

WESTHILLS DISTRICT ENERGY SHARING SYSTEM

CANADIAN CONSULTING ENGINEERING AWARDS 2012

CATEGORY F: SPECIAL PROJECTS

As Municipalities work to reduce their carbon emissions, a unique sustainable energy system has been created for developers in Canada who are being challenged with including sustainable technologies in their developments, yet cannot afford to carry the burden of increased costs in these emerging technologies. To implement a successful project, several key questions must be answered:

1. Where are the energy resources and how much energy is available?
2. Once the energy has been recovered, how can it be used?
3. What kind of infrastructure is required for the project?
4. How much will it cost to implement and how will it be financed?

The subject system is one of three where the above questions were answered; the systems were installed and all three are giving community energy consumption savings of more than 50% when compared to conventional District Heating Systems and providing substantial reductions in carbon emissions.



Figure 1: Entrance to Westhills Community

NEW APPLICATION OF EXISTING TECHNOLOGY, ORIGINALITY, AND INNOVATION

There are several ways to extract heat from the heat sources. Generally, heat pumps or heat exchangers transfer this energy from its source into a closed pipe system, using either water or a refrigerant as the carrier fluid. District Energy Systems have been around for hundreds of years, but older, high temperature systems, (greater than 50°C), tend to operate with steam or hot water and use centralized fossil fuel heat sources. A new and more progressive concept for transferring energy is a District Energy Sharing System (DESS), which uses a low ambient temperature energy (5-35°C). This concept increases the flexibility of the DESS by allowing a wide range of de-centralized energy sources, heating and cooling energy sharing between users and reclaim of energy from sources such as sewage treatment plants, lake water, etc. Connected clients use a heat pump to provide space heating, space cooling, or

domestic hot water. Figure 1 shows a schematic of the Westhills development in Langford, British Columbia, which is an excellent example of the DESS concept.

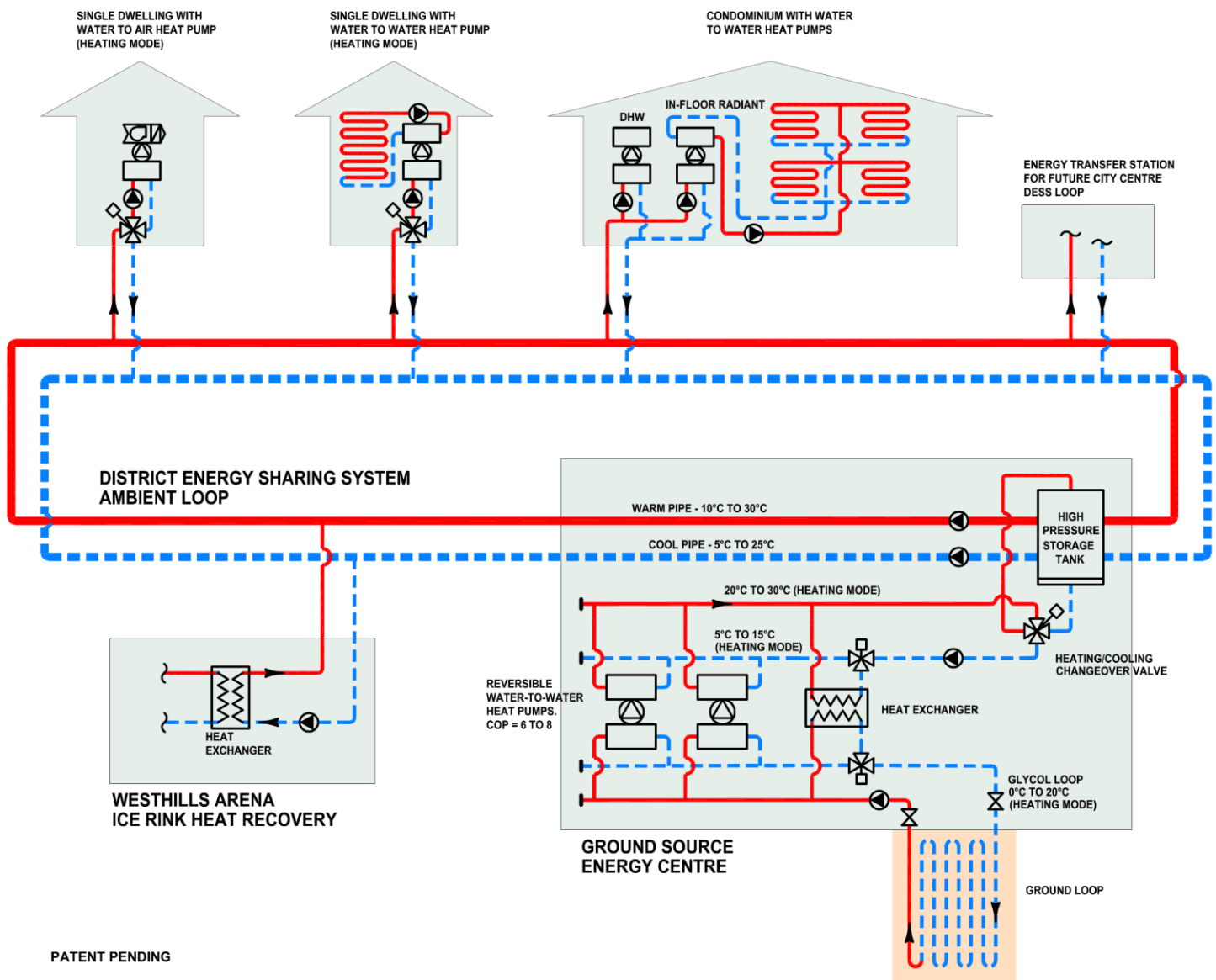


Figure 1: Westhills District Energy Sharing System schematic

This particular system has been in operation for over two years and Phase 3 is presently under construction. The phase 3 site can be seen in Figure 2 to the west of the current development. Currently, there are over 250 single family dwellings and 10 townhomes

connected to the DESS. A 68 unit condominium is connected to the DESS as well, and is scheduled for operation in the summer of 2012. The development is typical of the steps which must be taken to result in a successful energy conserving system.

The DESS is a two-pipe ambient temperature system that allows the use of either extracted or contributed energy. Residential buildings requiring heating during winter days can be supplied by office buildings that require cooling during occupancy. Meters in each building track as to whether the client is contributing or using energy from the DESS. A feasibility study performed for the Corporation of Delta, indicated that energy reductions of 80% were possible, when compared to using conventional systems. A similar study carried out for the large development at Langford, British Columbia, indicated similar energy savings and the project was given approval to proceed. The Westhills District Energy Saving System was the result and has been used as an example of the path which must be followed in order to arrive at a successful energy saving system. The Schematic Diagram has been included as Figure 1 above.

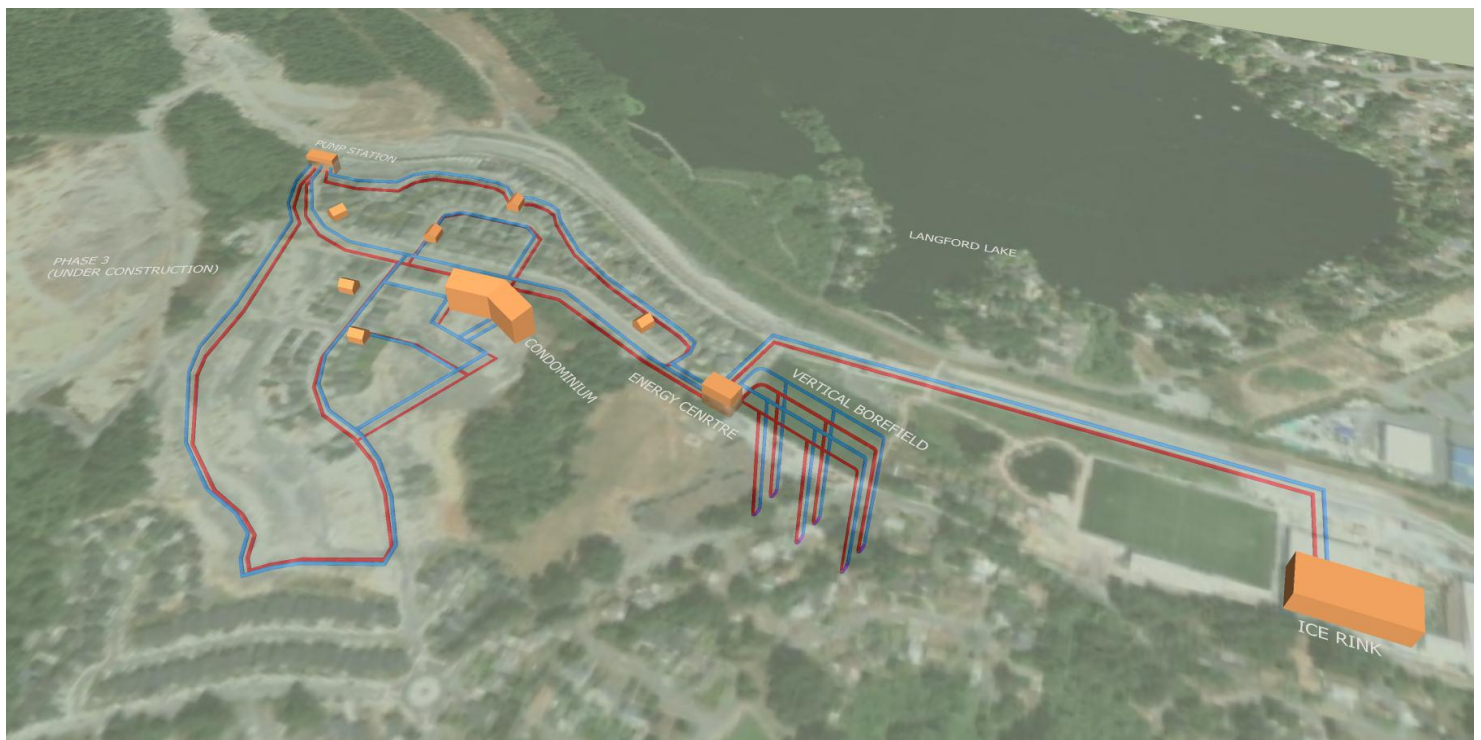


Figure 2: Bird's eye view of constructed Westhills development and DESS as of 2011

After two years of operation, the homes, which benefit from heating and cooling, have used an average of 40% less overall electricity (the only energy source) compared to similar

homes (size and vintage) using electric baseboard heating. The geo-exchange centre uses an ammonia heat pump and direct exchange heat exchangers. It typically operates with an overall system COP of between 5 and 10. During shoulder seasons, the heat recovery and natural geo-exchange within the distribution system provide all necessary energy for the homes.



Figure 3: Home mechanical room with reversible water-to-air/water-to-water heat pump for space heating, space cooling and domestic hot water heating

SOCIAL AND ECONOMIC BENEFITS

The results of a Proof of Concept review showed that the Westhills project would have the ability to become a future world-leading sustainable integrated district energy (electrical, and thermal) project. The highly integrated and optimized approach to serving community energy needs, will result in reduced life cycle costs and more stable and predictable energy costs

for users. Using the District Energy Sharing System will provide these lifecycle cost savings by reason of the reduced infrastructure, shared infrastructure, and the economies of scale.

The first stage in assessing the heat recovery options involved a high level overview of the potential heat sources and sinks, using district energy concepts and related costs. A Master Plan was established identifying the goals for district energy, the relationships among various energy sources and end users and the identity of key district energy opportunities. All of the possible energy sources such as building retrofits, re-developments and new developments, civic and institutional buildings, ice arenas and cold storage facilities, sewage treatment plants, etc, were taken into account along with the possibility of obtaining lower-cost capital and grant financing.

MEETING AND EXCEEDING CLIENTS NEEDS

After identifying the most promising opportunities, a detailed feasibility analysis was carried out to assess the feasibility of using the DESS. This involved consideration of the individual building envelopes, the mechanical systems, the DESS infrastructure and the various energy sources. It also included a phasing plan and an assessment of other renewable sources such as geo-exchange, bio-fuels, and solar. The ultimate goal of this feasibility study was to identify a DESS concept that provided the greatest benefits at the minimum cost, as well as maximizing potentials for reducing Greenhouse Gas Emissions (GHGs). Maximum GHG reduction occurs when overall reliance on fossil fuel energy is reduced to a minimum. A District Energy Sharing System (DESS), is an excellent method of achieving all of the above results. The following were the energy sources that were considered in arriving at the final proposal:

- Biomass (construction wood waste)
- Biomass (Pellets)
- Municipal Solid Waste (on-site and onsite/offsite solid mix)
- Closed loop or open loop geo-exchange.
- Closed and open loop geo-exchange using adjacent lake water.
- Solar heat and power.

A closed loop geo-exchange bore-field was selected as the first energy source due to its ability to provide heating and cooling, and the first phase available resources. The vertical bore-field is located under a soccer pitch at the entrance to the community and boasts over 220 wells that are 400 ft deep. Lake geo-exchange is planned for the development of the commercial centre, located next to Langford Lake.

There were no extraordinary problems of site location or hazardous conditions.



Figure 4: Soccer pitch with cutaway of Geo-exchange Headers



Figure 5: Soccer pitch with cutaway of Geo-exchange headers to/from Energy Centre

THE BUSINESS CASE

The business case for the District Energy Sharing System included financing costs and sources, a customer base and an ownership structure. Ownership and financing were closely linked. In the case of the subject project, the Westhills Master Plan called for the development of 472 acres of privately owned land as a compact community. To achieve this result the City of Langford worked with the landowner in partnership with the Canada Green Building Council and the Ministry of Community Services to collectively assemble a team of multi-disciplinary professionals, in order to prepare the desired city plan. Following the preparation of this Conceptual Plan, a rigorous analysis of topographical and environmental limitations and services was conducted in order to turn the Conceptual Plan into a more detailed, Land Use Site Plan, which would be physically achievable. The analysis and the product went through several iterations as input from the project's team members was received and addressed. An important part of the analysis of the proposal included an assessment of how the proposal rated when compared with LEED for Neighbourhood Development (LEED-ND). Once the proposal had been prepared to the point that there was confidence in all aspects of the plan, it was brought to the public using community meetings, newspaper advertisements, radio and web pages.

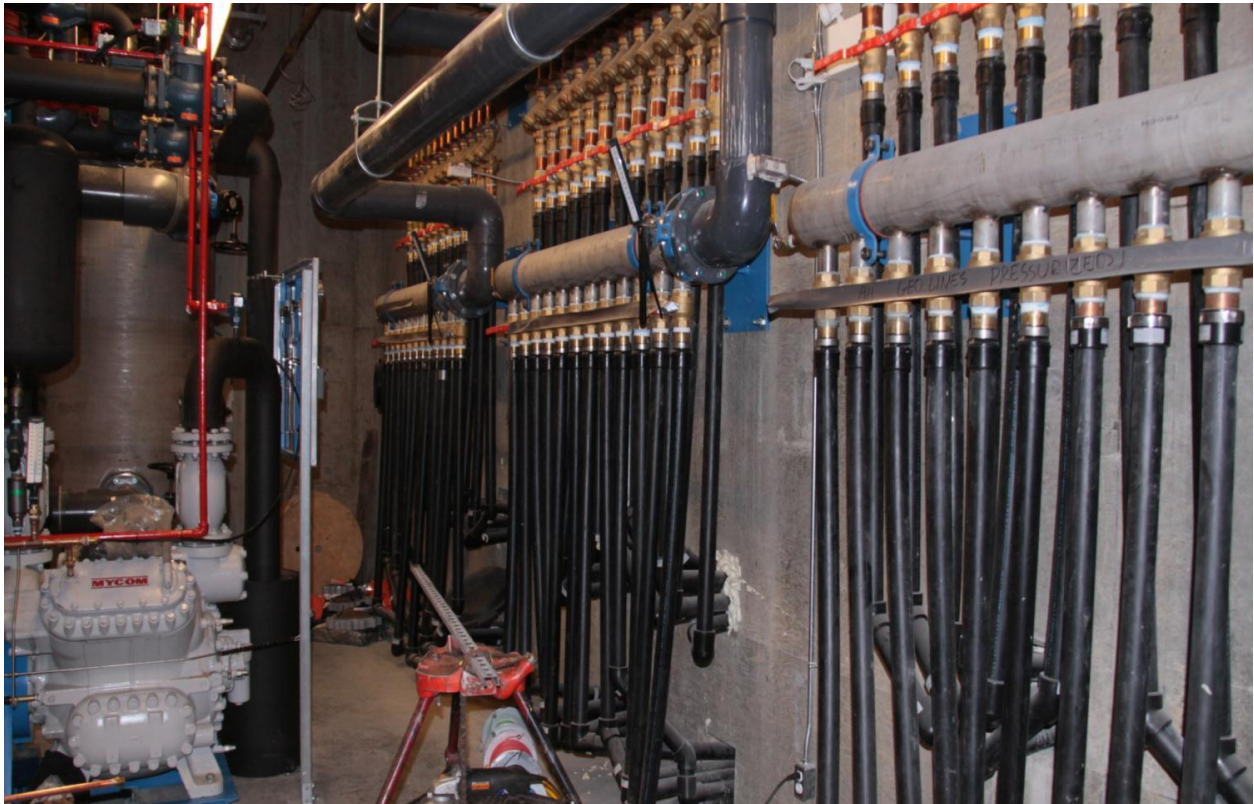


Figure 6: Geoexchange headers in Energy Centre and ammonia compressor at left

DOES THE ENTRY REPRESENT A UNIQUE MIX OF DIFFERENT TECHNIQUES, MATERIALS AND EQUIPMENT

Having all agreed on the business case, the challenge of developing the Mechanical aspects fell to the Design Team. Consideration was given to energy loading and supply profiles, distribution pipe material, back-up energy sources and control systems. Energy requirements vary from season to season and from morning to night and the DESS was designed with storage capacity sufficient to take care of these occasions. A bore-field was incorporated into the system as the receptacle for excess energy in summer and for back-up heating in the winter. As an ambient temperature DESS, the system does have the ability to store energy in the distribution piping for a couple of hours. This is sufficient to pre-condition the system to take care of peak heating periods. During extreme winter temperatures, natural gas fired boilers provide the back-up to meet peak demands. The materials used in the distribution system are unique. Due to the use of low temperature water in the distribution piping, it was

possible to use low temperature HDPE piping for all of the distribution mains at significant savings in cost and Greenhouse Gas reduction.



Figure 7: Homes with cutaway of DESS piping in the street

CONCLUSION

As climate change and GHG reduction continues to change the way we do business, consideration of waste streams as resources becomes ever more important. A DESS based on energy recovered from all available resources can be a catalyst for large scale, renewable opportunities. As with the Westhills project, given the right combination of technical expertise, capital funding, and champions of the cause, it will be possible for many municipalities to realize energy recovery, in all its forms, at a competitive cost.