NEWSLETTER NO. 6

FROM WASTE TO RESOURCES

Unlocking the potential of post-mining waste for hydrogen production, advanced mineral products and sustainable regional development.

Deliverable 6.1. Final concept of H2GEO technology

One of the most important outcomes of the H2GEO project was the development of the final concept of an integrated technology for the comprehensive utilisation of post-mining waste. Rather than treating mine waste dumps as an environmental burden requiring costly reclamation, the proposed approach considers them a valuable source of secondary raw materials that can be used for both hydrogen production and the manufacture of construction materials.

The developed technology integrates all stages of the process-from waste extraction and separation into carbon-rich and mineral fractions to their subsequent utilisation. The carbon-rich fraction is directed to gasification for hydrogen production, while the mineral fraction is used to manufacture natural aggregates, synthetic aggregates, geopolymer concrete, and geopolymer materials. This integrated approach enables the recovery and utilisation of nearly all extracted material, significantly reducing the amount of waste requiring disposal.

The final technology concept was also presented in the form of an integrated material balance illustrating the flow of materials throughout the entire process.

Co-funded by the European Union

Research Fund for Coal & Steel

H2GEO project has received funding from the Research Fund for Coal and Steel (RFCS) under GRANT AGREEMENT No. 101112386. Project co-funded by the Polish Ministry of Science and Higher Education under the program entitled „Co-financed International Projects", agreement no. 5676/FBWiS/2023/2024/2.

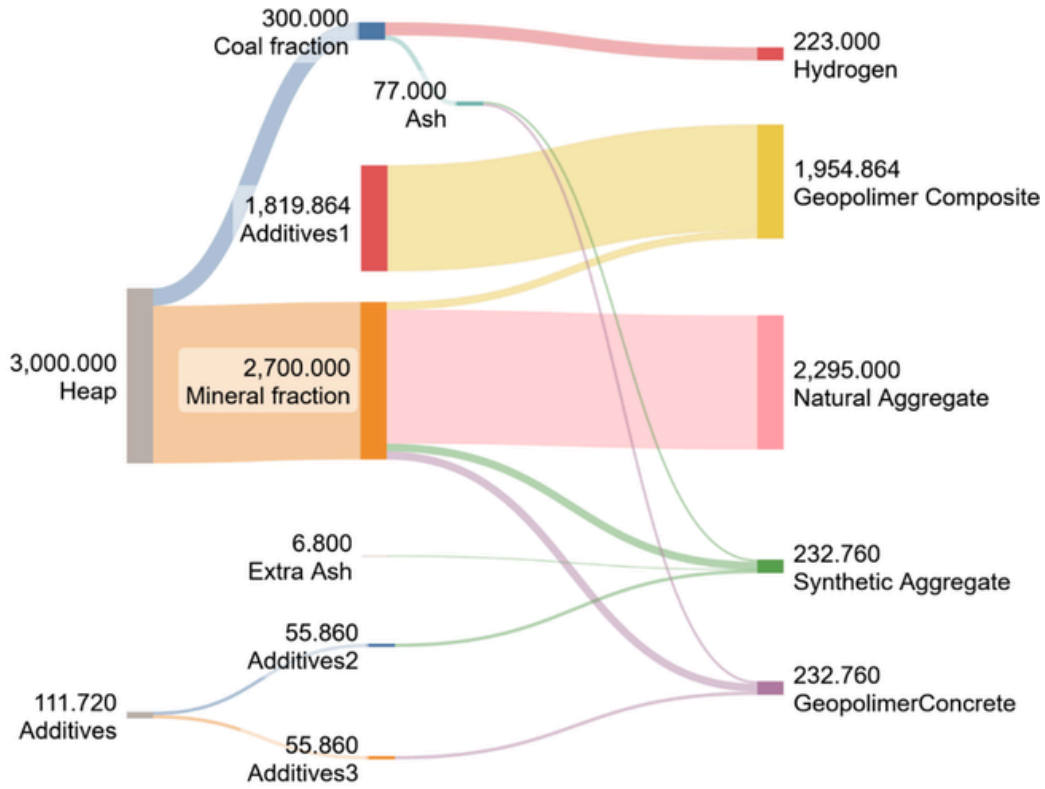

Figure 1. Integrated material balance of the final H2GEO technology concept showing material flows from post-mining waste dumps to the final products—hydrogen and construction materials

The material balance illustrates how waste recovered from mine dumps is separated into carbon-rich and mineral fractions and subsequently converted into hydrogen and a wide range of mineral-based products. It highlights the complementarity of the two technological pathways and the high level of utilisation achieved for all recovered fractions.

The analyses confirmed the feasibility of integrating established separation, gasification, and mineral processing technologies into a single, coherent technological system. The developed concept provides a solid foundation for further process optimisation, the construction of demonstration-scale installations, and the future industrial deployment of the H2GEO technology.

Deliverable 6.2. Economic aspects of hydrogen and geopolymer composites production from waste dumps

As part of the H2GEO project, a comprehensive economic assessment was carried out to evaluate the economic potential of post-mining waste. The study examined the opportunities for recovering valuable materials from waste dumps, their subsequent processing, and the benefits associated with the reclamation and redevelopment of post-mining areas.

The results demonstrated that the carbon-rich fraction can serve as a valuable feedstock for both direct energy generation and hydrogen production. Even greater potential was identified for the mineral fraction, which can be utilised in the production of aggregates and geopolymer materials, replacing natural raw materials and supporting the principles of the circular economy.

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An important part of the assessment also focused on the impact of land reclamation on the value of post-mining areas. Several future land-use scenarios were analysed, ranging from forest and recreational functions, through renewable energy installations, to industrial development. The results showed that well-planned reclamation can substantially increase the value of degraded land, creating new opportunities for its economic utilisation and future investment.

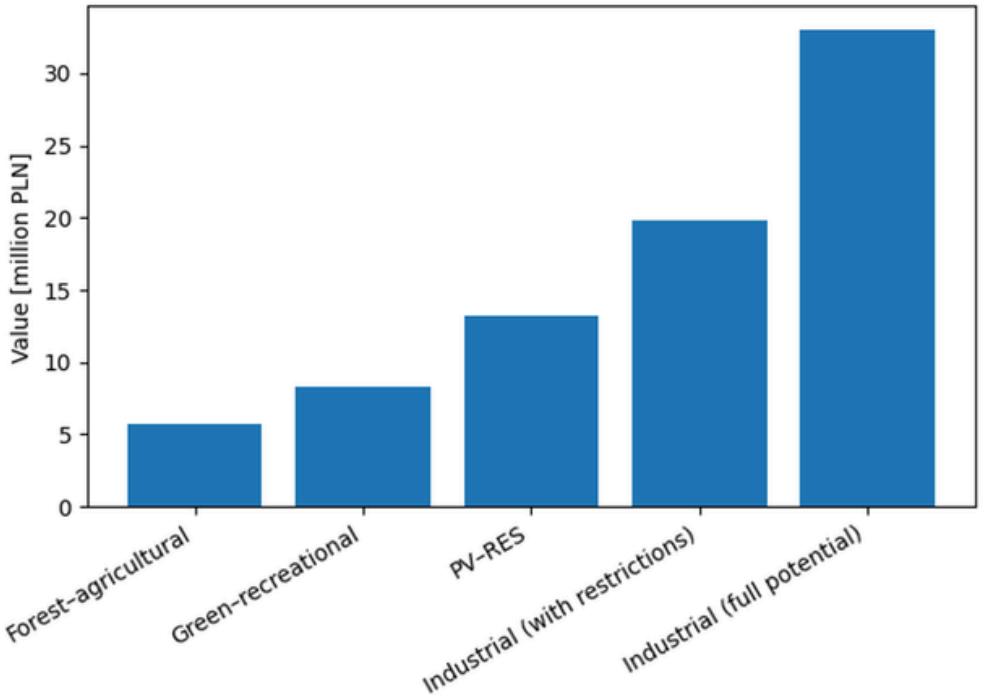

Figure 2. Land value after reclamation for different development variants

The analyses confirmed that the H2GEO technology delivers benefits not only through the recovery of valuable resources and the production of new materials, but also by increasing the investment attractiveness of post-mining areas. This integrated approach supports the transition of mining regions by combining environmental objectives with long-term economic development.

Deliverable 6.3 Results of Market, Social, Legal aspects and LCA Analysis

As the final part of the H2GEO assessment, Deliverable D6.3 examined the market, social, legal and environmental conditions for implementing H2GEO, which converts post-mining waste into hydrogen, aggregates and geopolymer materials. The results confirm that the concept supports circular-economy objectives by combining waste recovery, low-emission energy production and the redevelopment of post-mining areas.

The market analysis identified the growing European demand for low-emission hydrogen and sustainable construction materials as an important opportunity for H2GEO. The European hydrogen market is projected to reach approximately USD 69.17 billion by 2033, while the geopolymer market may reach USD 2.10 billion. The use of locally available post-mining waste could reduce feedstock and transport costs, limit dependence on global raw-material markets and stimulate new industrial activity and employment in former mining areas.

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The social survey showed that residents generally recognise the potential benefits of transforming mining-waste sites. Among the 100 surveyed residents, 92% expected the creation of new jobs, 89% positively assessed the transformation of these areas and 77% supported H2GEO implementation provided that high environmental standards were ensured. At the same time, concerns about traffic, dust, noise and emissions highlighted the importance of transparent communication, environmental monitoring and consultation with local communities.

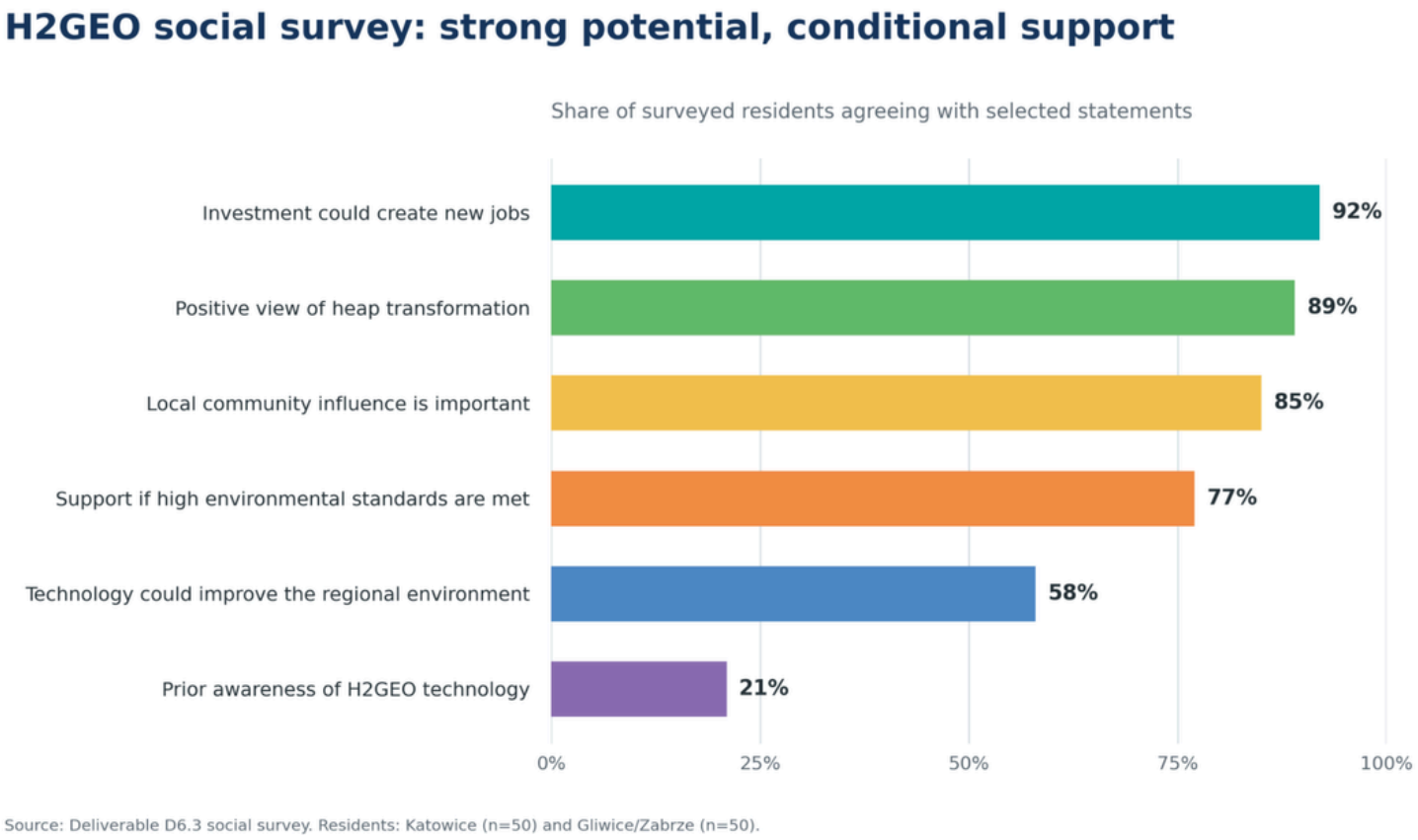

Figure 3. Selected survey results on public perceptions of H2GEO and its expected regional impacts

An important part of the work was also the analysis of the legal conditions associated with the implementation of the technology. The key requirements concerning waste management, environmental protection and the investment process were identified, emphasising the need to ensure that future installations comply with applicable national and EU legislation.

The Life Cycle Assessment provided particularly promising results for hydrogen production. The carbon footprint of H2GEO hydrogen was estimated at 1.90 kg CO_2 eq/kg H_2, approximately 84% lower than for conventional steam methane reforming. Geopolymer binders also showed favourable environmental performance compared with Portland cement. At the level of finished concrete, however, H2GEO geopolymer concrete had a higher carbon footprint than the reference OPC concrete-346 compared with 238 kg CO_2 eq/m³-mainly because of sodium silicate production. This is therefore an important area for further optimisation.

Overall, D6.3 confirmed that H2GEO offers significant environmental, market and regional development potential. Its successful implementation will depend not only on technological readiness, but also on regulatory compliance, economic conditions, reduced local impacts and active engagement with residents and other stakeholders.

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