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A combined geothermal energy, bio-energy, carbon capture utilisation and storage power plant with negative carbon emissions

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Prof. Martin Saar is the Chair of the Geothermal Energy and Geofluids (GEG) Group in the Department of Earth Sciences at ETH Zürich. The GEG Group investigates numerically and experimentally reactive transport of multicomponent-multiphase fluids (e.g., groundwater, CO_2) in the subsurface to study water- and CO_2-based geothermal energy extraction and conversion (to electricity), geologic CO_2 storage, grid-scale subsurface energy storage, and groundwater flow. The group also couples numerical subsurface fluid dynamics and thermodynamics models with surface power plant simulations to investigate the entire cycle of geofluid use during energy extraction and conversion. Prof. Saar received his Ph.D. at UC Berkeley (USA) and was the Gibson Professor and Chair for Hydrogeology and Geofluids at the University of Minnesota (USA) for 10 years, before coming to Switzerland. Prof. Saar holds several patents on CO_2-based geothermal energy utilization and founded TerraCOH Inc., a company that has licensed these patents. The GEG Group currently comprises about 15 researchers at various stages of their career and in several fields, ranging from (geo)scientists to engineers to mathematicians/computer scientists. The GEG Web Site is: GEG.ethz.ch

Abstract

Combining Carbon Dioxide (CO2) capture and geologic storage (CCS) with geothermal energy extraction is a form of CO2 utilization, i.e., CO2 Capture Utilization and Storage (CCUS), where 1) 100% of the captured CO2 is permanently stored underground, 2) the CO2 is nonetheless used as a heat and pressure energy extraction fluid, roughly doubling the efficiency of geothermal power plants and thus expanding the geographic resource base, where geothermal power generation is economically feasible, and 3) the CO2 is neither used to extract more oil or natural gas nor to make a physical product (e.g., synthetic fuels) which can release CO2 again. The only product is renewable, practically CO2-emission-free, baseload electric power. Moreover, when the CO2 is captured by a bio-energy (BE) CCS process (BECCS), then the technology results in negative CO2 emissions, i.e., in a high-efficiency, CO2-sequestering geothermal power plant with a negative carbon footprint. Finally, because naturally permeable, relatively shallow (typically 2.5 km deep) sedimentary rock reservoirs with relatively low temperatures (ca., 100oC) are used, no hydraulic stimulation is required, so that seismic risks are minimal and drilling costs are much lower than for 5 km-deep Enhanced Geothermal Systems (EGS). All concerns and potential benefits of CCS apply to CPG as well.