International data on successfully demonstrated

Energy Efficiency projects **CADDET Newsletter**

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Residential waste water heat-recovery System: GFX

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Summary

The GFX system was developed with a grant from the US Department of Energy (DOE), Energy-Related Inventions Programme. GFX converts a residential drainpipe into an energy-efficient heat exchanger, capable of feeding back power to cut the cost of a hot shower and increase the shower capacity of residential water heaters: both gas and electric. Third-party monitoring of the GFX system shows reduced energy consumption.

The situation

According to DOE's Energy Information Administration (EIA), electric water heaters provided 45% of US residential water heating needs in 1995. The EIA estimates that in 1995 residential water heaters in the US consumed 740 TWh of energy and commercial water heaters consumed 320 TWh.

Approximately 80-90% of all hot water energy goes down the drain, carrying with it up to 955 TWh of energy in the US alone. Efforts to recycle this waste energy, such as the GFX system, can result in significant energy savings.

The technology

The GFX system [currently manufactured by Doucette Industries, Inc. of York Pennsylvania] cools waste water by using a gravity falling-film heat exchange method to transfer waste water heat to incoming cold water. Its operation is based upon a natural phenomenon whereby surface tension and gravity cause failing films of drain water to spread and cling to the inner walls of vertical drainpipes. The tension is strong enough to cut the film speed to 0.4-1.2 metres per second (1.3-3.9 feet per second) and hold their thickness to approximately 300-685 microns (12-27 mils) at 0.03-0.20 litres/second (0.44-3.1 gpm), respectively. This enables a high rate of heat transfer. When hot shower drain water enters the drainpipe, its inner wall becomes coated with a thin falling-film. The incoming cold water is rerouted to flow up its coil so that it captures the heat from the falling-films. The GFX has no moving parts. just a tight

coil of 1.3 cm (1/2-inch) diameter copper tubing around a 3-inch copper pipe. A 1.9 cm (3/4-inch) coil and 10.15 cm (4-inch) pipe are also available. The unit is 0.6-1.5 metres (2-5 feet) tall and must be installed vertically. It replaces a vertical section of drainpipe (see Figure 1).

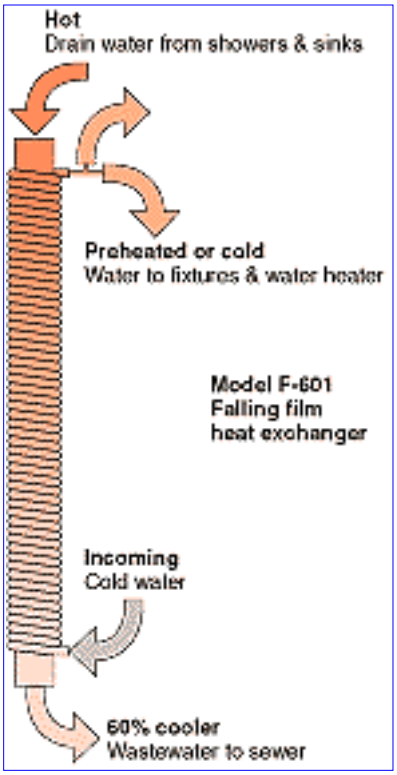

Figure 1.

Typically, about 80% of the heat leaving a showerhead is carried by drain water, so there is plenty to capture and recycle. Incoming cold water can be preheated by up to 20°C (36°F), while the drain water is cooled by an equal amount, leaving little energy to be wasted in the sewer. Preheated water can be fed to the entire house, the water heater, and/or the cold water input of a shower. The system can be installed by plumbers or do-it-yourself enthusiasts.

Energy monitoring results

Water heater	**Energy factor**	**Stand by loss** (Watts Avg.)	**First hour ratings**[1] (litres)
#1 Standard 50 gal. (190 litre) with GFX	1.17 to 1.42	64	409
Without GFX	0.83 to 0.86	99	174
#3 50 gal. stone-lined with GFX	1.49 to 1.71	52	681
Without GFX	0.91 to 0.93	39	227
With heat pump & without GFX	1.33 to 1.57	37	227

1. First hour rating - a theoretical estimate of how much hot water a heater can produce under a specified draw schedule in one hour.
2. 'Virginia Power Water Heater Testing and Optimisation Project,' Final Report (May 31, 1996) by Douglas Taylor and Prof. Gary Grossman, College of Engineering and Technology, Old Dominion University, Norfolk, VA, USA 23529.

Table 1: GFX & electric resistance water heating (third party evaluation[2]).

The GFX system has been tested for energy savings on three electric water heaters by researchers at the College of Engineering and Technology, Old Dominion University. Some of the key conclusions from their test results were:

'The GFX drain water recycling unit is an extremely effective heat exchanger. Its measured effectiveness (recycling efficiency) was very close to that specified by the manufacturer at 60%.'

'When properly installed, the GFX reduces energy consumption at varying load patterns from 47-64%, with an average of 55%.'

'GFX can increase the energy factor (overall winter heating efficiency) from 57-73% over resistance water heaters alone.'

'Resistance water heaters utilising GFX as a pre-heater can produce approximate First Hour Ratings1 of 410-680 litres (108-180 gallons); about two to three times that of resistance water heaters alone.'

'With a drain water temperature close to 38°C (100°F), the GFX can increase the temperature of the water entering the water heater by 11.1°C to 16.7°C (20°F to 30°F), depending on inlet water temperatures.'

'GFX provides enough energy to the inlet water to prevent the upper element energising (fast recovery cycle). This occurred in all tests with the three resistance water heaters.'

Several power companies and water utilities have also tested the system. One evaluation concluded that the unit would save more than the equivalent of 26,000 million litres (7,000 million gallons) of oil per year if it were used for all residential and non-residential water supplies.

Actual in-home energy savings would depend on a number of factors, including the shower flow rate, plumbing system, and type of GFX unit installed (Photo 1). The uninstalled cost of the in-home system ranges from USD 180 to USD 340. In those parts of the US where electricity costs 8.5-17 cents per kilowatt hour, GFX could save 20-40 cents per shower, which for a family of four amounts to annual savings of about USD 250 to USD 500.

Photo 1: Model F-2305S tripled the supply of hot shower water in an all-electric home in Herndon, Virginia.

Environmental effects

Estimating a reduction in air pollution based on the use of GFX is difficult since it depends on the type of energy available in a particular region. Burning one gallon (3.8 litres) of oil can release 10.2 kg (22.5 lb) of CO_2 plus 0.35 kg (0.78 lb) of NO_X emissions. Conserving 26,000 million litres (7,000 million gallons) of oil means eliminating approximately 80 million tons of CO_2 plus 2.7 million tons of NO_X. According to US Environmental Protection Agency standards, if just 6 million all-electric homes were to install GFX, US greenhouse-gas emissions would be reduced by over 20 million tons. Other applications GFX models have also been successfully installed in buildings designed for multi-family housing, such as the National Association of Home Builders (NAHB) 21st Century Town House Project (Photo 2) and a low-income housing project (Photo 3). Other applications for the GFX system include apartments, hotels, motels, and college dormitories. It can also be used to cut water heating costs for shower rooms, hairdressing salons, roadside rest rooms, camping grounds, etc.

Photo 2: Model F-2305S serves two upstairs bathrooms in the National Association of Home Builders 21st Century Town House Project in Bowie, Maryland.

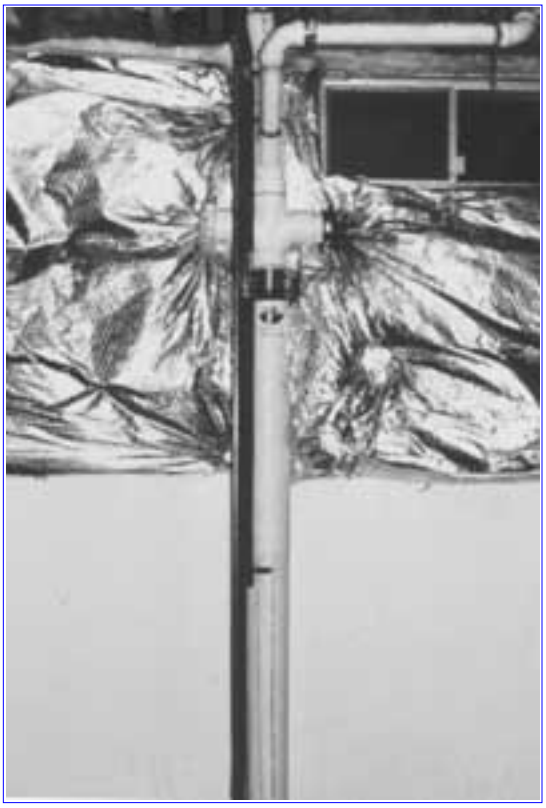

Photo 3: Model F-2305P serving the first floor shower and lavatory in an affordable housing project in Islip, New York.

GFX also shows promise for food processing applications where double-wall-vented construction is required for public safety. A recent US DOE study on applying GFX in the food processing industry reveals that canning factories alone utilise 136,000 million litres (36,000 million gallons) of water per year in approximately 3,000 canneries in the United States.

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NEWSLETTER

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