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feeding a 200-kW generator. This could encourag

Modeling Power Generation from Coproduced Geothermal Fluids

Introduction

This analysis estimates power generation economics for oil or gas wellfield installations with flowrates of coproduced geothermal water above about 10,000 pounds per hour per production well (about 20 gpm or 700 BPD per well), and with wellhead temperatures ranging upward from 190 degrees °F. Under these conditions, producing wells could be harnessed together to produce electrical power at competitive cost. Modular, packaged generation sets are available at ratings of about 200 kW, operating on binary power cycles, and the results here are largely based on the 200-kW capacity. However, energy costs are sensitive to generator capacity, so comparisons are given to show electrical costs using 50- and 100-kW capacities for the packaged generation units.

The key variables of interest for estimating coproduction electricity costs include:

Resource and ambient temperatures	Parasitic pumping power requirements
Flowrates of geothermal fluid	Costs for installation and operation.
Wellfield installation layout patterns	Access to distribution or transmission.

The scale of such applications is expected to be small in a developmental phase of implementing coproduction power projects. Initially, for example, sub-megawatt capacities might be generated from small numbers of wells configured as production units. This analysis defines a production unit to comprise a set of one or more production wells connected to one central injection well for return of produced waters. A sole exception to this definition is a singlet

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Figure 4 shows two sets of cases plotting LCOE versus production well flowrate for all seven well configuration cases, using a single production unit. The two plots compare 100- and 200-kW generator capacities at a production temperature of 190°F. Figure 4 complements Figure 2, which illustrates a 200-kW case at 220 °F. These two plots are on common scales, so the visual effect shows the proportions between cases and configurations for all curves. This layout gives a good sense of the transitions between generation capacities. Other cases (more production wells, more production units, variable generator capacities) will scale from these plots.

Curves are arranged from left to right as 9-spot, 7-spot, 5-spot, triangular, triplet, singlet, and doublet well configurations. In the bottom panel, the 9-spot and 7-spot curves are virtually coincident. PTC is excluded.

Figure 4 – Cost of Energy as a Function of Flowrate for All Wellfield Configurations

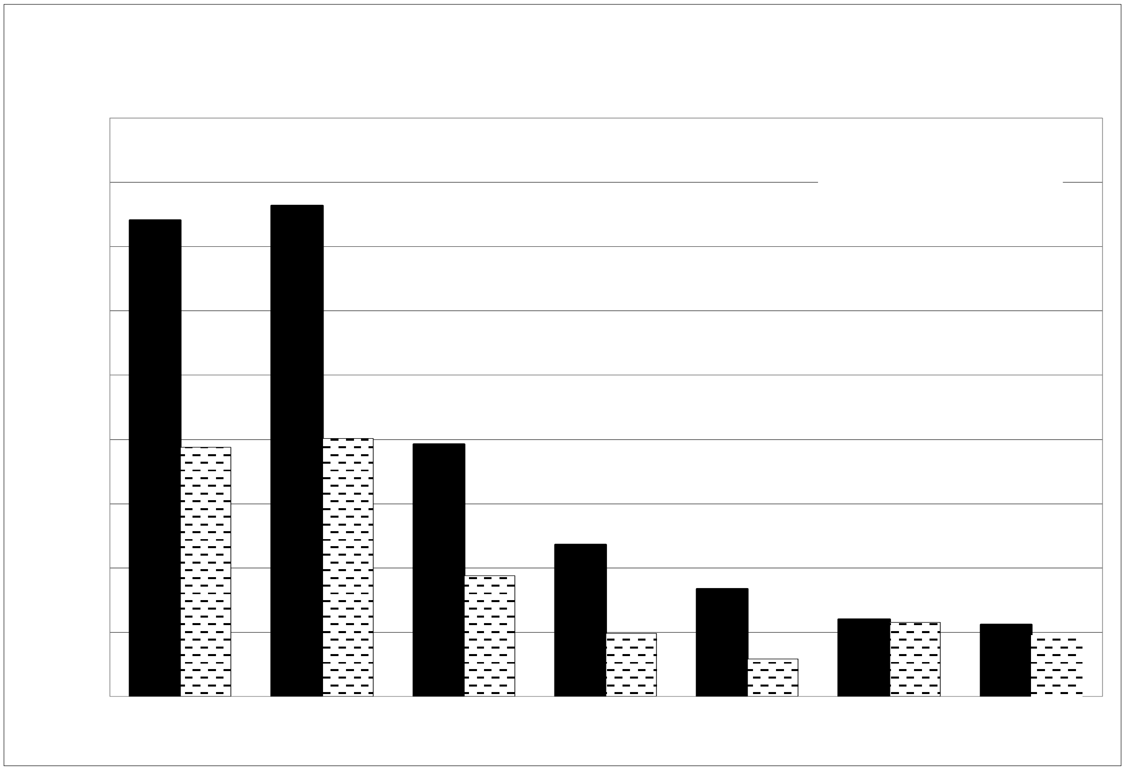
The flowrate ranges for each wellfield configuration in Figure 4 were selected to capture LCOE estimates between two pragmatic end-points: (a) a low-cutoff gpm value that limits LCOEs to about 10 ¢/kWh; and (b) a maximum gpm value that delivers enough recoverable geothermal heat to operate a single generator unit at just under 100 percent of its nominal capacity.

The plots show that near the low-cutoff rate, LCOE takes on a steep trend. And if production flowrates go higher than the maxima, the generator loadings would exceed 100 percent.

While these cases were forced to stay under 100 percent generator utilization, the model is set up to automatically add generation units in cases for which capacity utilization would exceed 100 percent. This practice effectively reduces the geothermal fluid flow per generation unit each time a unit is added by the model. This gives a cost effect which graphically corresponds to sliding up

4. As shown in

Coproduction of Geothermal Power from Oil and Gas Fields



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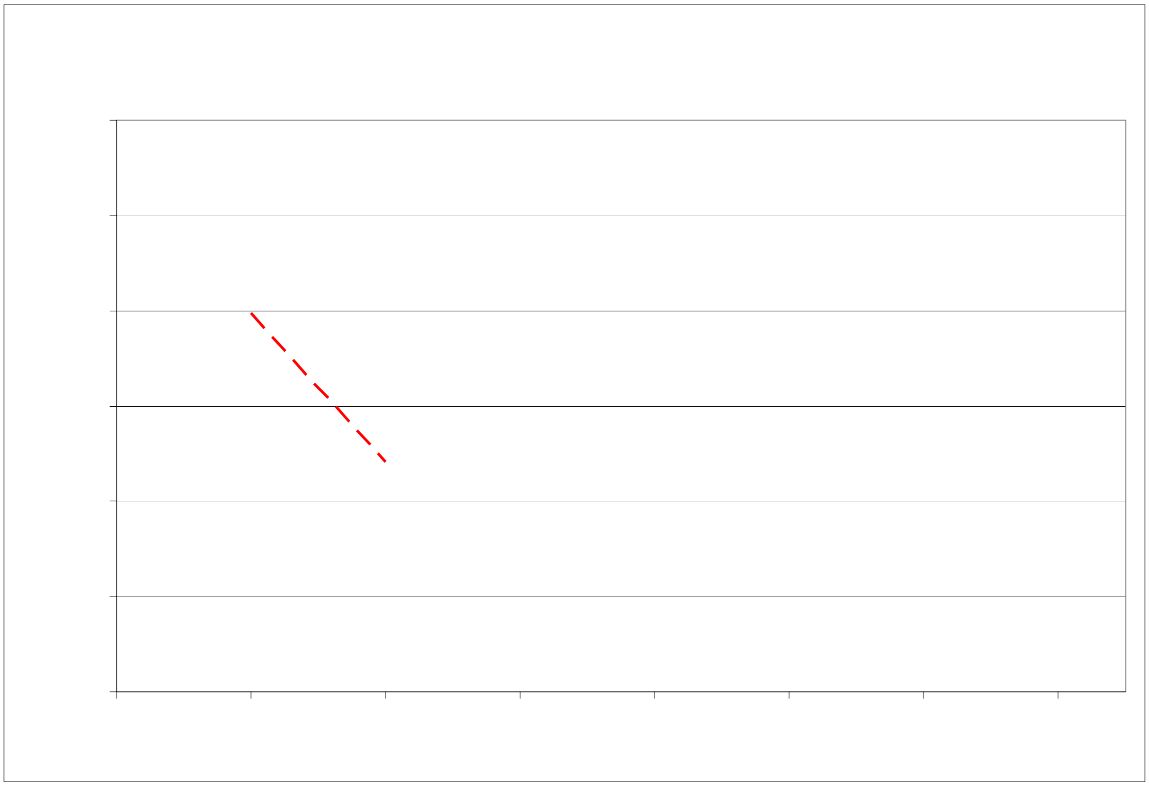

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Appendix A -- Model Description and Data Parameters

Model Organization and Method

This analysis uses a spreadsheet model that comp

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5-Spot Wellfield Production Unit Configuration

The configuration of the coproduction cost model relies on locating power generation units at centrally cited injection wells. This serves to define the wellfield geometry with which piping costs are estimated in the model.

For example, for sizing the piping systems for the seven wellfield configurations, the coproduction model uses definitions that all production and injection wells have respectively identical flowrates, and that the configuration geometries are scaleable to the user-specified acreage per production well. Piping costs are calculated based on these assumptions, using the input data values for flowrates and acreages for each case profile. There is a data input variable that gives the model an option to include or omit the calculated cost of the production gathering system piping from the total capital cost used to compute the LCOE. Injection piping is assumed to exist, and is not estimated as a cost component.

A 5-spot pattern serves as the basis for calculating header lengths from production wells to a central injection well for each of the other six layout p43,56put data val