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## Anthropogenic raw materials from coal combustion by-products

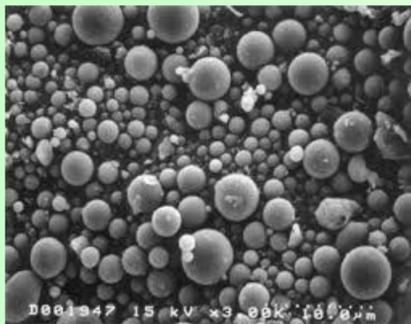
In Europe, nearly 100 million tonnes of slags and ashes are produced annually, of which up to 10% are recovered ferrous and non-ferrous metals, and as much as 85% are mineral parts that can be used in land reclamation, the cement industry and construction. The principles of circular economy impose an obligation on the industry to take care of the optimal use of resources. The economic use of ashes and slags from the energy and heating industries definitely fits in with this principle. Polish power plants and combined heat and power plants produce about 20 million tonnes/year of coal combustion by-products, including ashes and slags. This means that Poland is the European leader in terms of the quantity of good quality ash. The management of ashes and slags from the combustion of fossil fuels and alternative fuels (biomass and RDF) brings added value both for the environment and the economy - the by-products of combustion do not have to be landfilled, and therefore do not affect the environment. However, in many cases they can replace natural resources, such as aggregates, the production of which is expensive and energy-consuming. In the processes of electricity and heat production as a result of coal combustion, various energy wastes are generated, such as: fly ash, slags, ash-slag mixtures, microspheres, ashes from fluidized bed boilers, gypsum from flue gas desulphurization using the wet lime method, waste from flue gas desulphurization using semi-dry methods and dry, etc.



### The new perspectives

Research on the possibility of metal recovery has shown the possibility of recovering the metals from ashes (especially from ashes from municipal waste incineration).

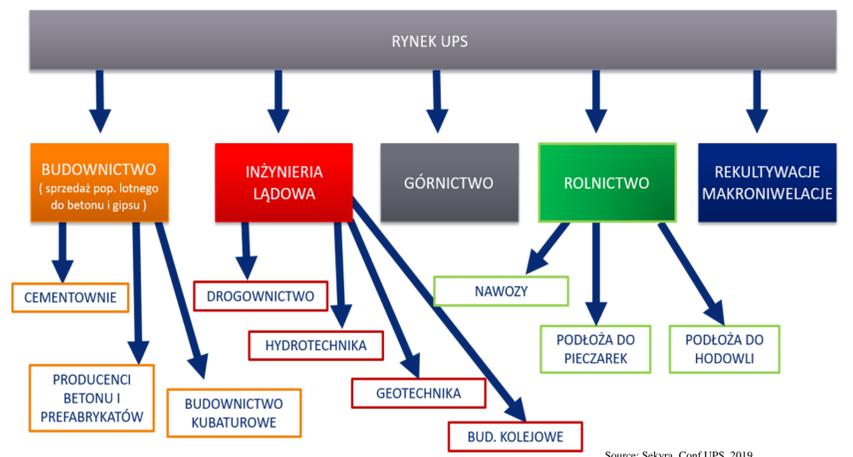
As regards the production of high-quality products, works are being developed on the production of microspheres in dry technology and metal concentrates, as well as micro and nano fillers and carriers. Microspheres can be used as a sorbent in liquid chromatography, a medium contrast agent for ultrasound for clinical trials, as sorbents for petroleum products.



Another direction of using fly ash is the production of bio-fertilizers. As part of the FUNash project, scientists from 3 Polish universities, the Lublin University of Technology, the AGH University of Science and Technology in Kraków and the University of Warsaw have created a research consortium. The aim of the consortium is to develop a series of functionalized materials, i.e. with increased usability, based on fly ash. It is a unique, comprehensive approach to the management of fly ash. The materials produced thanks to them will be used in construction (cements and biocements), agriculture (fertilizers and bio-fertilizers) and environmental engineering (sorbents and biopreparations for removing water, soil and gas pollutants).

The use of combustion by-products fits perfectly into the implementation of the principles of the circular economy.

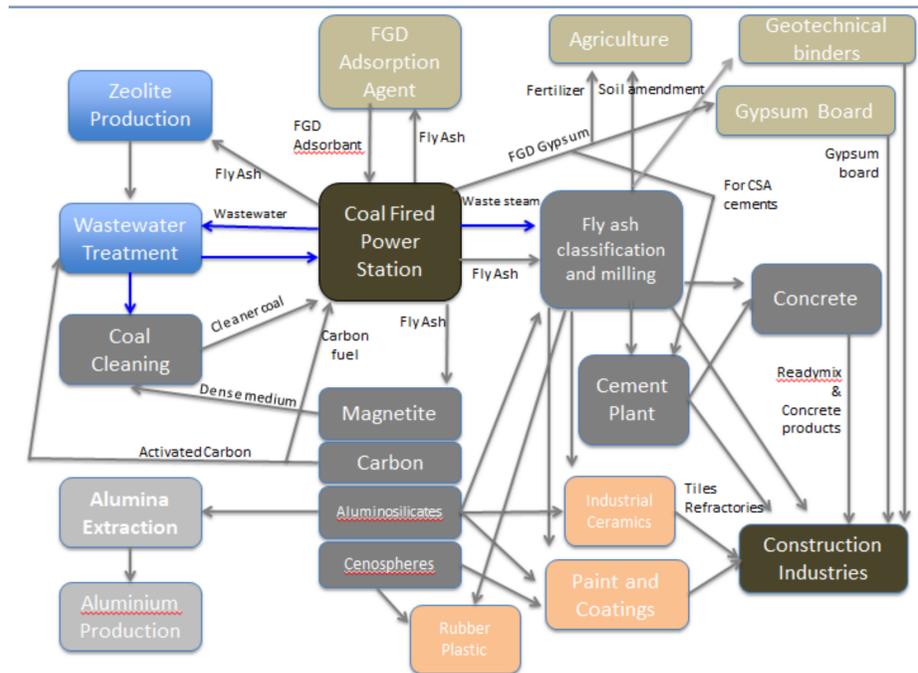
### Standards methods of using combustion by-products



Source: Sekyra, Conf UPS, 2019

Standards methods of using coal combustion products include:

- The use of fly ash in the building materials industry
- Manufacture of Portland cement clinker
- Production of cements
- Concrete production
- Production of lightweight aggregates
- Production of construction ceramics
- Use for reclamation works, macro-leveling,
- Application of fly ash in underground mining as:
  - filling old goafs,
  - active wall goafs and
  - redundant corridor workings;
  - carrying out explosion-proof dams and suppressing explosions;
  - fire hazard elimination; as well as
  - the release of methane fields to recover methane,
  - preventing air leakage through goafs



Source: David Harris, conference UPS, 2017

International Conference  
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