Blatchford Renewable Energy

District Energy Sharing System

System Owner
City of Edmonton,
Alberta, Canada

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Photo: **Ornamental flowers outside Littlewood Park in Blatchford community**

Executive Summary

Blatchford Renewable Energy (BRE) is a municipally owned utility that operates an ambient district energy sharing system (DESS) for a sustainable planned community. The DESS delivers ambient temperature water (10 to 25 C) to neighbourhood buildings, which are equipped with heat pumps used for heating, cooling and domestic hot water.

The City of Edmonton chose the system as part of its goal of creating Canada's first carbon-neutral community on the site of Edmonton's former municipal airport. When the business plan was approved in 2014, ambient temperature systems were highly unusual, particularly in a region of Canada known for fossil fuel production. Design was fully integrated with land-use and development planning of Blatchford, a medium-density neighbourhood on 217 hectares of land in the city core. The site is expected to eventually include 12,000 homes and more than 30,000 residents.

The DESS demonstrates the viability of water-source heat pumps in even the most demanding climates, as Edmonton's winter temperatures can plunge below -30 C, while summer temperatures rise above 30 C. The heat pumps are performing well in both extremes, and BRE's system integrates multiple low-temperature renewable energy sources while maximizing energy sharing, potentially eliminating the need for household fossil fuel use altogether.

The centralized hub of Phase One is Energy Centre One, a rounded building on the banks of a naturalized stormwater pond that also supports a multi-use path and recreation area. The pond sits atop 570 geoexchange boreholes roughly 150 meters underground. These boreholes contain long-lived high density polyethylene pipe (HDPE) piping and are sealed with ultra-high thermal conductivity graphite enhanced grout, a first such application in Canada.

Due to the large field size, two HDPE vaults contain manifolds which collect dozens of large header pipes into four supply-return mains. A high-efficiency ammonia heat pump in the energy centre has a 1 Megawatt capacity, which will be tripled as the Phase One development grows. The heat pump extracts thermal energy from the borefield and delivers ambient temperature energy through a distribution piping network.

BRE has been in operation since 2019, the first Blatchford residents moved in in 2020, and nearly a third of the community is under construction or is currently being prepared for development. More than a kilometer of pipe connects all existing buildings with the DESS, a network designed to be expanded to approximately 14 kilometres as the project develops.

Photo: **Installation of stage one distribution pipes**

Phase One represents the first 3 Megawatts portion of a projected total capacity of 35 and 46 Megawatts of heating and cooling demand on site. To allow for flexibility in the development, each phase will be built in a modular, interconnected network with up to six Energy Centres. The number of boreholes on the larger Blatchford site will eventually be expanded to meet increased energy demands of the growing development. Current projections are that the district energy system will obtain over 90 percent of its energy from renewable sources, including wastewater heat recovery, geoexchange, and energy sharing.

Preliminary design is also underway for the second phase Energy Centre to serve a town centre and market expected in one of the next stages of development. This is located at the east end of the Blatchford site, where a 2.4-metre diameter trunk sewer is buried 17 metres underground, flowing at up to 500 litres-per-second with a temperature of 25 C. A heat exchange unit connected to the sewer line is expected to provide up to 13 Megawatts of heating and 23 Megawatts of cooling capacity into the DESS.

The utility provides increased energy security while reducing emissions. Homes and buildings will emit about 75 percent fewer greenhouse gas emissions than a typical Edmonton neighbourhood, with more emission reductions as the electrical grid becomes cleaner. At full build out, the community is anticipated to save about 30,000 tonnes of greenhouse gas emissions annually.

Photo: **Blatchford's stormwater pond sits atop its geoexchange field**

Innovative and Unique Features

The DESS operated by BRE isn't just unique in size and scale, but in its setting in the northern most major city in North America, a region with some of the highest carbon energy impacts in the entire world. The operations of buildings in Edmonton account for roughly 40 per cent of all community emissions. The DESS serves as a proof of concept of the viability of an alternative to natural gas.

Photo: **Energy Centre One**

Another unique feature is that the City of Edmonton is the master developer and responsible for the DESS. This coordination has allowed features like building envelope standards and densities to be coordinated with the design, planning, and selection of the ambient DESS concept.

The DESS is the first geoexchange field built beneath a stormwater pond, seamlessly fitting another use into a naturalized landscape that also provides an amenity for the growing neighbourhood. The boreholes are lined with ultra high-capacity thermal graphite, another first for Canada.

The central heat pump also differentiates Blatchford from many other district-scale geoexchange systems, eliminating the need for antifreeze in the distribution network by keeping water above 10 C. This provides substantial cost savings and simplifies the viability of a network that will be expanded in stages.

Energy Efficiency Benefits

Individual buildings on site are required to use high efficiency building envelopes and the ambient DESS was fittingly selected as the best way to balance annual heating and cooling loads of 47,000 and 44,000 megawatt-hours. Energy sharing is expected to reduce the overall energy input load by up to 20 percent due to the mix of residential and commercial buildings at final buildout.

A typical geoexchange system in Alberta could operate at -1 C, but Blatchford's central heat pump upgrades the water to 10 C before entering the home heat pump. This improves efficiency and capacity of customer systems by 20 percent, allowing smaller home systems and lower electricity bills.

Widespread adoption of heat pumps was identified in the International Energy Agency's "Net Zero by 2050" roadmap as a key pathway for decarbonization. The central heat pump at Energy Centre One is particularly efficient thanks to custom design and the use of ammonia as a refrigerant, which allows it to operate with a coefficient of performance greater than 10. In addition to shifting electricity use to a more efficient central pump, BRE has already added a small solar array and can make a stronger case for utility-scale renewable electricity strategies to further reduce carbon emissions.

Photo: **High-efficiency ammonia heat pump inside Energy Centre One**

Financial Advantages

BRE recovers capital and operating costs through utility rates and user fees. However manifested in the utility's fiscal policy, a utility customer in Blatchford will not pay more for utility rates plus maintenance than someone outside the community. In the first townhouses, the cost of a single water source heat pump is similar to a gas furnace and split air conditioning unit elsewhere in Edmonton.

Natural gas rates are subject to global market fluctuations, yet Blatchford's renewable energy rates are set locally and anticipated to be more stable. It is expected that Blatchford's DESS will significantly outperform conventional systems as natural gas prices increase and carbon tax policies rise from $30 to $170 per tonne by 2030.

As it stands, a heat pump with a coefficient of performance of 5 and electricity at $0.13 per kilowatt-hour is only slightly more expensive than natural gas at $0.02 per kilowatt-hour ($5.50 per gigaJoule).

Service capacity has also been carefully matched to meet increasing demands. Despite a significant financial investment up front, per capita capital and operating costs will continue to decrease as new buildings are connected.

Edmonton is already home to many net-zero builders, but Blatchford has allowed the City to further facilitate the implementation of new building mechanical systems. This will further grow the application of sustainable building technology in the region.

Photo: **Solar PV array atop Energy Centre One**

Additional Information

A project like Blatchford requires political commitment over an extended period of time. The fate of the city centre airport was a major issue during the 2010 Edmonton municipal election. It took another election cycle before the airport was closed in 2013, and a new Council approved a guiding concept and a new business plan the next year.

The creation of the BRE has put the City of Edmonton on a strong footing. With nearly a million residents, Edmonton is planning for a population twice that size, which means increased density and public transit within a shrinking carbon budget. In the past year, the City approved a new Community Energy Transition Strategy and Action Plan, built around international ambitions to keep warming within 1.5 C.

The first two stages of the development are mostly sold or under construction. By working closely with builders to enhance their experience in district energy systems, the initial challenge of unfamiliarity with district energy systems will likely create new opportunities in the future.

The site's forthcoming town centre will increase the efficiency of the system through energy sharing. The planned use of ambient heat from sewer lines will also provide a massive reduction of emissions from waste heat, an innovative example of how energy can be captured from unconventional sources.

The small BRE team has created an innovative district energy system that will serve a large residential community for generations to come.

Photo: **Townhouse development connected to the DESS**