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Harnessing green roofs for urban-based carbon dioxide removal via enhanced rock weathering in Europe

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Green roofs offer a promising opportunity for integrating enhanced rock weathering (ERW) as a large-scale carbon dioxide removal (CDR) strategy in urban environments. By leveraging underutilised rooftop spaces, ERW-enabled green roofs could contribute to climate targets while aligning with existing markets and policies. Compared to rural deployments, urban CDR solutions may allow for faster implementation and measurable carbon removal at scale, benefiting from financial incentives and evolving legislation.

In this study, we conducted a desktop assessment to evaluate the potential for CDR green roof rollout in Europe, examining possible configurations, estimating European and global tonnage removal potential, identifying optimal rollout locations and analysing key opportunities and challenges for large-scale deployment. Additionally, we are conducting an ongoing feasibility study on green roofs in the Netherlands, monitoring pH, electrical conductivity, alkalinity and cation release to assess weathering activity in a real-world setting.

The CDR potential of green roofs in Western Europe is estimated in the range of millions of tonnes, with further increases possible through expanded rooftop coverage in the upcoming decades. Several European countries, including France, Germany, Spain, UK and Italy, show strong rollout potential. Beyond the inherent benefits of green roofs, CDR deployment can complement photovoltaic systems by enhancing efficiency while benefitting from reduced evaporation and sun exposure. It also enables refined monitoring, reporting and verification (MRV) and optimisation of ERW processes. Additionally, structured drainage channels could facilitate the collection of alkaline-rich water for secondary CDR applications.

Our feasibility study has demonstrated rising pH values, increased electrical conductivity, enhanced alkalinity and cation release in amended plots, indicating significant weathering activity and additional CDR. However, the release of elements such as nickel from ultramafic amendments highlights the need for careful management, including appropriate substrate composition, feedstock selection, plant choice and fertiliser application.

Scaling CDR from laboratory settings to real-world green roof deployments provides a controlled and measurable demonstration of effectiveness. While challenges such as financial costs, climatic factors, legislative support and MRV limitations remain, green roofs could serve as demonstrators for larger rural projects or function as standalone tools for urban CDR deployment, offering multiple co-benefits and reducing financial risk.