

## **Optimization of Hybrid Geothermal Heat Pump Systems**

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Hybrid ground-source heat pump systems (HyGSHPs) couple conventional ground source (or 'geothermal') heat pump (GSHP) equipment with supplemental heat rejection or extraction systems (for example, a cooling tower). In cooling- or heating-dominated climates, the use of these supplemental systems has been shown to significantly reduce the size, and therefore the first-cost, of the ground-coupled heat exchanger that is required and therefore make the total system economically attractive. Finally, HyGSHPs can achieve higher yearly averaged performance than GSHPs, provided the supplemental systems are appropriately controlled. However, the design and controls of HyGSHPs are significantly more complex than GSHPs and there is currently little information in this area available to the practicing engineer.

The overall objective of this project is the development of a detailed simulation-based tool incorporating physics-based models of the HyGSHP system components using the TRNSYS simulation program. This includes utilizing and refining component models of supplemental devices such as cooling towers, fluid coolers, and solar collectors. The simulation results will be used to develop design guidelines and identify optimal control strategies for HyGSHP systems. These design guidelines will be presented in the form of tables and charts that correlate the optimal performance and component sizes of a well-designed HyGSHP systems over the a range of relevant operating conditions. In addition, a distributable software tool will be created with a graphical user interface, in order to allow parametric study and design of HyGSHP systems under user-defined and arbitrary loadings and climates. The distributable program will be made available to users (through ASHRAE). The program will be self-contained so that it will not require the user to own TRNSYS or any other software.