Feasibility study of a low-temperature geothermal power plant for multiple economic scenarios

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Abstract:

Deep-geothermal energy is a renewable energy source which provides a constant heat flux to the earth surface. If this heat is used properly, the geothermal power plant might deliver a constant electrical power output. However, the drilling costs for the geothermal wells are high, and hence the economic feasibility is not always secured. This is especially the case for low brine temperatures, which are common in the northwest of Europe. Next to the brine conditions, the feasibility of a low-temperature geothermal power plant strongly depends on the economic conditions (e.g., the evolution of the electricity price, lifetime and discount rate). Therefore, in this paper, we will investigate multiple scenarios for the economic situation and discuss the effect on the plant performance and the economic feasibility. The considered set-up is an air-cooled Organic Rankine Cycle (ORC), using Isobutane as the working fluid. The brine temperature is 130°C. The design of the heat exchangers and the air-cooled condenser is optimized together with the operating conditions based on a thermo-economic optimization algorithm. The net present value (NPV) is taken as the objective function. Using the NPV, we take into account the performance, the economics as well as the time-dependency of money. In previous work, two of the co-authors were involved in similar thermo-economic optimizations, but assuming fixed values for the economic parameters. Yet, we found out that the same geothermal project might be profitable (NPV=13MEUR) or loss-making (NPV=-8.5MEUR), depending on the economic situation. The ORC performance (optimal design & operating conditions and the corresponding electrical power output) strongly depends on the external economic parameters such as the electricity price. Good economic conditions are an incentive to build a more expensive ORC which generates a high electrical power output, whereas in bad conditions, a cheap ORC must be chosen which produces less electricity.

Keywords:

Feasibility study, Low-grade geothermal energy, ORC, Thermo-economic optimization.