

AN ANALYSIS OF POWER GENERATION PROSPECTS FROM ENHANCED GEOTHERMAL SYSTEMS

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ABSTRACT

This paper presents an analysis of power generation prospects from Enhanced Geothermal Systems (EGS), specifically, reservoirs with subcommercial permeability enhanced by hydraulic stimulation. EGS is also known as “hot dry rock” or “hot fractured rock” systems. The performance under consideration here is the net electrical power delivered as a function of time over the 20-to-30 year life of a power plant. Although the parameters in this exercise generally reflect conditions encountered at the Desert Peak EGS project in the State of Nevada, United States, the conclusions are applicable, at least qualitatively, to any EGS project.

The analysis relies on numerical simulation of three types of EGS set-ups: (a) doublet (an injection and production well pair), (b) triplet (an injector flanked by a production well on each side), and (c) five-spot (an injector at the center and a production well at each corner of a square). Desert Peak EGS site is a low-permeability fringe of a hydrothermal system with a temperature of 210°C and pre-enhancement porosity and permeability values of 2% and 1 millidarcy, respectively. The stimulated volume within the system is modeled as a double-porosity system (that is, matrix blocks separated by fractures), and the hydraulic characteristics of the reservoir are assumed to remain constant following enhancement. The assumed thickness of the stimulated zone was varied from 150 to 1,200m, and a range of fracture spacings (from 0.33 to 300m) and fracture permeabilities (from 1 to 100 millidarcy) following enhancement was considered. The spacing between the injector and producers was also varied.

The injection water temperature was assumed to be 82°C. The injection rate was dictated, through reservoir simulation, by the production rate assigned; production wells were allowed a maximum drawdown of 3.4 MPa and the injection well was limited to a maximum pressure buildup of 6.9 MPa. From the forecast of the production temperature, the gross power available per unit produced mass was calculated as a function of time from the First and Second Laws of Thermodynamics; from this, the net power available versus time was calculated, for each well geometry, after subtracting the parasitic power needed by injection and production pumps. For each combination of assumed geometry, injector-producer spacing, stimulated thickness, enhancement level (fracture spacing and permeability) and production rate, three criteria of performance were computed and correlated to the above variables: (a) net generation profile (generation versus time), (b) net power produced per unit injection rate, and (c) fraction of in-place heat energy recovered.

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