CO2-Storage-Based Geothermal Electricity Generation Potential of Sedimentary Basins in the United States

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ABSTRACT

To manage global climate change and maintain global mean surface temperatures within 2°C of the pre-industrial value, the Intergovernmental Panel on Climate Change has concluded that the cumulative amount of CO2 emitted to the atmosphere must be below 3600 GtCO2. But more than half of this budget has already been emitted, and meeting this aggressive goal requires a substantial reduction in CO2 emissions—between a 40% and 70% reduction by 2050 and even negative emissions (up to a 120% reduction) by the year 2100. For these reductions to be achievable there must be extensive investment in zero and low-carbon energy technologies, such as wind, solar, nuclear, and fossil fuel, the latter with CO2 capture and (geologic) storage (CCS). Estimates suggest that if CO2 emission mitigation efforts are delayed until 2030, the market share for these energy technologies will need to increase to approximately 90% by 2100 and costs will increase 40%. As such, there is an urgent need to deploy these energy sources. CO2 Plume Geothermal (CPG) combines CCS with geothermal resources to produce baseload and/or dispatchable renewable electricity with no CO2 emissions. With CPG, underground-stored CO2 is circulated to the surface, extracting heat from the naturally porous and permeable sedimentary basin. These geologic resources are more ubiquitous than the faulted systems presently used with natural geofluid (brine) geothermal electricity generation. Thus, CPG could be a vital part of climate change mitigation if it is spatially and economically viable. In this work, we combine our existing levelized cost of electricity (LCOE) models with geospatial data on sedimentary basins in the United States to conduct a resource assessment of the national potential for CPG systems. The results indicate that 7200 km2 of the U.S. has an estimated CPG LCOE less than $50/MWh and 160,000 km2 has an LCOE less than $100/MWh, which are less than other dispatchable energy technologies, e.g. coal with CCS ($143/MWh) and natural gas peaking plants ($191/MWh). These LCOEs are also favorable when compared to other renewable energy technologies, like conventional geothermal ($98/MWh), wind ($47/MWh), and solar ($55/MWh), although the latter two are variable and not dispatchable. Unlike conventional geothermal energy, which is limited to the southwestern U.S., CPG could be extensively deployed in sedimentary basins in the central and eastern U.S. where average geothermal temperature gradients exist.