



July 2024

## Post-mining land rehabilitation: Soil substitutes

Coal mining and the energy industry generate large amounts of solid waste, which must be disposed of in landfills. In order to transform the coal mine-affected areas into a green ecosystem, it is useful to develop artificial soils suitable for different plant communities.

Coal combustion by-products (CCPs) such as fly ashes, energy slags, slugs and products of the desulphurisation process are useful components for artificial soils. The possibility of using fly ash from coal combustion is the subject of numerous discussions in the literature studies. It is a source of macronutrients being essential for plant growth and development and helpful in changing the acidic pH soil into alkaline or neutral. Nevertheless, the potential for using CCPs for soil reclamation is limited due to the high content of toxic heavy metals, the increase in the salinity of land and groundwater and the lack of organic matter.

Production (mill.t)	EU15	EU28*
CCPs total	40.33	>105
Fly ashes	30.42	>88
FGD products	33.85	>21

\*Estimate based on coal consumption

The ECOBA statistics showed that the amount of CCPs produced in European countries (EU28) in 2016 was more than 105 million tonnes.



Estimate on production coal combustion by-product in European Countries  
[www.ecoba.com/ecobaccpprod.html](http://www.ecoba.com/ecobaccpprod.html)

## Partners

 Universidad de Oviedo UNIVERSIDAD DE OVIEDO (UNIOVI)	 GIG Research Institute GŁÓWNY INSTYTUT GÓRNICICTWA (GIG)	 FAEN Fundación Asturiana de la Energía FUNDACIÓN ASTURIANA DE LA ENERGÍA (FAEN)	 Technische Hochschule Georg Agricola DMT-GESELLSCHAFT FÜR LEHRE UND BILDUNG mbH (DMT-THGA)
 Magellan & Barents MAGELLAN & BARENTS (M&B)	 WĘGLOKOKS WĘGLOKOKS KRAJ S.A. (WĘGLO)	 grupohunosa HULLERAS DEL NORTE, S.A. (HUNOSA)	 PREMOGOVNIK VELENJE PREMOGOVNIK VELENJE d.o.o. (PV)

## GreenJOBS progress

### EU Research Fund and Steel Transf. (RFCS)



The GreenJOBS Project participated in High-level the FRCS Event “European Coal in Transition: rising like a phoenix” organised by EURACOAL and the European Commission’s Research Executive Agency (REA)(Oviedo, Spain, 8 May 2024).

The aim of the event was to promote the RFCS research programme calls and discuss future priorities.

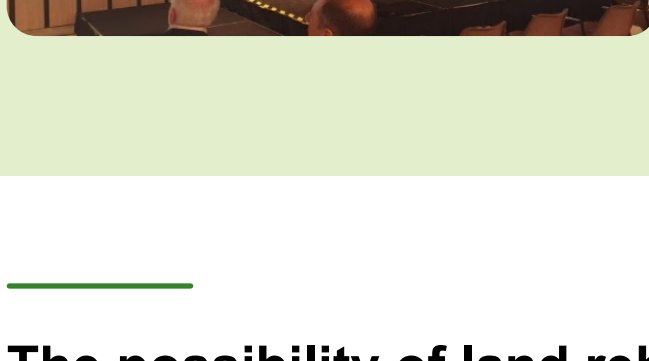
### GreenJOBS at the International Post-Mining Symposium



Tansel Dogan PhD from the TH Georg Agricola University, Research Center of Post-Mining participated with the speech “Research Center of Post-Mining and its projects on Reactivation and Transition”.

Germany’s last coal mines closed in 2018, leading to the creation of a Research Center focused on post-mining challenges, including repurposing former mines for renewable energy and sustainable development through projects like “GreenJOBS.”

### GreenJOBS at 105th World Mining Congress



Prof. Alicja Krzemien participated in the 105th meeting of the world mining congress organized by the International Organising Committee with the speech “Business models to stimulate new economic activities in post-mining areas-GreenJOBS Project” (Santiago de Chile, Chile, 14 April 2024)

## The possibility of land rehabilitation of coal mine-affected area in Velenje, Slovenia, using soil substitutes



The artificial soils were investigated at a laboratory scale using CCPs from Šoštanj Thermal Power Plant (TEŠ) and lignite from coal mine Premogovnik Velenje d.o.o. The Velenje mining site is located in the northeastern region of central Slovenia. The study site covers a surface of 0.5 km<sup>2</sup> and is surrounded by two artificial lakes, Šoštanj-Družmirje and Velenjsko.



**Preparing soil substitutes was to restore the high subsidence post-mining area in Velenje and transform it into a green surface for recreational use.**

Artificial lakes were created as a result of underground excavation of coal lignite. Due to the underground longwall coal mining extraction, PV causes subsidence of the surface above the mining area. The subsidence at the PSU develops gradually as the coal is extracted within the area of influence of the mined coal panels.

The land subsidence rehabilitation area in Velenje, Slovenia, was built up with a by-product of burning lignite named Stabilizat, which is a composite of fly ash and gypsum generated from Termoelektrarna Šoštanj (TEŠ) power plant.



The research outlines a new approach to developing artificial soils to restore coal mine-affected areas in Slovenia. Using coal lignite with its combustion products to develop soil substitutes is ecologically friendly and suitable for plant communities.



**This research mainly aimed to transform degraded and subsidence terrain into a good ecosystem, before installing photovoltaic or wind renewable energy.**

Soil mixtures were analysed in a laboratory to determine their physicochemical parameters, including chemical composition, pH and electrical conductivity.

The obtained data indicated the most promising soil covers for further land rehabilitation in Velenje’s subsidence area. The results will be considered for assessing circular economy technologies for land rehabilitation and ecological restoration of coal mining-affected areas and creating a potential for new jobs.

### Example of land rehabilitation of coal mine-affected area in Poland



Source: recoveryproject.eu

Reclamation effect of using artificial soils based on industrial waste from thermal power plant in Poland was the subject of RFCS RECOVERY project.

The safe use of CCPs, mining waste and organic materials as components for creating artificial soils for land rehabilitation of coal mine affected areas in Libiąż. The applying soil substitutes showed spontaneous successions of mesic and dry meadow species after the second year of vegetation.



### Phytotoxicity tests in laboratory conditions

The compositions of artificial soils, using different combinations of CCPs with lignite coal as an organic amendment were proposed.

The conventional phytotoxicity test under laboratory conditions determined seed germination and early growth of the tested plants in the artificial soils.

**A phytotoxicity test with white mustard (Sinapis alba L.) determined which of the soil substitutes have the best plant growth-stimulating properties.**



Further research is needed to evaluate the long-term development of plant communities in the reclaimed subsidence area.

