OAK RIDGE NATIONAL LABORATORY

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To: Marc LaFrance, Manager
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Subject: GFX Evaluation

We are completing analysis of a 1-year study of the performance of a GFX system located in a triplex in Duluth. The purpose of this memo is to provide you with a preliminary look at our findings.

1. The installation

A number of studies of the Gravity Film Heat Exchanger (GFX) have been performed where the GFX is installed in single family homes. However, it is apparent that the benefit of the GFX would be greater in multifamily dwellings where two or more apartments share a common drain line. If a GFX were located in this drain line, the opportunity for heat recovery from drain water from all apartments would likely be larger, there would be more energy saved by the GFX and the economics of the GFX would be improved as compared to a single family installation. Of course, this assumes that hot water consumption patterns for families are about the same whether they live in single family or multifamily dwellings. To evaluate the performance of the GFX in a multifamily setting, Oak Ridge National Laboratory through DOE's Appliance and Emerging Technology Program (**www.eren.doe.gov/buildings/emergingtech**) identified a site for the study, installed a GFX along with instrumentation into this site and initiated the 1-year study. The site was a triplex for low-income families owned and operated by Center City Housing in Duluth. Hot water for all three units was supplied by a single, 40-gallon electric water heater located in the basement. A single GFX modified slightly for use in multifamily installations was designed and built for this project by the manufacturer. The modification consisted of separating the coil around the central pipe of the GFX into four parallel circuits to reduce the pressure drop caused by a large flow of fresh water through the coils of the GFX. This modification was made only to minimize water demand from one apartment from affecting another apartment. The 60-inch GFX was installed to ensure balanced flow: that is, both hot and cold water to the apartments passed through the GFX. Balanced flow, although not necessary for a GFX installation, nevertheless maximizes the heat exchange effectiveness of the system.

2. The Experiment

Instrumentation consisted of flow meters at the inlet to the hot and cold water lines manifolds leading to the apartments and to the GFX, temperature sensors at critical locations and a watthour meter to record the energy consumption of the electric water heater. Data from these sensors were recorded at frequent and regular intervals using a datalogger and transmitted electronically to Oak Ridge for analysis. Data collection for this 1-year experiment began in June 1999.

3. Preliminary Findings

Data from the experiment showed first of all that there was significant variability in the amount of hot water used by the tenants in the apartment over the duration of the experiment. Monthly hot water consumption ranged from a low of about 2000 gallons in December (64.5 gpd) to about 6000 gallons in April (200 gpd) as shown in Figure 1. This was supportive of evidence that all of the apartment units were not occupied at all times during the experiment and that the number of occupants for any one apartment varied over the course of the experiment.

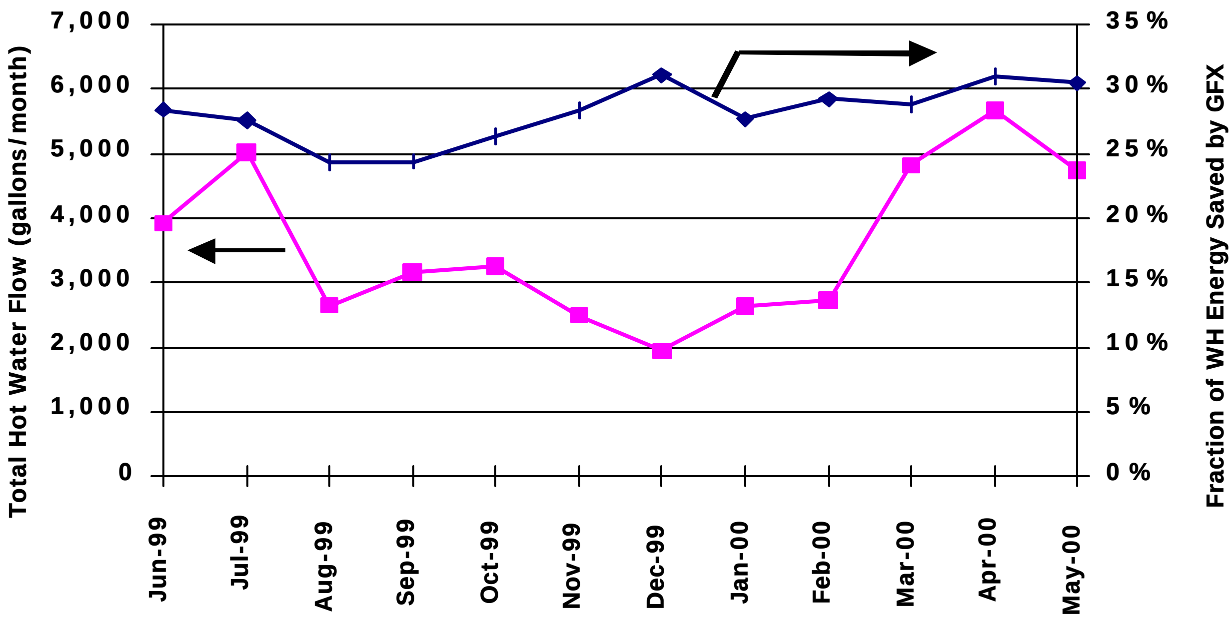


Figure 1. Total hot water use and GFX benefit over the field study in Duluth.

As was noted earlier, the 40-gallon electric hot water tank was instrumented so that the heat delivered to the hot water as well as the electrical energy provided to the hot water tank could be measured. From these measurements, a “field” energy factor could be determined. The energy factor (efficiency) is important to know, for it can be used to determine the additional energy to the water heater that would have been needed if the GFX had not been in place. The energy factor (efficiency) for the water heater remained at about 0.80 for most of the year, dropping to 0.75 during December, January and February – the coldest months. In our analysis, the water heating energy savings provided by the GFX were based on the measured efficiency of the electric water heater. These savings are shown by the plot at the top of Figure 1. As can be seen, the GFX saved from 25% to about 30% of the overall energy needed for water heating. These savings as a fraction of total hot water energy, did not vary with the total hot water flow as shown in Figure 1. From months with little hot water use (e.g. December) to months with high hot water use (e.g. April), there was no change in the relative savings provided by the GFX.

We also examined how the energy provided by the GFX and the electric water heater varied depending on the inlet temperature to the GFX. Both the GFX and the electric water heater did more water heating during times when the average inlet water temperature was low (e.g. 54F) than when is was warmer (e.g. 64F) as shown in Figure 2. The data points each represent weekly averages of data taken during the experiment. As expected, the GFX provided more energy at times when the inlet water temperature was low.

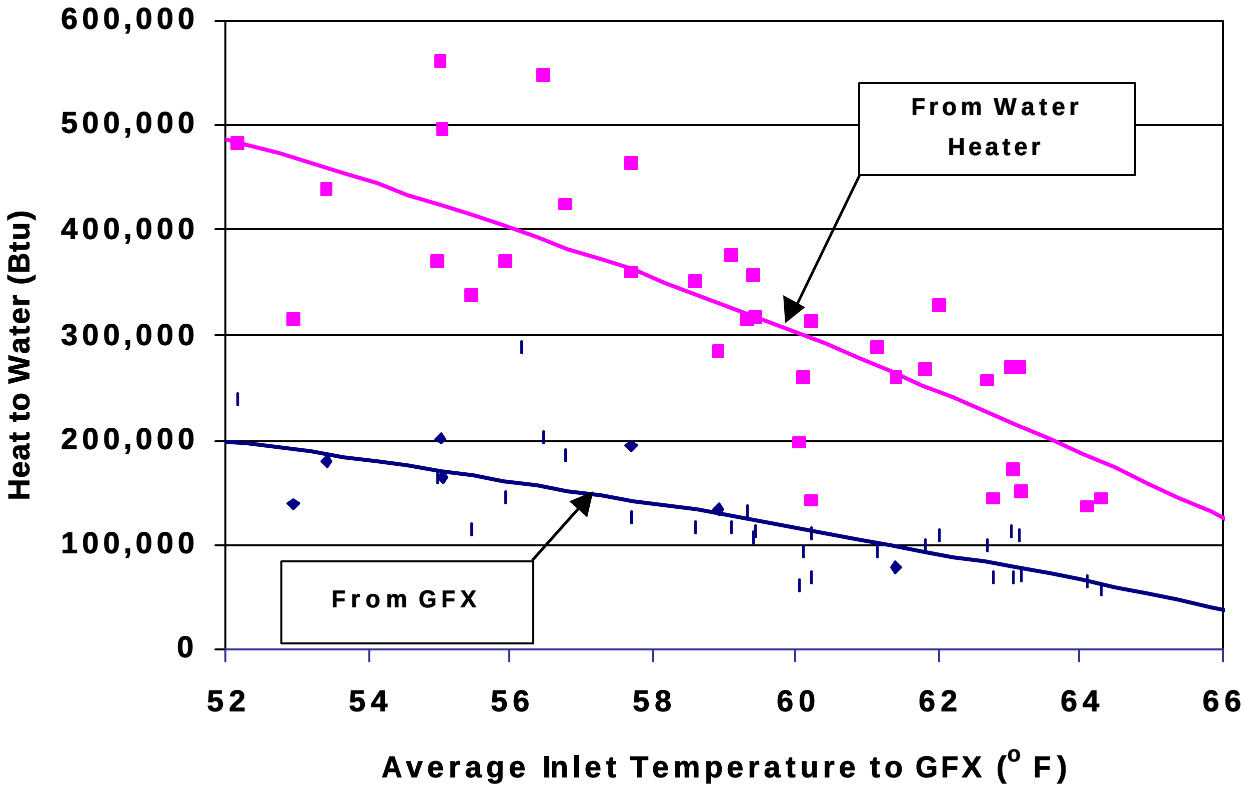


Figure 2. Heating contributions depend on inlet water temperature.

Finally, we calculated the equivalent electrical energy that was saved by the GFX in the triplex over the course of the experiment. The pattern of cumulative electricity savings is shown in Figure 3. The fact that the savings tended to be greater during the spring was due to greater hot water consumption by the triplex occupants during this time. Over the 1-year period, the GFX saved a total of 2800 kWh of electricity. If this electricity were valued at $0.08/kWh, the savings in operating costs would be $225.

4. Conclusions

This experiment confirmed that the fraction of energy saved by the GFX does not depend on whether it is installed in a triplex as in this case or in a single family home. With high or low hot water consumption, the relative savings of the GFX were much the same. In terms of absolute energy (and cost) savings, it is important to recognize how the thermal energy contributed by the GFX would have

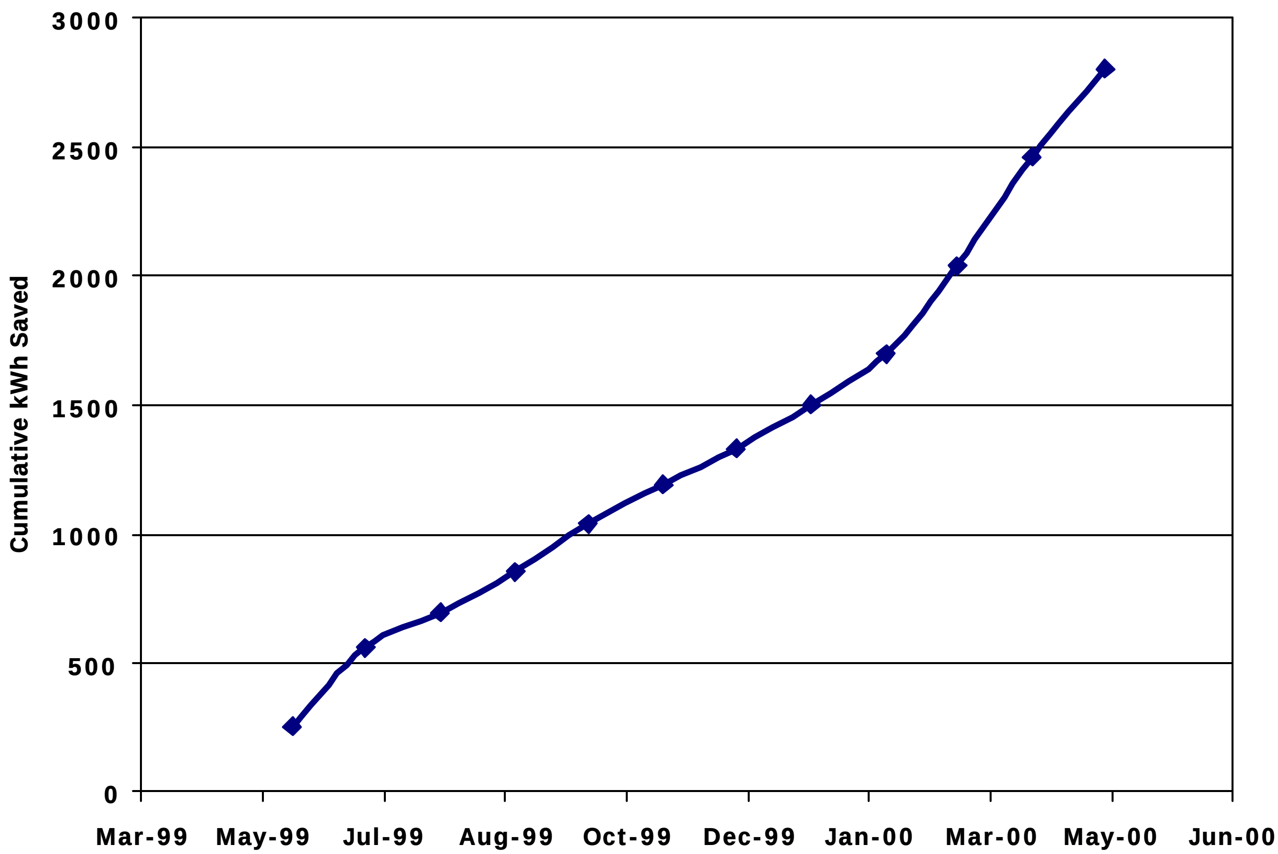
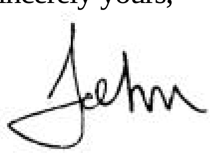


Figure 3. Annual Savings by GFX.

been provided if the GFX had not been there. This requires that the field efficiency of the main water heater be measured and applied to a calculation of the GFX benefit. In this experiment, we determined that the GFX would save between 25 and 30% of the total energy needed for hot water production based on the measured efficiency of the resistance water heater in the triplex. Over the year of this experiment, the GFX saved the equivalent of 2800 kWh of electricity.

Multifamily buildings with large hot water consumption patterns are an ideal application for the GFX. In cases where hot water is provided by resistance water heaters, operating cost savings should be sufficient to justify GFX installation with short simple payback times. The payback time for a specific application obviously depends on installed cost, the amount of hot water consumed daily and the cost for delivering hot water using the conventional water heater.

Sincerely yours,



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