

BOOKING GEOTHERMAL ENERGY RESERVES

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ABSTRACT

Formal booking of geothermal energy reserves, for accounting purposes or annual reporting to shareholders or portfolio management, is not yet a common practice among geothermal companies. In the petroleum industry booking of oil and gas reserves is a routine practice, and at least two geothermal operators that are subsidiaries of petroleum companies book geothermal reserves. As in the petroleum industry, the reserves should be booked in appropriate resource uncertainty categories. To this end we propose three reserve categories with reference to the cumulative probability of exceeding the estimated reserves level: "proved" (equivalent to the 90th percentile), "proved-plus-probable" (equivalent to the lesser of the median and most-likely values), and "proved-plus probable-plus-possible" (equivalent to the 10th percentile). However, before any reserves are booked in the proved category, we believe prospects for commercial productivity from the reservoir should be demonstrated. For the purpose of booking, reserves can be expressed in kilowatt-hours and also in equivalent barrels of oil.

The available methods of estimating geothermal reserves are reviewed here as regards their applicability to booking reserves: empirical methods based on analogy, volumetric reserve estimation, decline curve analysis, lumped-parameter modeling and numerical simulation of the reservoir. Of these methods, only volumetric estimation and numerical simulation are concluded to be generally suitable for booking geothermal reserves. While numerical simulation is more sophisticated than the volumetric method, the latter can be readily conducted in a rigorously probabilistic way while the former cannot. Therefore, for booking reserves, volumetric estimation is the most practical approach. Numerical simulation can allow refinement of the proved reserves, approximate verification of the probable and possible reserves estimated by the volumetric method, and also help in portfolio management. For the purposes of annual updating of booked reserves it usually should be adequate to simply subtract the cumulative amount of energy produced from the initially estimated proved reserves while leaving the probable and possible reserve levels unchanged. Results of step-out drilling or supplemental exploration may call for reassessment of the reservoir volume under the probable and possible categories, whereas monitoring of reservoir performance upon exploitation may indicate the need for reassessment of proved reserves. The proposed approach to booking reserves has been applied to nine producing reservoirs (located in four geothermal fields) in the Philippines, developed and operated by the Philippines National Oil Company-Energy Development Corporation; these fields have a combined installed generation capacity of 1,100 megawatts.

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