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Subsurface spatial planning for aquifer production under subsurface uncertainty: using best practices from oil and gas industry

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Direct Heat production from geothermal aquifers can –theoretically- benefit considerably from optimizing particular well layouts optimizing the recovery of heat in the aquifer. This optimization or so called subsurface spatial planning, can deal with various optimization criteria, e.g. maximum heat recovered, maximum rate of heat produced per unit surface. Further optimization can be subject to various constraints, dealing with techno-economic key factors such as mimimum required lifetime (prior to thermal shortcut), minimum production temperature and power produced. Further geological criteria such as minimum distance to faults generally need to be incorporated. Under these optimization criteria, well Layouts can be optimized under uncertainty of the subsurface, adopting state of the art optimization techniques developed in the oil and gas industry. Key to these techniques is to assess holistically the sensitivity of reservoir performance to particular well design parameters while fully incorporating the effects of subsurface uncertainty on reservoir performance. The societal need for optimization is particularly emerging in areas where heat demand is relatively high (e.g. green house areas) and Heat in Place limited (e.g. aquifers of limited thickness). In this paper we discuss a best practice holistic workflow for aquifer optimization and present the results of optimization techniques for detailed geothermal aquifer characterization in the Netherlands. The models tend to demonstrate that although subsurface spatial planning can appear technically attractive for maximizing the collective performance of doublets planned in a optimized well layout, subsurface uncertainty generally possess additional economic risk to individual doublets because of unsolicited thermal shortcutting/pressure interference. In addition it is difficult in balancing individual and collective performance aims in optimisation. In particular collective optimization in terms of maximizing the heat recovered can sacrifice considerably individual performance, through placement of production wells at suboptimum locations in terms of production temperatures.