# Ash Mining and Reprocessing

**Efficiency Technologies Limited**

# Background

- Ash (Fly Ash, Furnace Bottom Ash, Pulverized Fuel Ash) is the by-product of Coal combustion.
- The quantity of ash waste products at each coal station is significant and can create major environmental hazards
- Ash has utilization as an additive for Cement Filler and land reclamation, but mainly it is used in its raw ash form.
- Ash can contain a wide range of metals and components that impact how the waste is used, and how it must be stored, with special regard to the leaching characteristics of different minerals.
- Typically in the UK, power generation uses anthracite with a high calorific value and low ash. The contents of carbon in a coal can be from 91 up to 95 %, ash of anthracite makes 2.5-3 %.

# Ash Composition

Chemical composition of anthracite on impurity

| | | | |
|---|---|---|---|
| $Al_2O_3$ | 0.9 % | $Fe_2O_3$ | 0,14 % |
| $SiO_2$ | 0.6 % | $P_2O_5$ | < 0.008 % |
| $SO_3$ | 1.24 % | $C_{com.}$ | 97.5 % |
| CaO | 0.07 % | | |

Chemical composition of ash formed after burning of anthracite on power station

| | | | |
|---|---|---|---|
| $Na_2O$ | 1.12% | CaO | 2.13 % |
| MgO | 1.48 % | $TiO_2$ | 1.24 % |
| $Al_2O_3$ | 43.74 % | $Fe_2O_3$ | 0.66 % |
| $SiO_2$ | 42.43 % | NiO | 0.07 % |
| $P_2O_5$ | 0.16 % | CuO | 0.12 % |
| $SO_3$ | 0.28 % | $ZrO_2$ | 0.11 % |
| $K_2O$ | 0.39 % | | |

Solid phase trace element Analysis – Typical ranges from UK sources of PFA

| Element | Content in mg/kg | Element | Content in mg/kg |
|---|---|---|---|
| Antimony | 1 to 325 | Lead | <1* to 976 |
| Arsenic | 4 to 109 | Manganese | 103 to 1,555 |
| Barium | 0 to 36,000 | Mercury | <0.01* to 0.61 |
| Boron | 5 to 310 | Molybdenum | 3 to 81 |
| Cadmium | <1.0* to 4 | Nickel | 108 to 583 |
| Chloride | 0 to 2,990 | Phosphorus | 372 to 2,818 |
| Chromium | 97 to 192 | Selenium | 4 to 162 |
| Cobalt | 2 to 115 | Tin | 933 to 1,847 |
| Copper | 119 to 474 | Vanadium | 292 to 1,339 |
| Fluoride | 0 to 200 | Zinc | 148 to 918 |

* Indicates below the limit of detection

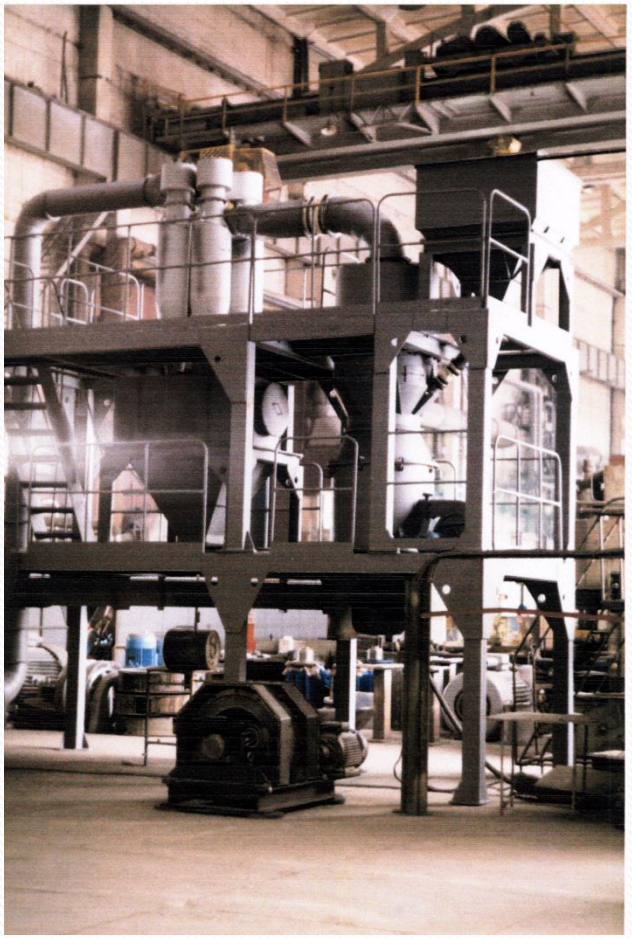
Data : UKQAA

EFFICIENCY TECHNOLOGIES

# EFT Strategy – Resource extraction

**Mineral Processing**

- The equipment and technology developed process this ash waste - with extraction of concentrates of the raw mineral materials contained in it.
- In this case it is desirable to take $Al_2O_3$ and $SiO_2$.
  - From one ton ash waste (in view of factor of extraction of 0.8) it is possible to receive 349.9 kg $Al_2O_3$ and 339.4 kg $SiO_2$
  - The remaining 320.7 kg ash waste can be processed with full recycling. Specific results are subject to the chemical and mineralogical analysis of the feedstock.
- Rare Earth and Minor metals are also extracted in smaller quantities but economic value is significantly higher per Kg



EFFICIENCY TECHNOLOGIES

# Extracting Value added products

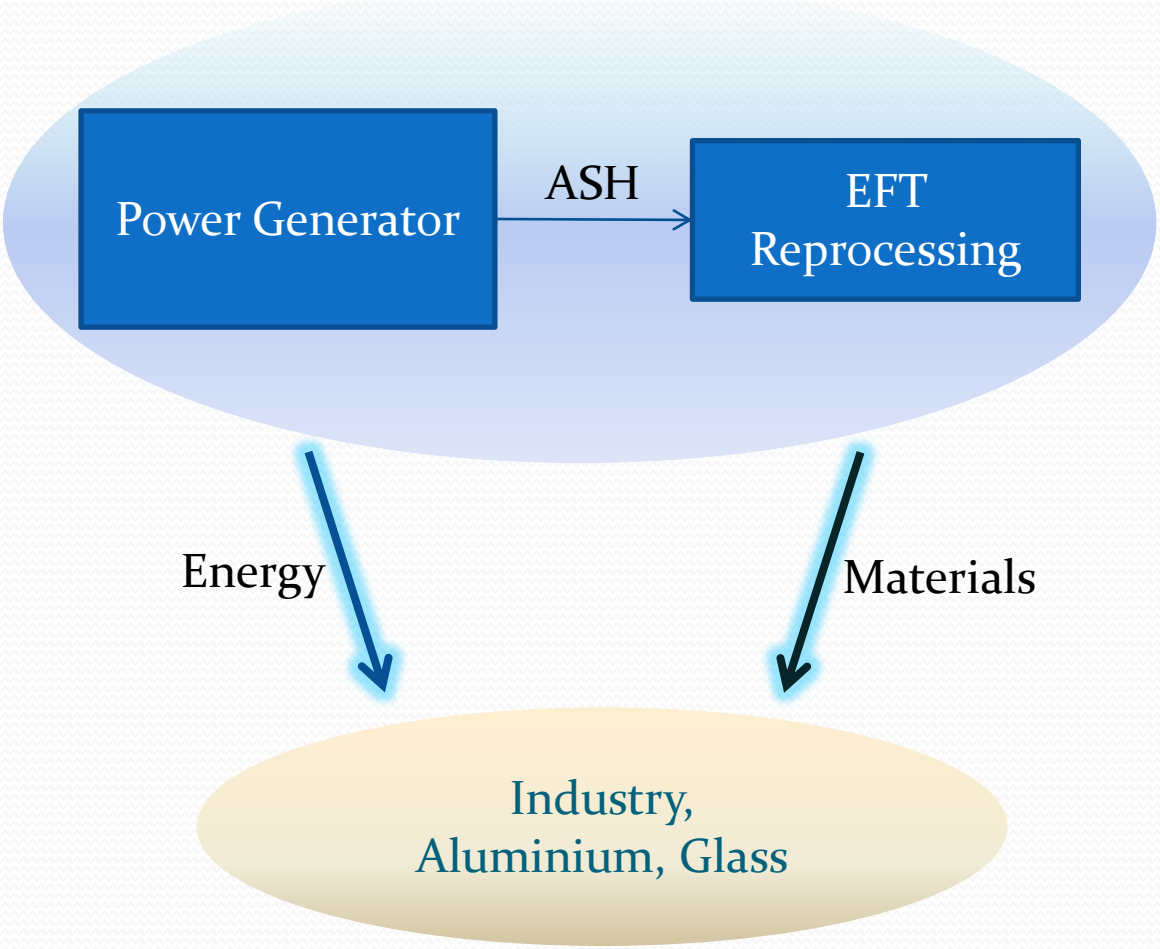
- High Quality $Al_2O_3$ and $SiO_2$ can be used:
  - $Al_2O_3$ - additives in cements, initial raw material for the aluminous industry, and manufacture of chemical compounds (aluminum sulfate and aluminum oxychloride types).
  - $SiO_2$ - additives in dry building mixes, filler in plastic, industrial rubber products.
  - Enhanced processing of received $Al_2O_3$ and $SiO_2$ to manufacture mullite (aluminum metasilicate) $Al_6Si_2O_{13}$, used as a component of glasses, porcelain, refractory materials.
- High Value Rare Earth and Minor Metals extracted
  - Vanadium, Titanium, Selenium, Germanium, Zirconium, Manganese etc
- Minimal waste by-product (waste reduction)
- Processing can be undertaken centrally or on site, eliminating transportation
- Residual carbon returned for combustion

EFFICIENCY TECHNOLOGIES

# Why can we do this?

- **Efficiency Technology has the rights and access to state of the art processing technology and know-how**
  - High efficiency Mineral Grinding to Micron levels
  - Efficient mineral separation and classification
  - Advanced chemistry and extraction technology
  - Proven team of metallurgists, chemists and engineering expertise and technology
  - Expandable and modular design
- **Creating value products**
  - Ash is an easily accessible and cheap source of minerals and metals
  - Rare and Minor Earth metals provide high value for low volume
  - $Al_2O_3$ is a cleaner feedstock for aluminium production than Bauxite, a raw material that is in high demand with complex political issues (WTO USA/China)
  - High purity individual compounds provide great value than the Ash

EFFICIENCY TECHNOLOGIES




EFFICIENCY TECHNOLOGIES