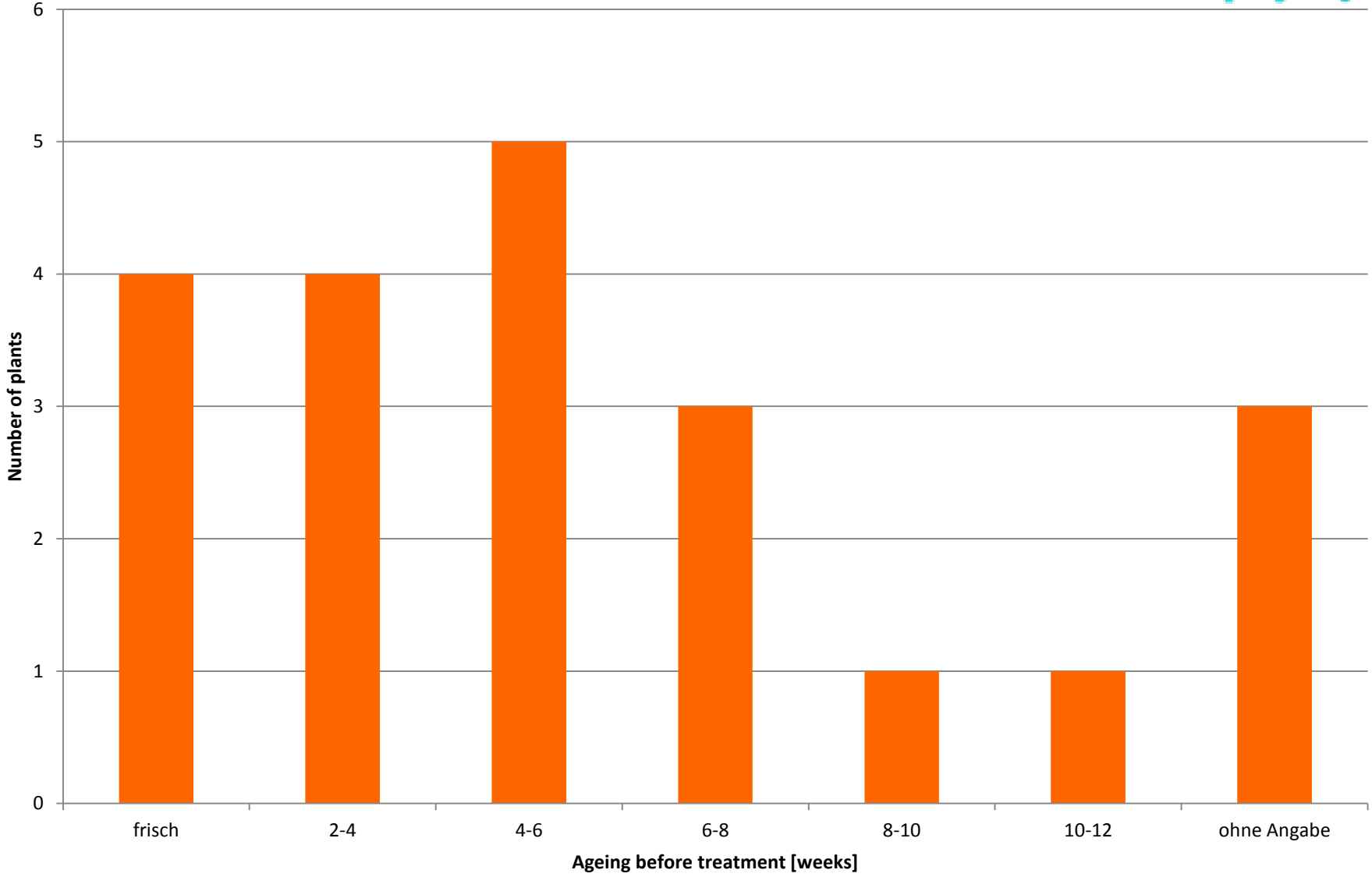
**Eingangsbedingungen Schlacke**

| | Verbrennungsanlage | | Verbrennungsart | | | | Abfall | | | | | | | | | | Vorbehandlung | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Anlage | Alleinentsorger | Rostfeuerung | Wirbelschichtfeuerung | Drehrohrofen | anderes | Hausmüll | hausmüllähnlicher Gewerbeabfall | Gewerbeabfall | Sperrmüll | Klärschlamm | EBS | Sonderabfall | anderes | Zusammensetzung unbekannt | Metallabscheidung vor Verbrennung | grobentschrottet | Zerkleinerung | klassiert |
| 1. | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

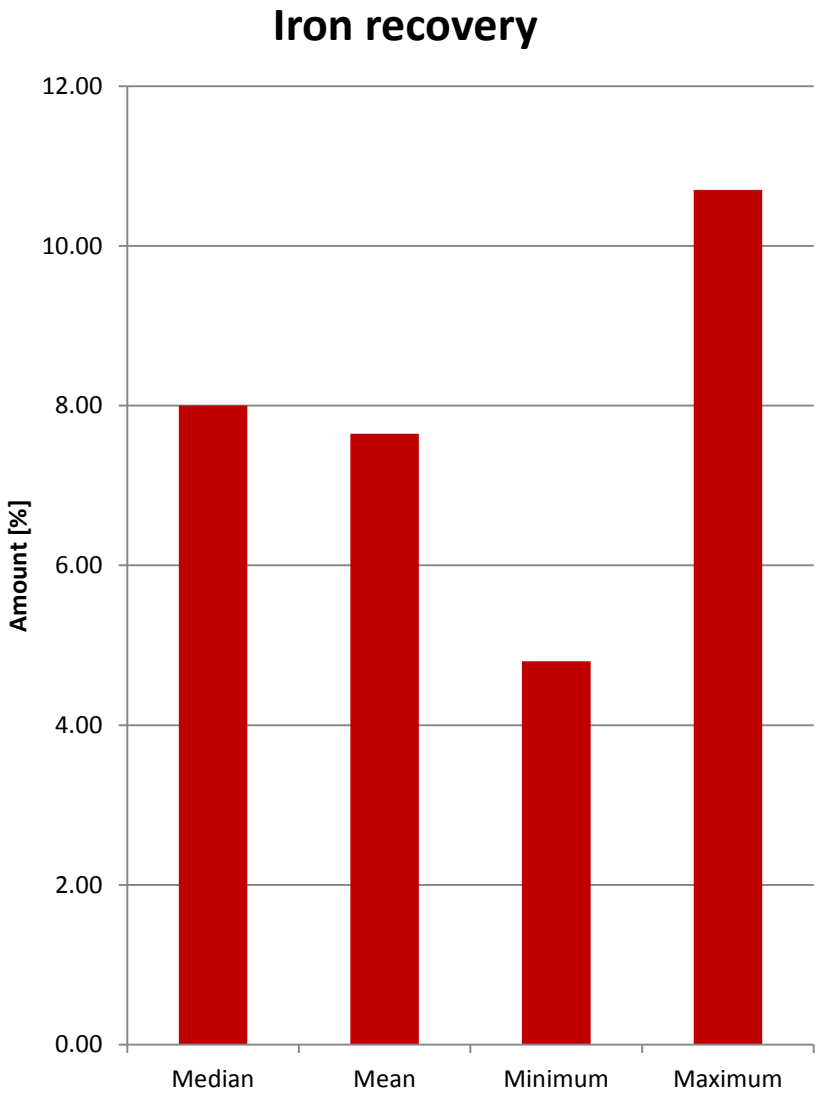
# State-of-the-art bottom ash treatment

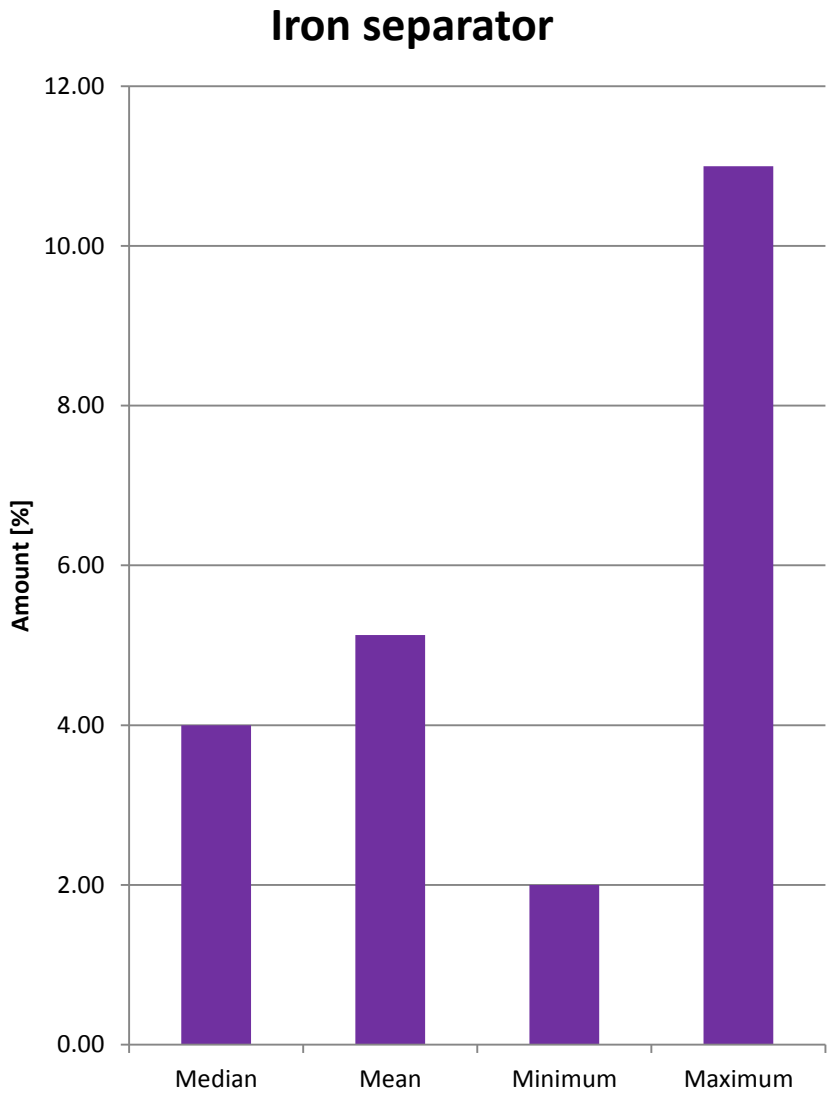


# Ageing of bottom ashes



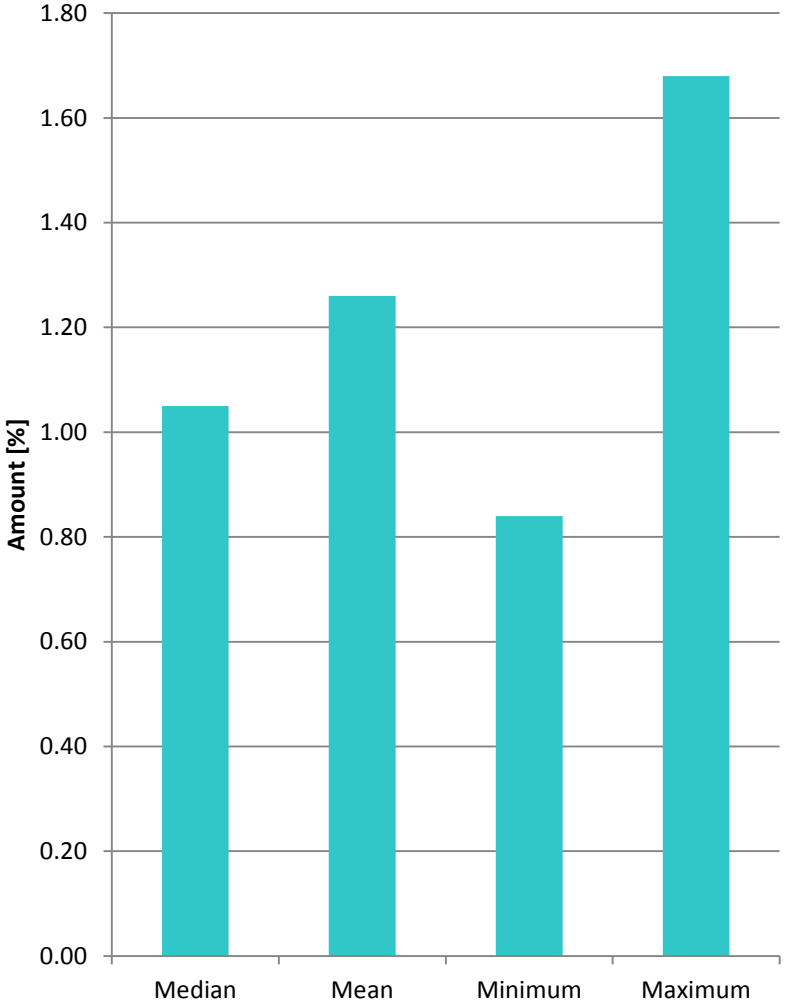
# Iron


Iron recovery
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Amount [%]
Median
Mean
Minimum
Maximum

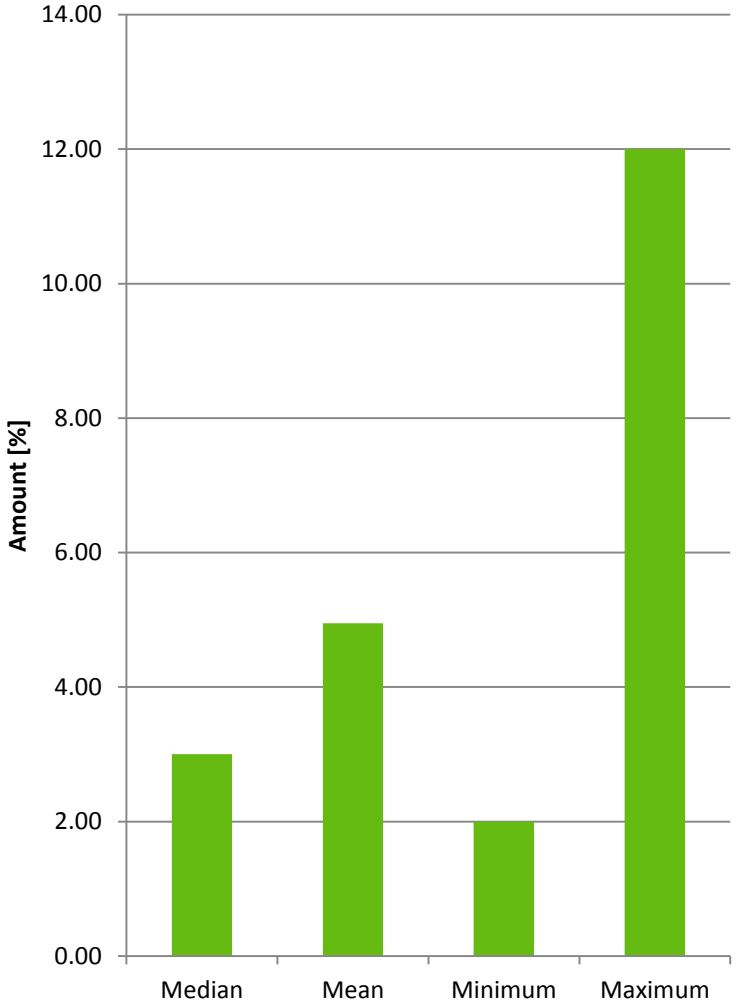

Iron separator
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Amount [%]
Median
Mean
Minimum
Maximum

# Non ferrous metals

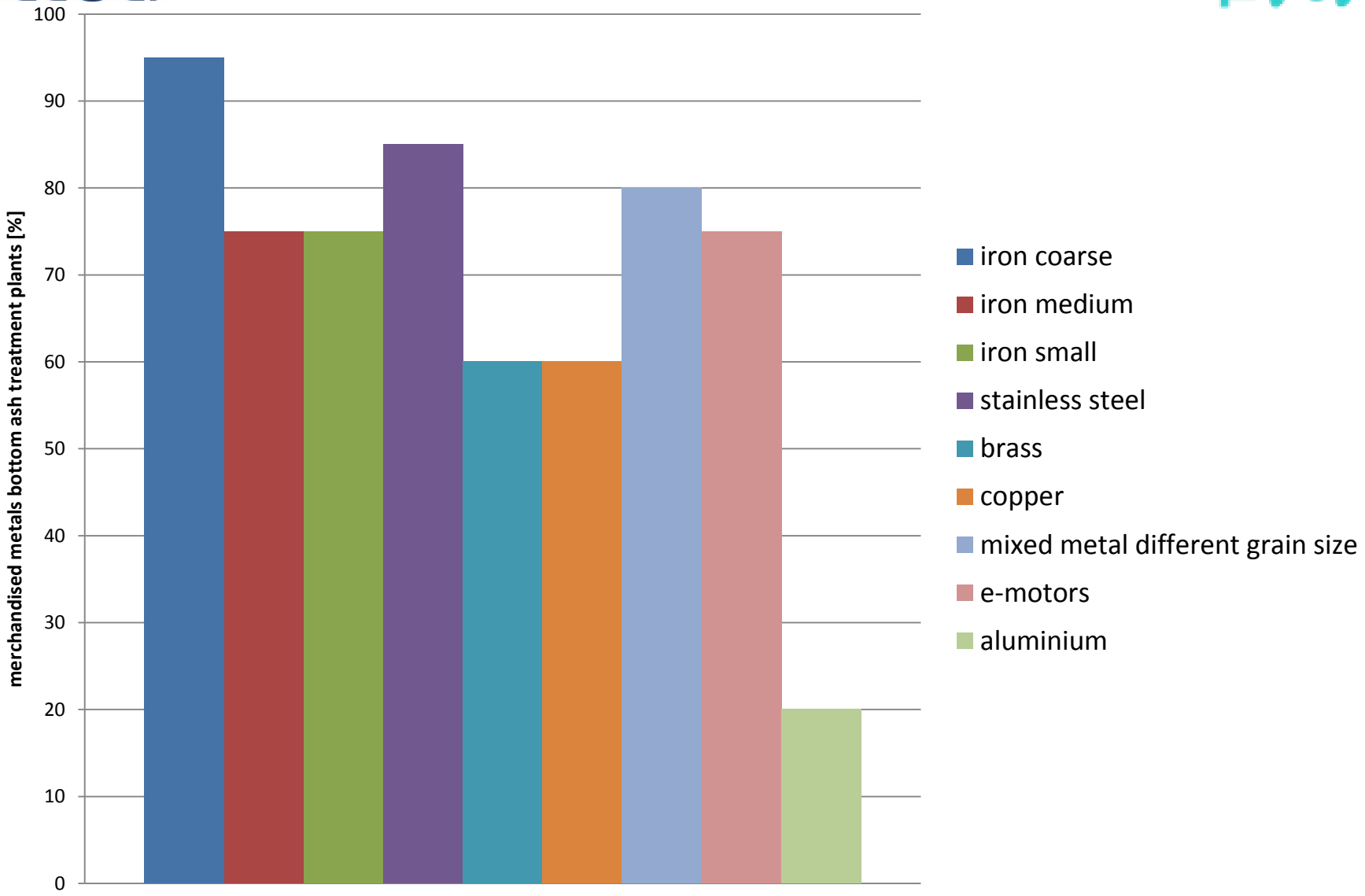
## nf recovery



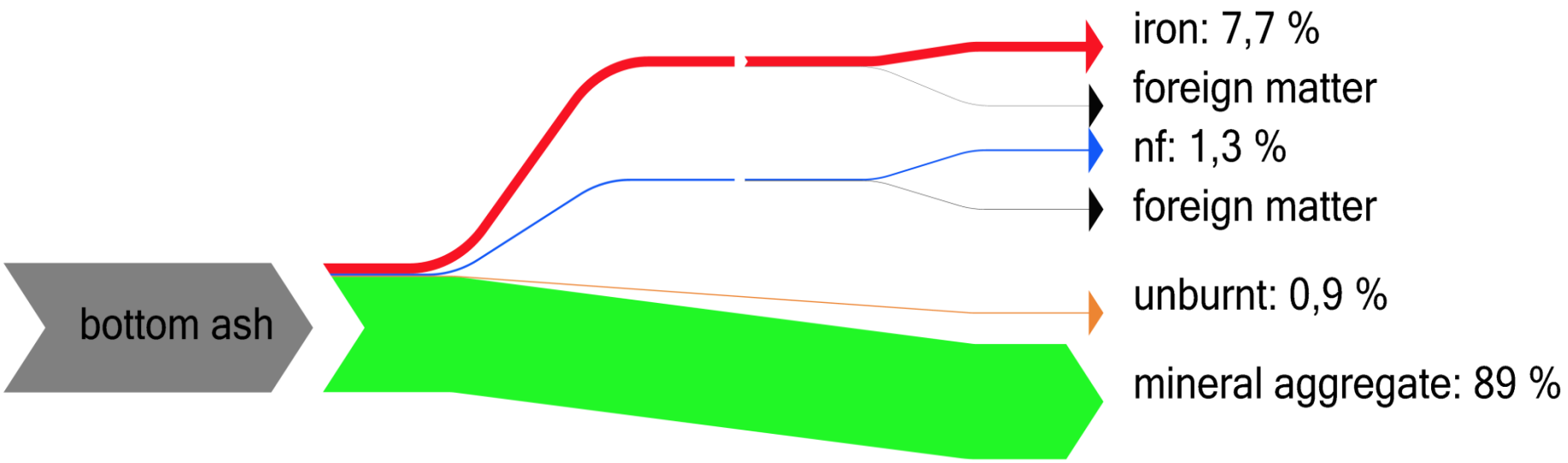

## nf separator



# Metal qualities extractes from bottom ash



# Bottom ash treatment results



# Recovery rates Germany

| | | complete | iron | nf |
|---|---|---|---|---|
| **Best** | Recovered from total BA amount | | 10,9 % | 2,4 % |
| | **Recovery rate** | **114 %** | **116 %** | **104 %** |
| **Best** **with foreign matter** | Recovered from total BA amount | | 10,7 % | 1,7 % |
| | **Recovery rate** | **106 %** | **114 %** | **74 %** |
| **Average** | Recovered from total BA amount | | 7,9 % | 1,7% |
| | **Recovery rate** | **82%** | **84 %** | **74 %** |

# Metal Recovery Rates Europe

| Country | Recovery Rate (%) | Sources |
|---|---|---|
| Austria | 63 | BMLFUW (2015); CEWEP (2014) |
| Belgium | 78 | Hoornweg, Bhada - Tata (2012); Van Brecht et al. (2012) |
| Denmark | 25 | Hoornweg, Bhada - Tata (2012); B&W Vølund (2014) |
| Finland | 51 | Hoornweg, Bhada - Tata (2012); CEWEP (2014) |
| France | 73 | ADEME (2010); AMORCE (2012) |
| Germany | 82 | Kuchta, Enzner (2015) |
| Italy | 65 | ISPRA (2015); Amato (2013) |
| Netherlands | 61 | Corsten et al. (2013); CEWEP (2013) |
| Norway | 68 | Avfall Norge (2015); CEWEP (2012, 2013) |
| Portugal | 46 | Viegas (2012); CEWEP (2014) |
| Spain | 49 | Andrés Pastor, Rodríguez Perez (2008); Gallardo et al. (2011); CEWEP (2012) |
| Sweden | 58 | Blomqvist (2012); Grönholm (2016) |
| Switzerland | 64 | Hoornweg, Bhada - Tata (2012); Bunge (2015) |
| United Kingdom | 39 | Wrap (2010); Zero Waste Scotland (2010); arc21 (2014); Defra (2015); Willows Power & Recycling Centre (2015) |

Amount of recovered metals based on data from:

- a study for a single plant / a single plant operator
- a study for a number of different plants
- a study referring to the whole country

# Metal Recovery Rates from BA

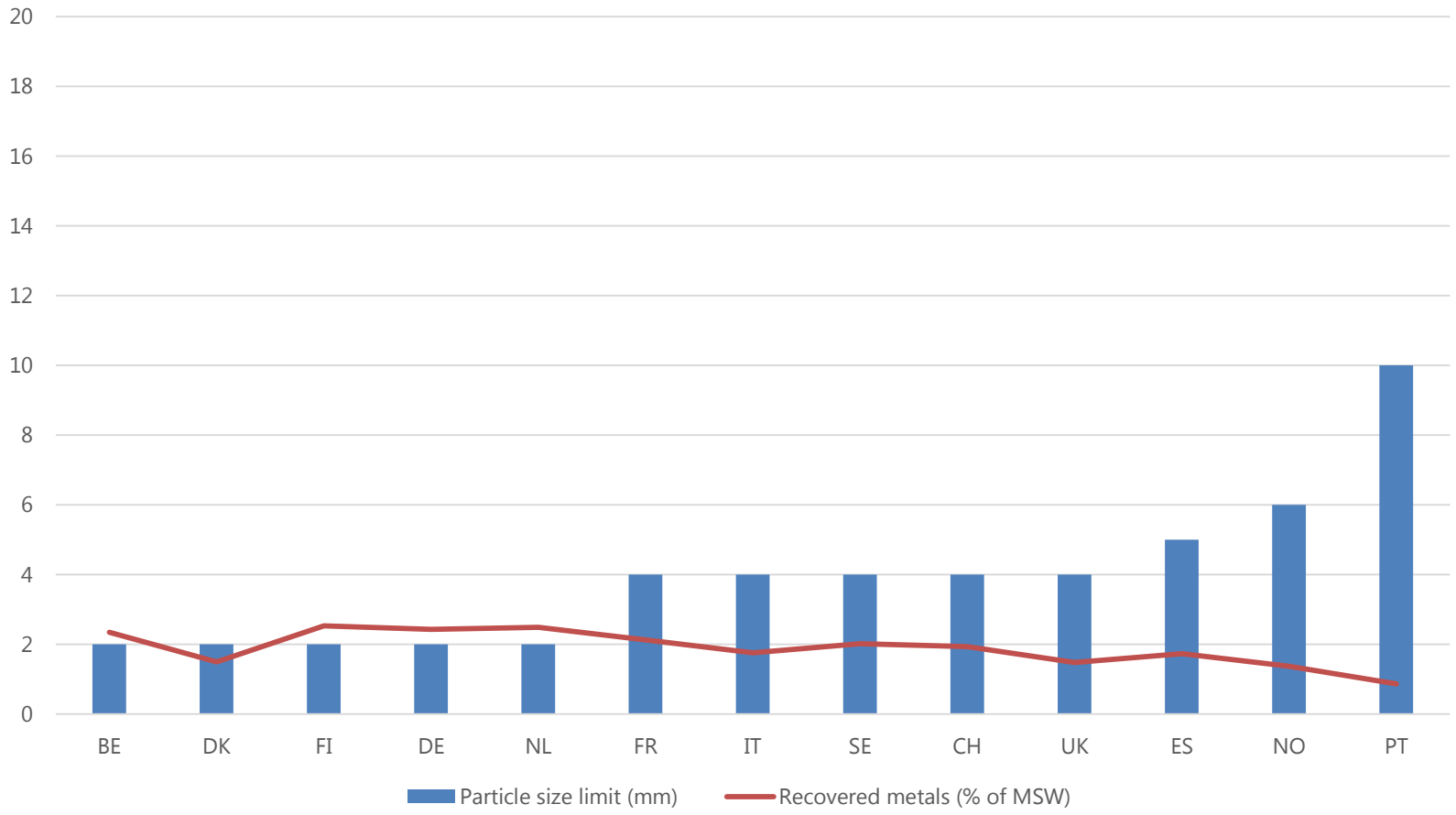
Calculated based on:

- the **concentration of metals in the MSW**
- the **percentage of recovered metals** from the BA

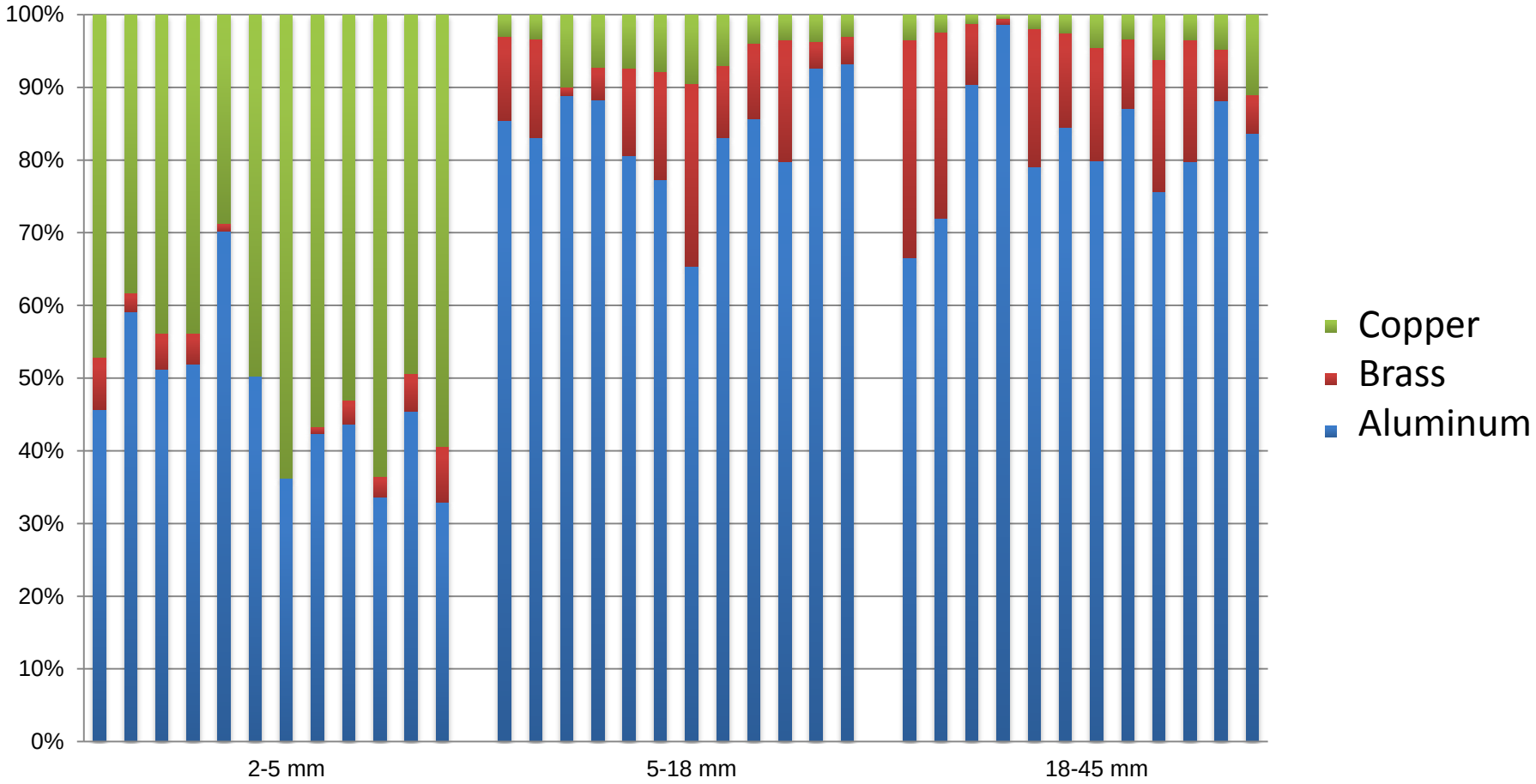
Actual recovery rates may differ due to:

- No **actual** MSW composition in some cases
- metal recovery data from single treatment plants affecting the representativeness

# Particle Size Treated and Metal Recovery



# Non ferrous metals particle size



# Conclusion

- Advanced technology is applied
- **Ø 5 magnet separators** for **7,7 % iron**
- **Ø 5 eddy current separators** for **1,3 % nf**
- 89 % remaining as mineral material, 0,9 % organic matter

# Thank you for your attention