

Executive Summary

Manoa Elementary School's mechanical system was originally designed as a central plant system that included air cooled condensing units to provide cooling and dual fuel boilers when heating was necessary. Air distribution was provided by five rooftop variable air volume air handling units which utilized an energy recovery unit ventilator on the exhaust. Each zone is equipped with a series fan powered box to limit space conditioning.

The system redesign looked into exploring the results of three heat pump systems to determine their effects on the building as well as model the differences between the types. The impact of selecting a higher first cost system with improved energy performance will be analyzed throughout the process.

A vertical loop ground source heat pump system was selected as the first alternative. Water source heat pumps were selected to replace the rooftop air handling units. These heat pumps were designed to operate in parallel with dedicated outdoor air units to decouple the sensible and latent loads. The required loop length was calculated and then optimized to minimize the construction cost.

A horizontal loop ground source heat pump system was selected as the second alternative. This system was designed with the same parameters as the vertical loop system. The purpose of this analysis was to compare the performance of this system, whose ground loop is relatively inexpensive, with the expensive vertical ground loop.

An air source heat pump system was selected as the third and final alternative. This system was selected to compare cost and performance with the ground source heat pumps.

Trane Trace 700 was used to model all the systems and determine their annual energy use. The results from this analysis showed the costs and benefits of utilizing the different heat pump systems. Total energy costs of the three proposed designs were compared to the designed system and a baseline model is shown below. Research was also performed on the façade. The design and performance of vertical and solar shading devices and the impact they have on the total energy cost was also analyzed.

