

Doug Copping, Laurel McCarthy, Katie King, Karim Rizkallah

ERS 250 - Drainwater Heat Recycling at the University of Waterloo

T.A. Meghan Beveridge

1 December 2003

Abstract

This project aims to assess the feasibility of the installation and effectiveness of a drain water heat recovery system at various locations on the University of Waterloo campus. A drain water heat recovery system captures lost heat energy from waste water and allows it to be reused, saving both energy and money. Through the use of interviews, case studies, potential site analysis, and intensive research on the specifics of this particular product, many feasible locations were established. The installation of the product in any of these locations would be environmentally and economically beneficial.

Introduction

This ERS 250 project was designed to determine the feasibility of a drain water heat recovery system within certain buildings at the University of Waterloo (hereafter referred to as "UW"). A group of four ERS 250 students have researched the feasibility of a particular drain water heat recovery product in a number of locations on campus. An attempt will be made to determine whether or not this product could have a positive environmental effect while also reducing operating costs sufficiently to make it a realistic or even desirable project.

Due to the constantly increasing awareness of the finite limit of global resources, conservation and recycling have become extraordinarily important. Like in the case of many other “greening” projects, the drain water heat recovery concept promises important environmental benefits that would reduce the demand on these resources. By recycling the heat from used or “grey” water, some the energy normally required for heating can be conserved, and thus the ecological footprint of the water system is reduced significantly. Unlike most environmental or “greening” initiatives, however, the economic limitations in this case are non existent. Installation of this product should become quite profitable within a relatively short amount of time.

In a forward thinking institution like the UW, the environmental benefits of campus greening projects alone should be enough to motivate their implementation. Realistically, however, the economic interests of the university bear considerably more weight. In this case, the economic consideration for the project should fortunately not stand in the way of reducing the campus energy consumption. On the contrary, this system would become economically profitable within a relatively short amount of time not to mention improve UW’s positive leadership image. The environmental awareness that could extend outwards as a result of the successful implementation of such a project would also be extremely significant, and should not be overlooked.

Purpose/Rationale

This project was chosen due to interest in the drain water heat recovery product mentioned by Patti Cook at the initial stages of the ERS 250 course. Our group wanted to explore more unconventional ways of recycling more unconventional resources; in this case, drain water. In an attempt to encourage recycling on campus, we wanted to encourage people to “think outside the blue box” and consider recycling other things than just cans and bottles etc. Hopefully this project will push the university to implement a GFX system, or at least consider it in the future. Ideally, this project would also inspire future greening the campus students to research less conventional technologies such as the GFX, and help them get the research and coverage they require and deserve.

Background

The Drainwater Heat Recovery system from RAI (hereafter referred to as RAI) is a new and innovative technology that considers environmental concerns and takes advantage of the North American lifestyle. North America is well-known for its over consuming and wasteful practices. Although these practices are degrading the Earth, technologies such as the GFX system integrate the two realities: the environment cannot withstand current human routines and that North Americans are over-consuming. The GFX system utilizes waste heat which would normally be lost to reduce water heating costs; hence, electricity.

The RenewABILITY Energy Inc. product is a moderately simple technology that captures the lost heat energy, which would normally be lost as it

goes down the drain, is reused. The Gravity Film Heat Exchanger (GFX) system takes advantage of ultra-high heat transfer rates (see figure 1). Grey hot water falls down the vertical section of the drain pipe where there's a thin film that captures the heat from the water. The heat is then transferred to the cold water that is circulating in the GFX around the outside of the drain pipe. The incoming cold water is preheated before going into the water heater and plumbing therefore saving money and energy on water heating. It can bring cold water from a temperature from 10 C to 24 C. The excess heat is used to preheat water that conventionally would require the use of a water heater. This system has no moving parts or heating elements, which assures maintenance-free operations. It simply replaces a section of drainpipe, which would be useable by almost any building or home. The simplicity and efficiency of this product makes for a practical investment.

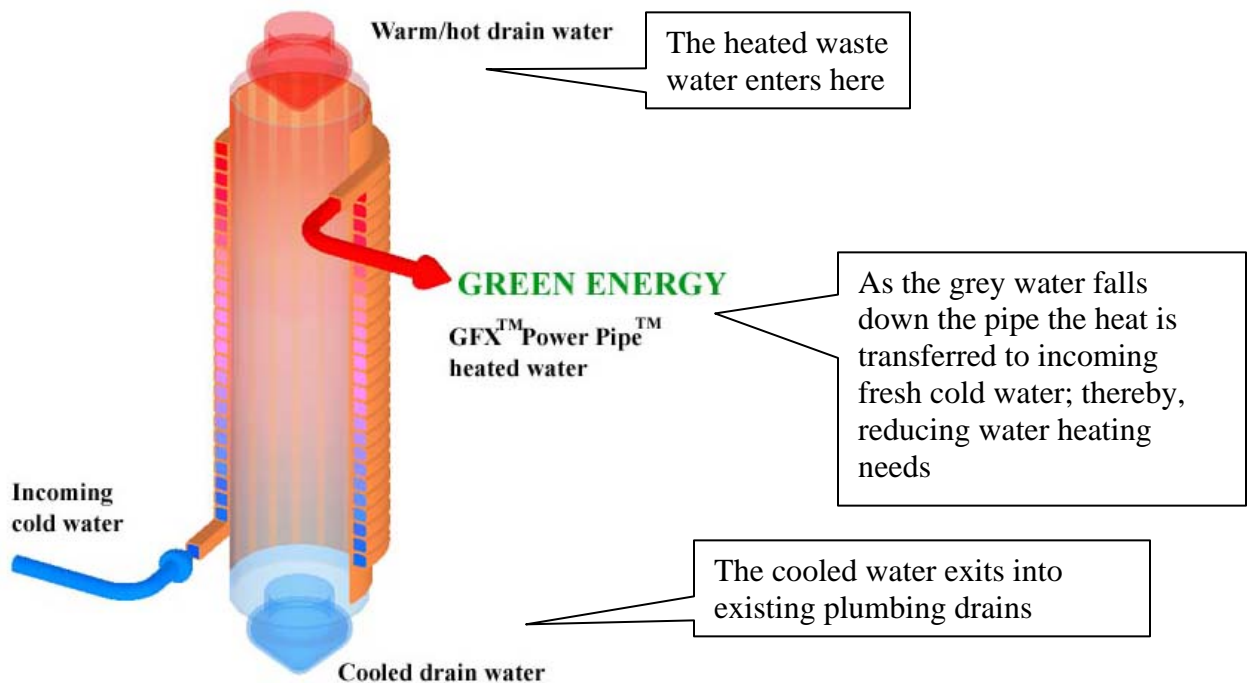


Figure 1 As hot grey water flows down the vertical piping a thin film captures and transfers the waste heat to the cold water that flows up the copper piping and exits into the water storage tank or directly into use. This minimizes the amount of energy needed to heat water.

The Drainwater Heat Recovery System saves energy and money. This system is capable of recycling up to 60% of the lost heat energy. It reduces energy consumption by 5-10%; therefore, reducing greenhouse gas emissions. The GFX system is cost efficient since it can pay for itself from the savings within 2-5 years, and can last from 50-60 years. Furthermore, the heat recovery system works most efficiently in buildings that have multiple drainage systems and high shower use, such as the to-be-constructed grad-houses and the PAC at University of Waterloo. Because of the high and continuous use, the GFX system would be worthwhile to install (RenewABILITY Energy Inc. 2002).

Research Methods

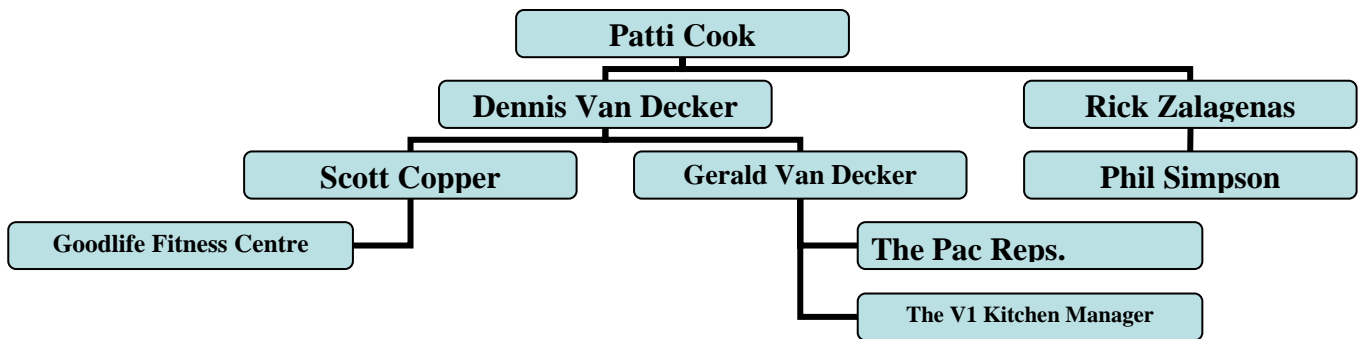


Figure 2 The flow chart demonstrates the sequence in which we received different information from different informants. This chart stresses the importance of being able to talk to people. This chart does not show the many 'dead ends' that occurred throughout the process.

The snowball sample was our fundamental research method used to generate relevant information (see figure 2 above). Patti Bester of the University of Waterloo Sustainability Project (UWSP) introduced us to our major contacts at

RenewABILITY Inc. and within the university administration. Initial contact was predominantly through emails, eventually leading to phone conversations. From this point we established interviews with Scott Cooper of RAI, and obtained additional contacts, detailed product knowledge, and information regarding other successful implementation sites across North America, including the Goodlife Fitness Centres, namely a recent installation in Kitchener. We then set up another meeting where we toured the nearby Goodlife Fitness Centre, observing a working example of the RAI drain-water heat recover system. This provided the opportunity to ask specific questions about the setup and to take necessary pictures for documentation. Further communication with RAI allowed us to develop contacts with the president and vice-president of the company, Gerald and Denis Van Decker, who provided another perspective and additional product information. Our group collaborated to clearly define a vision for the project with the efforts of RAI by initiating a multi-party conference call. Around the same time, we were also developing our connections within the administration elite. E-mails and phone calls eventually lead to an interview with Rick Zalagenas, the Director of Plant Operations and chief engineer. This provided a UW perspective with respect to implementing the power-pipe product, providing good direction as to some of the potential issues with the product. Rick introduced our group to Phil Simpson, a senior engineer who allowed us to look over some blueprints, identifying locations of potential implementation. Phil then escorted our group beneath the PAC and V1 to physically assess feasibility of these sites with respect to the excess space available and, most importantly, to determine

whether the current plumbing setup would support such a system. Our next step was to collect quantitative data to calculate payback periods based upon potential energy savings. To achieve this goal, we revisited the PAC and questioned administration, asking about peak periods, changes in facility use between seasons, number of average daily visitors, and the estimated showers taken based upon the number of towels used. To determine the volume output by the showers, we measured the amount of time required to fill a 2 gallon plastic bucket using one shower head, and then calculated the rate of water flow from this data. Predicting typical water temperature and average shower length, we formulated a fairly accurate estimate for expected thermal energy output from shower waste-water within the PAC. Our group toured the V1 cafeteria courtesy of Marc Villeneuve, the manager of food services at Village 1, who explained the kitchen setup, identified locations of hot water use, provided us with information about the specific dishwasher model used and identified V1 cafeteria peak periods. From this knowledge we could identify average quantity and temperature of waste water, and estimate the potential amount of energy recycling the GFX system could produce. We also estimated installation costs by visually inspecting the sites proposed for implementation. This research data produced an accurate feasibility study.

The perspective of this approach risks being biased by the initial source, Patti Bester of the USWP, who introduced us to our major contacts, RAI and administration elite. This is dangerous because the first contact strongly influences the shape of the 'snowball' or research that results. Therefore, the

foundation of our research was built upon these biases, affecting the outcome of our project accordingly.

Boundaries, Scope, Systems Analysis

Depth of field research was limited to University of Waterloo and the surrounding Kitchener-Waterloo area because our possible traveling distance was restricted geographically. These boundaries are legitimate and did not impede our progress as the purpose was to eventually implement the RAI heat exchanger on the UW campus. An excellent example was available within this region to compare with respect to feasibility. For background research we utilized information from campuses across North America where the concept of recycling thermal energy from waste water was being exercised with success.

Critical Analysis of Our System

The actors within our system form a dynamic relationship. Our group members are the central component within the system as we facilitated contact between actors, gathering information from both the private and the public sector. Our research team acted as mediators by drawing together RAI with contacts on campus holding decision making power with respect to energy saving programs. RAI and UW have a historic business relationship as RAI has been proposing the implementation of the power-pipe on campus. Looking at the broader scope of our project we consider the public-private partnership (PPP) between these two parties. This relationship affects building construction decision making and

impacts resulting environmental performance. There are many programs designed to improve this relationship. Leadership in Energy and Environmental Design (LEED) is a Green Building Rating System created to define green-building by establishing standardized measurement; promote integrated, whole-building design practices; and recognize environmental leadership in the building industry (Leadership in Energy and Environmental Design, 2003). This initiative is achieved using volunteer, consensus-based national standards for expanding environmental ingenuity across Canadian buildings. For another example, consider the Central Board of Irrigation and Power (CBIP) whose main objective is to implement sustainable development within the water resource sector. This organization establishes relationships between public and private sector organizations, bringing them together to deliberate on issues of mutual interest and providing information with respect to new technology (Central Board of Irrigation and Power, 2003). The R2000 program is established by Natural Resources Canada, setting efficiency initiatives for new buildings to be constructed meeting their high level of standards or existing buildings to be retrofitted to meet the same goal (Natural Resources Canada, 2002). It is a systematic approach to design that incorporates cost effective, energy efficient technology (Canadian Home Builders' Association, 2002). These are examples of programs that initiate and regulate benchmarks for building standards. Their existence can result in greater performance, as benchmarks raise the platform of efficiency. However, within the context of our project, tender specifications did not include LEED, CBIP, R-2000 or any other form of standardization. As a result,

the system is essentially neutral, and not weighted in support of our cause. Thus, it becomes difficult to implement such products because regulations do not strongly encourage it.

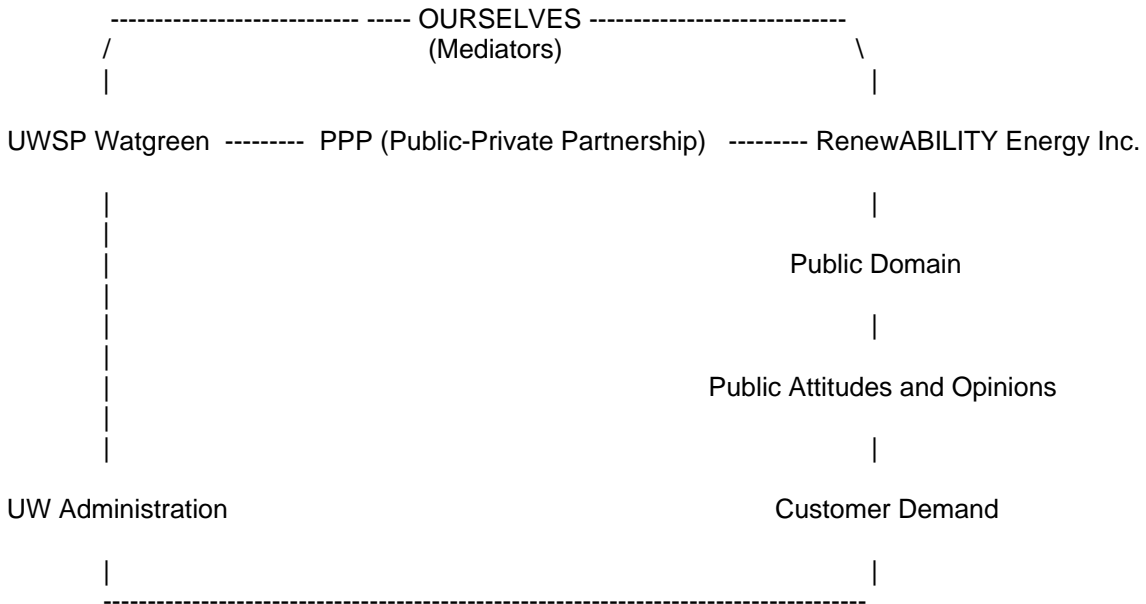
However, the UWSP is a component within our system that encourages our project efforts. A partnership with this organization led us to essential sources of information including contacts with administration decision makers. Without help from the UWSP, it would be quite difficult for our group to initiate conversation with the appropriate people, and it would take a much longer time to build our snowball. Therefore, the UWSP acts as a catalyst within our system, speeding up our research efforts by developing a knowledge network, increasing the rate of information collection and reducing the time required to complete it.

The University administration is a major player in our system. Many projects are in place to encourage energy efficiency because at any given time, the institution is operating on a finite budget that encourages cost saving initiatives. Although ranked as a lower priority, contributing positively to the environment is also on the agenda. According to Rick Zalagenas, when the school can reduce emissions and save money at the same time, "there better be a damn good reason if we are not doing it." In this situation, University Administration is a customer of RAI, as they sell their technology for a profit. This factor causes the University to question the nature of their business, resulting in some scepticism. Therefore, statistical, quantitative evidence that implementing the power-pipe would result in financial benefits is the fundamental prerequisite needed before action is taken.

The Good Life Fitness Centre project represents private sector interests outside of the university. Both customers and suppliers are affected by economic principles of supply and demand. In the case of RAI and their power-pipe product, the equation for its demand lies upon the foundation of public attitudes and opinions. Demand will increase if general attitudes embrace the concept of energy efficiency and believe the product contributes significantly towards this cause. If however, attitudes are indifferent towards saving energy, or the benefits of the product are not held with complete confidence, demand will be vulnerable. UW does not escape these conditions, and as customers of RAI, their attitudes and opinions establish demand for implementation.

Following the vision of innovative educator David Orr, the purpose of greening the campus program is to utilize the university campus as laboratories, developing effective ways to build greener communities, modeling the world students seek to create. By applying knowledge gained from these model experiments, UW administration has the potential power to influence the public domain, public awareness, and attitudes and opinions by proving greening the campus initiatives are not only effective, but also possible on a larger scale, beyond the confinements of UW.

Portrait of Our System



Interview Process

Interviews were the key to the success for the project. Each interviewee created new insights as well as new bias to the projects dynamics. From our standpoint we were just facilitators between the Drainwater Heat Recovery team and UW administrative body. The interviews occurred throughout the term (see figure 3 below). To understand the discrepancies that arose out of each interview and the bias each presented one must look at each individual interview then combine them as a whole. The perspectives from each interview will be assessed with what the thoughts were then, not based on information given in the end.

Date	Interviewee
Friday September 26 th	Scott Copper
Wednesday October 22 nd	Goodlife Fitness Centre
Wednesday October 29 th	Rick Zalagenas
Wednesday October 29 th	Phil Simpson basement tour (#1)
Tuesday November 4 th	Conference Call with Dennis and Gerald Van Decker and Scott Cooper
Tuesday November 18 th	Phil Simpson basement tour (#2) with G. Van Decker and S. Cooper
Tuesday November 18 th	Gerald Van Decker and Scott Cooper
Wednesday November 19 th	PAC representatives
Wednesday November 19 th	V1 Kitchen Manager

Figure 3 The chart shows which time coincides with which interview. This chart however does not show the people that were contacted which were not of importance or were not helpful.

The first interview was with the sale representative for the GFX Power Pipe system Scott Cooper. He is a recent University of Waterloo graduate who was interested in pursuing to have one of the systems installed in the to-be-built grad houses. He emphasized the environmental dedication of the product and how all universities should adopt these types of technologies to promote a forward-thinking ideal. Scott Cooper also introduced the conflicts between UW administration and the GFX sales representatives. The bias that was presented was that the GFX team was a small company whose sole concern was the environment. The impression was also given that UW administration is unwilling to implement the relatively economically safe investment although the estimated economic return in the PAC was one year.

The Goodlife Fitness Center was the second interview that took place. Scott Cooper accompanied us to the Goodlife Center in Kitchener where we saw the Power Pipe work and the plumbing that it entailed. All Goodlife Centers

across Ontario and many in Quebec are installing one of these systems due to the high volume of hot and continuous showers. The technical aspects of the system were explained and a greater understanding and appreciation for the system was developed.

The third interview occurred with Rick Zalagenas, director of maintenance and utilities of plant operations. It is his decision alone that allows permits the installation of one of the systems. The results of the interview with Mr. Zalagenas came to us as somewhat of a surprise. Mr. Zalagenas has been approached about countless pilot projects, such as the Drainwater Heat Recovery system, and as such has become sceptical of these products. After all, the GFX Power Pipe team is a company whose goal, like any other business, is to make money. Mr. Zalagenas had several issues of installing the product. One being that the heated grey water that passes through the heat coil system requires the perfect distribution in order to retain maximum heat return. Secondly, Rick pointed out that the projected savings were theoretical recovery rates; hence, the 3-5 year payback is only an estimated timeframe with no supporting evidence. Another problem Rick Zalagenas observed was the architecture of the PAC and Village 1 (V1) residences, which have high hot water shower usage, were built in the 1960's and may not facilitate the new technology. Rick Zalagenas mentioned that the to-be-built grad-houses were under construction by Reed construction and since it was not being constructed with UW that it was not in his hands to install the product in the new building. However, Mr. Zalagenas did purposed that if our

group proved that the system works, through our own mathematical data findings and that it could work in any of the UW buildings, he would install the product.

Immediately after the interview with Rick Zalagenas the group was directed to Phil Simpson maintenance supervisor. He facilitated a basement tour of both the PAC and V1 to see if a Power Pipe could be installed. There were a few immediate obstacles that were observed. First being that since the PAC was constructed in the 1960's the piping was lined with asbestos. Asbestos is incombustible, chemical-resistant, fibrous mineral forms of impure magnesium silicate, used for fireproofing, electrical insulation, building materials, brake linings, and chemical filters (Dictionary.com, 2003). It is also known as very harmful to human health. The safety of the workers that would be installing the product must also be considered. Another problem encountered with Phil Simpson is that excess pool water also drains into the same pipe as the water from hot showers. The cool grey water mixing with the hot would lose much of the energy that could have been utilized. In V1 one major problem was the distance from the hot water tank to the shower drainage pipes. It was thought that the long distance traveled by the water would lose a lot of the heat energy, and require the use of a pump. Although there was hot water draining from the dishwasher that we thought there could be a possibility for the system. The tour was believed to have showed how that product was not feasible.

The conference call between Gerald and Dennis Van Decker, both engineers, Scott Cooper, and the ERS 250 group proved to be a very effective way of communicating. The discussion created a dynamic to the apparent

'unfeasibility' of the Power Pipe. As discussed, the problem with implementing a heat coil exchanger in the grad-houses is the Private Public Partnership (PPP) made between UW and Reed Construction. Discrepancies of policy arose in terms of who was responsible for utilities of the grad-house buildings. It was established that UW does the payments for utilities and therefore has a vested interest in utility cost reduction. The GFX engineers were in contact with administration prior to the project; however, little was established in regards to the actual feasibility of the product in the any of the UW buildings. Politics and policy as well as red tape and miscommunications have been halting the process from advancing further. The GFX team offered the university a free upfront \$20,000 water softener as well a no risk payment plan whereby the university would pay nothing for the system initially. The heat coil would be paid back through the savings of electricity. The company would get 75% of the savings and the university would get 25%. Essentially, a system could be installed for free and the university would receive 25% of potential savings. It's a fairly safe economical endeavour. However, Rick Zalagenas wanted to purchase the system immediately to save money in the long run. Either way, the system was still a very economically, logistically, and environmentally sound investment. One technical problem that arose out of the discussion is that chlorine is corrosive with copper. There is a large amount of chlorine, from the pool, that could potentially harm the copper coil system. Fortunately, there is a coating that can be used to protect the copper. The coating increases the overall cost of the system, but it is a minuscule amount compared to the life cycle of the system

which is more than sixty years. The interview also established the fact that there was a need for the GFX Power Pipe engineers to actually see the PAC and V1 plumbing in order to identify the feasibility of installing the heat coil system.

The second basement tour was guided again by Phil Simpson. Gerald Van Decker and Scott Cooper attended the tour with the 250 group to identify the feasibility. The outcome of the second tour was much more positive. Mr. Van Decker noted that the PAC is an ideal building to retrofit the system, mainly due to the high, continuous usage of the showers. There would be a need to retrofit some of the plumbing due to the contamination of cool water from the pool. It was also discovered that the women's showers would be extremely difficult to retrofit a system; therefore, it was established that only the men's shower water could be utilized. Gravity could not be used to flow the water so there is a need for a pump; however, there is an existing pump that is not fully utilized that could be employed. Floor plans were intensely reviewed by the Power Pipe team and it was established that V1 could potentially host a system, if the dishwasher was a certain model. The outcome of the tour was both positive and encouraging.

The next interview was with Gerald Van Decker and Scott Cooper discussed further how the problems could be resolved with PAC. They were also interested in the V1 dishwasher. Mr. Van Decker needed other quantitative data from the PAC and V1 in order to assess the building. The results of this interview were that the PAC needed to be retrofitted with new plumbing in order for the system to be installed. Despite the initial negativity towards the installation obstacles, the PAC is actually an excellent building in which to install the system.

The final interviews were with some employees at the PAC and the Village 1 kitchen. At the PAC, some quantitative data was collected to determine the output volume, the amount of shower heads, and the amount of towels used in the change room facilities. The workers at the desk where towels and other equipment is acquired informed us of an estimated amount of people that use the showers as well as important data indicating general usage tendencies and patterns. Afterwards, Marc Villeneuve, the manager of food services at Village 1, gave us a brief tour of the cleaning equipment in the kitchen as well as information concerning cleaning practices and schedules. We were specifically interested in how the main dishwasher worked to see the viability of installing the Drainwater Heat Recovery System for the purpose of the dishwasher.

Case Studies

The GFX drain water heat recovery product has been implemented in a number of other facilities, including the Goodlife Centres across Canada as well as a number of universities. By looking at these facilities, it was discovered that the physical activities centre at UW would be an excellent candidate, because of the similarities between frequent shower usages for a heat recovery system. The Kitchener Goodlife Centre provided an example of a GFX system that was implemented in a facility with similar water usage patterns to the PAC, i.e.: shower frequency and shower numbers. By looking at the Goodlife Centre system, insight was gained into what kind of facility could benefit from a drain water heat recovery system, details of the mechanics of the product such as how

it is installed and details on the process used to heat the water. It was an excellent way to see and understand how the product worked. Other academic institutions in Canada have implemented the GFX system on their campuses. These include the University of Regina, York University, Humber College and the University of Calgary.

In order to evaluate GFX performance in a multi-family setting, OakRidge National Laboratory set up a study site with the U.S. Department of Energy. The site consisted of a triplex in which hot water for the units was supplied for by a single 40 gallon electric water heater in the basement. The study began in June 1999 and took place over one year. A 60 inch GFX unit was installed and both hot and cold water passed through the GFX. Flow meters, temperature sensors and a watt-hour meter were used to measure the results. In this analysis, water heating energy savings provided by the GFX were based on the measured efficiency the electric water heater. The GFX unit saved 25-30% of the overall energy for water heating. There was no change in relative savings between months with little or a lot of hot water use. Over the one year study, GFX saved 2800 kilo Watt hours of electricity in the triplex. If this electricity was valued at 0.08\$/kWh, the savings in operating costs would be \$225.00. This study showed that multifamily buildings with large hot water consumption patterns are an ideal application for the GFX system (Tomlinson, 2000). This would also conclude that the more hot water usage and the more people taking showers would only increase the benefits of the GFX, which means that a facility such as the PAC would be a prime candidate for this system.

Results – On Campus Feasibility

All costs, dates, and financial details below are estimated using exact data from RAI concerning prices, and estimated measures for materials and labour costs. All estimates are were made conservatively by rounding costs and other requirements up (ie not in favour of the product), and calculating the funding accordingly.

Physical Activities Centre (PAC)

The PAC was the first location considered during the design phase of the project due to its similarities to the Goodlife Centre where the GFX was already installed in terms of showering and significant resultant hot water usage. Due to the old age of the building and therefore the more archaic plumbing techniques used, considerable costs would be present during the installation phase of a heat recovery product at the PAC. The measurements and usage assessments, however, indicated a prime location in terms of hot water use.

The thirteen (13) showers in each changeroom have an output of over three (3) gallons per minute, which is rather high flow. That along with the significant traffic through the PAC result in heavy hot water usage ideal for the GFX product.

The heat source would be the drainwater from the men's showers (and not the women's, due to the inaccessibility of those drain pipes). The heated freshwater would then be split. Roughly half of it would travel back to the men's showers replacing the cold water, thus reducing the amount of hot water required

to maintain the same shower temperatures (as opposed to 33% cold water and 66% hot water, it would be closer to 60% 'warm water' (ie fresh water run through the Power Pipe) and 40% hot water). The remainder would travel into the hot water tank itself, reducing the amount of energy needed to raise the water temperature to the standard level. This would greatly reduce the load of work currently on the hot water tank. Some pumping would be required to maintain the flow in the system, but there is fortunately a pump already installed and unused right in an ideal and accessible spot.

Due to some rerouting of pipes and the larger size of product required (multiple sets of four (4) GFX pipes, significant rerouting), the total costs would approach \$24,000. The savings, however, would be quite significant as well, and it is estimated that the product could potentially save over \$5,000 per year, thus it would pay for itself in less than five years and then provide excellent savings for (see figure 4 below).

GFX – UWaterloo PAC FINANCIAL SUMMARY	
Total Installed Cost	\$ 24,374
Enbridge Incentive (\$.05/m3)	\$ 895
Net Installed Cost	\$ 23,479
Estimated Annual Energy Savings	\$ 5,131
Simple Payback [years]	4.6

Figure 4 – PAC GFX product estimated Financial Summary

Although the purpose of this project was to determine the recycling feasibility of the heat from drainwater, it is important to note that conservation is often a much simpler and more effective means to reduce energy consumption.

In the case of the PAC, lower flow shower heads could be installed to significantly reduce water usage while not noticeably compromising the shower facilities.

Village 1 Cafeteria (V1 Caf)

The V1 Caf was determined as a potential site when looking at building diagrams with Phil Simpson. The dish washing facilities were to be the source of hot waste water in this case.

Although there were multiple appliances with high water use, we were informed that the main dishwashing unit, a Champion UC-CW6-WS, was the only one used regularly enough to justify the installation of a GFX unit.

This particular dishwasher unit is fairly new (as the cafeteria has been renovated within the last few years), and already has a few water and energy saving technologies integrated which result in roughly 40% savings. This is a nice example of the effectiveness of conservation rather than 'band-aid' recycling solutions.

Still, the machine consumes over three gallons per minute, and the water is heated with internal electrical temperature boosters to a maximum temperature of 180°F. Although there is less flow in this case than in the PAC, a smaller GFX unit would prove effective in particular due to the extremely high water temperatures. The heated fresh water would be cycled back into the washing machine to reduce the amount of work required of the electric boosters.

This much simpler installation, a four (4) pipe model, would have a considerably reduced initial cost than the PAC installation, but the savings would also be less prominent. Overall, it is estimated that an installation in the V1 Caf would pay for itself more quickly than one in the PAC, but the future savings would not be as great (see figure 5 below).

GFX – UWaterloo V1 Caf FINANCIAL SUMMARY	
Estimated System Cost	\$ 8,108
Enbridge Incentive	\$ 305
Net Installed Cost	\$ 7,803
Estimated Annual Energy Savings	\$ 2,381
Simple Payback [years]	3.4

Figure 5 – V1 Caf GFX product estimated Financial Summary

The possibility of routing the wastewater from some of the other appliances, particularly if a greater use is noticed, could help ameliorate the above figures.

Columbia Lake Grad Houses (CLGHs)

The CLGHs, a new complex of three hundred (300) townhouses next to the current location of the Columbia Lake Townhouses, were of interest due to their being currently under construction. The setup in individual townhouses such as these would be a simple, one pipe system feeding the shower and faucets of the house.

One of the possible conservation considerations in these houses would be to opt for forty (40) gallon hot water tanks rather than the sixty (60) gallon tanks currently being installed. A forty gallon tank can provide a very reasonable amount of hot water for these three person houses, in particular with the support

of a GFX unit reducing the demand on the tank. There would not only be savings in terms of the tank itself (roughly \$80 per house) but the GFX unit would be particularly effective with the resulting greater demand.

Unfortunately, the first phase of construction is already completed, so one hundred (100) units already have sixty gallon tanks installed. Still, the remaining units could be modified easily and relatively cheaply if the changes were to happen soon, and even the first hundred units could benefit from a GFX system in place.

Estimated figures are provided for both the sixty and forty gallon tanks. Note that the estimated \$80 dollar savings is considered in the estimate for the forty gallon tank (see figure 6 below).

GFX – UWaterloo CL Grad Houses (300 units)		
FINANCIAL SUMMARY		
Water Heater Size	60 gallon	40 gallon
Water Heater Sizing Savings (at 80\$/unit)	N/A	\$ 24,000
Net Cost for Adding the GFX	\$ 183,100	\$ 159,100
Estimated Annual Energy Savings	\$ 44,472	\$ 46,695
Simple Payback	4.1	3.4

Figure 6 – CLGHs GFX product estimated Financial Summary

** Prices are calculated for all three hundred units.

Westcourt Towers (WTs)

The WTs is another new residence located just south-west of campus across University Ave and Keats Way. This location was brought to our attention quite late in the project, but turned out to be the most promising. The construction for this six floor apartment style building has just begun, with only a foundation currently in place.

In this style building, it is possible for one GFX unit to be used for multiple house units, thus significantly increasing the effectiveness and efficacy of the system overall. The layout of the building allows for one four (4) pipe GFX system to be split between four (4) apartment units with no elaborate or complex plumbing. Each apartment contains two (2) showers and an average of four to five (4-5) residents. This creates an excellent ratio of GFX units to end users.

The payback time estimated under three (3) years is phenomenal in terms of the scale of the project and the future savings that would be generated (see figure 7 below).

GFX – UWaterloo Westcourt Towers FINANCIAL SUMMARY	
Net Installed Cost	\$21,816
Estimated Annual Energy Savings	\$8,802
Simple Payback [years]	2.5

Figure 7 – Westcourt Towers GFX product estimated Financial Summary

The important thing to note in such a system is that a retrofit installation is practically impossible. The only feasible way for the system to be installed in an apartment is during the construction phase. This leaves a rather limited window of opportunity. It is currently the most financially appealing setup out of all the installations we have assessed, but it will become a lost cause once the internal walls of the building are constructed.

Limitations

The limitations of the GFX system are few; however, the policies and politics behind installing this product are numerous. Due to the bureaucratic system of the University changes to construction norms and ‘unneeded’

replacement of structures are a complicated and frustrating process. Throughout this project process, there was so much red tape and dead ends that had to be understood in order to unfold the important information.

Other limitations that the group encountered were the short time frame. With little less than three months to complete the project it was difficult to accomplish anything, or see the results of your labour. The project's scope was confining. The GFX product extends much farther than the confines of Ring Road, just as university politics and policies reach much deeper than originally anticipated. Our scope was narrow.

The research method was snowball. The qualitative method relies on a few key players as informers of other people (see figure 1). This method worked well with this project; however, due to the very nature of the method, we relied heavily on other people. Relying on people becomes difficult when time schedules conflict. The group was forced to be dependent on key informants and when they were not available, we were unable to proceed with the project.

Due to the time constraints of the project, the ability to actually install one a GFX systems is extremely difficult; therefore, the group's efforts and dedication were often undermined. Being second year students our voice was often unheard. Furthermore, being Environment and Resource Studies (ERS) students and having little mathematical or technical expertise our findings were of a qualitative nature. The knowledge of how to technically test the system would have been a benefit to the project.

Assumptions/Bias

The data collected from key informants was mostly acquired through interviews of some form. In using this technique it was assumed that the information given was accurate and truthful. By assuming this, the group ran into some obstacles due to conflicting data. The misinformation was found out, however, and the group was able to proceed with limited setbacks.

The group was subjected to bias from each side of the issue; the RAI company and the UW administration. It was difficult to sort through each bias to remain both an observer and facilitator to this project. As a facilitating group we have to be aware of our position and we stay away from going with one side or the other. A bias that we have brought to this project is that we are ERS students. As such, our ultimate concern is typically the environment; therefore, any environmentally positive elements are considered to be quite valuable while any opposing economic or other reasons may be dismissed rather readily.

Recommendations and Conclusion

In the end, we determined that this product is feasible in all buildings we considered, but would be especially effective in the Westcourt Towers and, to a lesser extent, the Columbia Lake Gradhouses. The implementation of a GFX drain water heat recovery system in the PAC has proved to be relatively complex due to the way the plumbing is currently set up, so it is recommended that this product be considered in the Westcourt Towers and Columbia Lake Gradhouses first. The installation in the PAC would still save considerable amounts of energy

and money, but the initial costs are simply more significant and that project may be more easily motivated with live, on campus experience and familiarity with the product.

It is recommended that further research be done into the feasibility of a GFX unit in the V1 and other kitchens on campus. Although kitchens were not the focus of this particular project, there is considerable potential for these areas to have use for a GFX unit, and this should be explored further in the future. As far as the Village 1 cafeteria goes, it is a smaller project with smaller rewards, but the feasibility is quite positive. Perhaps it can also be installed in due time, when the product has locally proven itself on the more promising projects.

It should be the moral obligation of an academic and innovative institution such as a university to be a leader in the environmental field, especially when there is so much information available about a product that would not only save money but also energy, thus reducing the ecological footprint of the institution. It could also potentially educate, inform, and influence others to reduce their water usage and environmental impacts in general. Not only would this product's implementation be an environmentally wise action, but it would also save the university a significant amount of money, something that could obviously benefit the university itself, its students, and their community. Universities are the birthplaces and breeding grounds of new and innovative ideas and technologies, yet on campus practices rarely take these internal resources into consideration.

It is recommended, to ensure this product is seriously considered for buildings in the future, that a policy be put in place that requires a feasibility study

of this product in each new facility to be built on UW property. If the feasibility study indicates that a drain water heat recovery system would save enough energy to be economically worthwhile, then there would be no reason not to have it installed. Such a policy would allow for the greatest reduction of initial costs by avoiding retrofitting and redundant construction work. A similar approach should be applied to any other proven green architecture initiatives.

Rarely are the economics and logistics of an environmental initiative this ideal. To choose not to implement this product wherever feasible is to literally pour energy, and therefore money, down the drain. The only thing now standing in the way of the implementation of drainwater heat recycling on campus is red tape and beaurocracy. If such issues can prevent an initiative as plainly beneficial as this one from being put into operation, then “greening the campus” is but a *pipe* dream.

Literature Cited

- RenewABILITY Energy Inc. 2003. GFX Drainwater Heat Recovery System. <http://www.nomorecoldshowers.ca/howitworks.html>
- Google Web Definitions. 2003. Define: Asbestos. [www.repair-home.com/info/glossary%20\(a-g\).htm](http://www.repair-home.com/info/glossary%20(a-g).htm)
- Central Board of Irrigation and Power. 2003. About CBIP. Central Board of Irrigation and Power. <http://www.cbip.org/ABTCBIP.htm>
- Natural Resources Canada. 2002. The R-2000 Program. Office of Energy Efficiency. <http://oee.nrcan.gc.ca/r-2000/english/about.cfm>.
- Canadian Home Builders' Association. 2002. Housing Industry - R2000 Homes. Canadian Home Builders' Association. Burnaby B.C.
- Leadership in Energy and Environmental Design. 2003. About LEED. U.S. Green Building Council. http://www.usgbc.org/leed/leed_main.asp
- Tomlinson, J.J. GFX Evaluation. Buildings Technology Center, OakRidge National Laboratory. 2000

Informants

- Cook, Patti. September 2003.
- Van Decker, Gerald. President of RenewABILITY Energy Inc. November, 2003.
- Van Decker, Dennis. Sales representative of RenewABILITY Energy Inc. September to November, 2003.
- Cooper, Scott. Sales representative of RenewABILITY Energy Inc. September to November, 2003.
- Villeneuve, Marc. Kitchen Manager of Food Services in V1 and V2. November 2003.
- Simpson, Phillip. Maintenance Supervisor of Plant Operations. University of Waterloo. October and November, 2003.
- Rick Zalagenas. Director of maintenance and utilities of Plant Operations. University of Waterloo. October, 2003.
- Physical Activity Center (PAC) employees. University of Waterloo. November, 2003.