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Engineering Sedimentary Geothermal Resources for Large-Scale Dispatchable Renewable Electricity

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Mitigating climate change requires substantial penetration of renewable energy and economically viable options for CO_2 capture and storage (CCS). We present an approach using CO_2 and N2 in sedimentary basin geothermal resources that (1) generates baseload and dispatchable power, (2) efficiently stores large amounts of energy, and (3) enables seasonal storage of solar energy, all which (5) increase the value of CO_2 and render CCS commercially viable. Unlike the variability of solar and wind resources, geothermal heat is a constant source of renewable energy. Using CO_2 as a supplemental geothermal working fluid, in addition to brine, reduces the parasitic load necessary to recirculate fluids. Adding N2 is beneficial because it is cheaper, will not react with materials and subsurface formations, and enables bulk energy storage. The high coefficients of thermal expansion of CO_2 and N2 (a) augment reservoir pressure, (b) generate artesian flow at the production wells, and (c) produce self-convecting thermosiphons that directly convert reservoir heat to mechanical energy for fluid recirculation. Stored pressure drives fluid production and responds faster than conventional brine-based geothermal systems. Our design uses concentric rings of horizontal wells to create a hydraulic divide that stores supplemental fluids and pressure. Production and injection wells are controlled to schedule power delivery and time-shift the parasitic power necessary to separate N2 from air and compress it for injection. The parasitic load can be scheduled during minimum power demand or when there is excess electricity from wind or solar. Net power output can nearly equal gross power output during peak demand, and energy storage is almost 100% efficient because it is achieved by the time-shift. Further, per-well production rates can take advantage of the large productivity of horizontal wells, with greater leveraging of well costs, which often constitute a major portion of capital costs for geothermal power systems.