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Stability of abandoned pit slopes - how groundwater and lake water control may support safety while flooding

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In Europe's move towards decarbonization, renewable energy emerges as a key player, with its swift expansion crucial for cutting carbon emissions. Addressing the modern energy scenario, an innovative energy storage solution: transforming abandoned open-pit mines into large-scale facilities using pumped-hydro power storage (PHS) technology. This system operates by elevating water during periods of low demand and releasing it to produce electricity when demand peaks, mirroring the function of traditional hydropower plants.

A significant hurdle in this transformation is the initial flooding of the mine pit to form the lower reservoir of the PHS system. This phase is marked by complex geotechnical challenges, especially in terms of mine slope stability, influenced by the difference in water head between the groundwater and the reservoir. A key aspect is to ensure an effective hydraulic head, particularly when the upper reservoir is positioned in areas with minimal head difference from the lower reservoir. Our approach revolves around managing the head difference between lake water and groundwater effectively, safeguarding mine slope stability for PHS operations. To achieve this, we compare two different approaches to maintaining the head difference between lake water and groundwater and assess the slope stability for different stages of flooding using the Limit Equilibrium Method (LEM). These approaches are aimed at refining the hydraulic head difference, thereby maximizing the energy generation capacity and promoting efficient, sustainable energy solutions, while ensuring safe operation in terms of slope stability.