MARKET TRANSFORMATION OF GROUND-COUPLED HEAT PUMP SYSTEMS IN CANADA

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ABSTRACT

Varying seasonal temperatures, the greenhouse gas reduction imperative, the sustainable development goal, the benefits for energy consumers, the profitability for energy utility providers, and, electricity de-regulation, are all helping to transform the market in Canada for ground-source heat pump technology. Canada's approach to conditioning, mobilizing, and transforming the marketplace for ground-source heat pump systems is predicated upon the economic and environmental benefits afforded this market-ready technology. This paper will highlight how Natural Resources Canada, through its Renewable Energy Strategy and programs, provides the impetus necessary for moving ground-source heat pump systems into the mainstream HVAC market and thus contributing to Canada's agenda as it relates to science, technology, economy, and the environment.

BACKGROUND

Canada encourages greater use of renewable energy and energy efficient technology because their increased use supports sustainable development goals and helps to reduce energy-related impacts on greenhouse gas emissions that contribute to climate change. They also support broader economic objectives related to job creation and export development. Energy research, development and technology transfer are integrated into Canada's science and technology policy framework.

Although various methods apply to heat pumping technology, the focus of this paper is on ground-coupled systems, i.e. on the use of geothermal energy for producing heat rather than electricity. Ground source or geothermal heat pump (GSHP) technology also called earth energy systems, uses a renewable form of energy since heat energy is transferred from a natural source such as the earth or groundwater. GSHPs are also energy efficient with applications to both heating and cooling space and heating water. As such, it is addressed both within the context of tapping a renewable energy source, i.e. earth energy, and of operating as an energy-efficient, end-use technology.

Natural Resources Canada (NRCan) promotes GSHP heating and cooling systems through its Renewable Energy Deployment Initiative (REDI). REDI was introduced in April 1998 as an enhancement to Canada's Renewable Energy Strategy of 1996. To assist in the development of a stronger, self-sustainable renewable energy (RE) industry for Canada, NRCan's initiatives are linked to three strategic pillars underlying the Renewable Energy Strategy: 1) enhancing investment conditions through tax policy instruments to enable improved access to financing for the renewable energy sector, 2)

technology research and development to lower the cost and improve the reliability of renewable energy technologies and 3) market development initiatives to stimulate demand for renewable energy technologies. REDI focuses on market development. Initiatives like REDI reflect the spirit of Canada's energy policy which is market-based and oriented toward sustainable development goals.

REDI is part of a suite of climate change initiatives which draws upon a voluntary approach as a way of responding to a call to action emanating from public policy objectives such as the reduction of energy-related greenhouse gas (GHG) emissions. With a voluntary approach, information and suasion tools as opposed to regulatory or fiscal instruments are used for policy implementation. Many climate change initiatives are programs in which participation is voluntary, even where direct financial incentives to increase the attractiveness of a potential investment are available. However, it is usually a mix of policy tools working in concert with one another, that is required in order to create the momentum necessary for bringing about change in the marketplace.

In the case of the REDI program, a financial incentive is but one of the strategies used as a means to encourage take-up of renewable energy systems and to strengthen the domestic RE industry. REDI provides a consumer incentive for qualifying RE systems which use solar energy and biomass energy but there is no purchase incentive for earth energy, or GSHP installations. The reason for this is the industry's preference for assistance with initiatives to increase market awareness and for infrastructure support by way of standards development and training initiatives, rather than the provision of consumer incentives. This reason notwithstanding, a GSHP purchase decision is not without economic merit of its own, given the system's low life cycle costs. Although GSHPs can be considered for both new construction and retrofit building projects, it is easier and less costly to seize the opportunity with new construction projects. REDI is linked to other energy efficiency and alternative energy initiatives at NRCan which focus on both the new building and retrofit, markets.

On the regulatory front, Canada's Energy Efficiency Act is designed to eliminate inefficient energy-using equipment from the market. Test standards for heat pumps are mandated through Canada's Energy Efficiency Regulations for HVAC equipment. Under these Regulations, ground or water-source heat pumps must meet federal energy efficiency standards in order to be imported to Canada or shipped between Canadian provinces for purposes of sale or lease. The regulations apply to a product even if they are incorporated into a large unit or machine, even if the latter is an unregulated product. Ground or water-source heat pumps with a rated capacity of less than 35kW must have a minimum co-efficient of performance (COP) of at least three.

Canadian standards for both GSHP equipment and design and installation practices have been recently revised in order to reinforce industry performance standards and increase confidence in the technology. With respect to equipment, standards for the testing and performance of water-source heat pumps have been adapted from ISO Standard 13256-1:1998. CAN/CSA-C13256-1 (water-air and brine-air heat pumps) and CAN/CSA-C13256-2-01 (water-water and brine-water heat pumps) establish

performance testing and rating criteria for factory-made residential, commercial and industrial, electrically driven, mechanical compression type heat pumps. These standards together supersede CAN/CSA-C446-94 (Performance of Ground Source Heat Pumps) and CAN/CSA-C655-M91 (Performance standard for Internal Water-Loop Heat Pump), respectively. With respect to GSHP design and installation standards, a new CSA standard, CAN/CSA-C448 (Design and Installation of Earth Energy Systems supersedes the previous standards for residential and other small buildings (CAN/CSA C445-M92 (R1998) Design and Installation of Earth Energy Heat Pump Systems for Residential and other small buildings) and for commercial and institutional buildings (CAN/CSA C447-94 (R1999) Design and Installation of Earth Energy Heat Pump Systems for Commercial and Institutional Buildings). Specifications mentioned in other CSA standards for equipment and material used in GSHP systems such as ground or water-source heat pumps and piping, are again referenced in new CAN/CSA-448 standard. The new standard also includes a third component: Design and Installation of Underground Thermal Energy Storage Systems for Commercial and Institutional Buildings, which has been added to complement the design and installation series. It applies to the intentional storage of energy in the ground for later use.

Canada also has an energy efficiency rating system for residential heating and cooling equipment. The EnerGuide Rating System is a voluntary program for equipment manufacturers where participating manufacturers include an energy efficiency rating for their product in their brochures. Currently, air-source heat pumps are among the products in the residential sector which are included in the EnerGuide rating system and discussions to include water-source heat pumps are underway. Canada has also recently introduced the Energy Star® program to promote high efficiency energy-using products. The inclusion of ground or water-source heat pumps in both the EnerGuide rating system and Energy Star® labelling program in addition to increasing the pool of GSHP expertise trained in accordance with revised CSA standards for design and installation practices, would collectively reinforce the marketing infrastructure for GSHP heating and cooling systems in Canada.

In addition to the above programs, NRCan delivers other voluntary, energy efficiency and alternative energy initiatives in buildings, which are conducive to the promotion of GSHP systems in the non-residential sector. Since these programs do not have a single technology but instead concentrate on a wholistic set of actions for improved energy use including the use of renewable energy, they provide a larger window of opportunity for GSHP to be deployed. The Commercial Buildings Incentive Program (CBIP) provides a financial incentive for energy efficient building design that exceeds Canada's Model National Energy Code by at least 25 per cent. Incorporating a GSHP system together with other energy efficient investments in the design of a new commercial building assists greatly in meeting CBIP's energy performance criteria. Planning support for environmental and high energy efficiency building projects from NRCan's energy technology program is also another conduit for increasing the visibility of GSHP technology as an environmentally-friendly and energy-efficient, HVAC choice. In the retrofit market, programs like the Energy Innovators Initiatives for commercial, institutional and industrial sectors and the Federal Buildings Initiative advocate a

comprehensive approach to increased energy efficiency in organizations without focusing on any single technology. Opportunities exist for promoting GSHP systems with these programs if GSHPs are included as part of the integrated package of measures considered during the project development cycle.

The market development for any innovative technology requires the development of enabling tools or information to reduce decision risk. To this end, NRCan's energy technology programs in the areas of renewable energy technology and buildings, have assisted in the development and diffusion of decision support tools such as software for analyzing GSHP investments, energy efficiency modelling for buildings, and for designing GSHP systems.

Seeking out other initiatives external to the REDI program, and orchestrating all the possible opportunities where GSHP technology could be supported to aid in its promotion, is one way of creating the necessary synergy for developing the Canadian market for GSHPs. However, strengthening the infrastructural supports for the GSHP industry alone will not accelerate increased adoption of this technology. Other opportunities must also be identified and pursued so that a totally different marketing approach can be applied, if GSHP systems are to find their way into the mainstream HVAC marketplace in Canada. One such opportunity could be found within energy utilities. A major turning point for increasing the market penetration of GSHPs could be reached should energy utilities participate in promoting the technology and not necessarily through conventional rebate offers. Economic and environmental drivers such as deregulation of the energy markets and the Kyoto protocol which are currently impinging upon the business of energy utilities, bode well for positioning GSHP systems as a distinct commercial opportunity for electric and gas utilities in Canada. This will be discussed later when the market potential of GSHPs are analyzed.

DISCUSSION

Canada's vast landmass of almost 10 million square metres and its seasonal temperature variations are conducive for considering the installation of heat pumping technology which is isolated from the weather elements and uses the ground or water as a heat source and sink. Given the Canadian climate with its wide range of temperatures and the country's predominantly higher heating load, a GSHP system is a rational technology choice for Canadians since none of the system's components is exposed to the outdoor air temperatures. However, despite its market-readiness, GSHP systems have had negligible penetration in the Canadian heating, ventilation and air-conditioning (HVAC) market because of institutionalized barriers in the marketplace.

It is estimated that GSHP systems comprise less than 1 per cent of Canadian HVAC sales and less than 2% of the HVAC market in the United States. (MRCL,1999). The main market impediments relate primarily to a lack of awareness and knowledge about the technology and its benefits and the often-higher initial costs of installing a GSHP system. Other barriers to increased deployment of GSHPs pertain to market inefficiencies in the product supply chain, and lack of a solid installation and service infrastructure for the product. In terms of the technology adoption curve, GSHPs would

be considered innovative or unconventional, compared to other HVAC choices. Therefore, the challenges inherent in the marketing of any innovative technology are present with GSHPs: namely, it constitutes a higher risk decision for purchaser and seller alike.

A lack of knowledge about the technology and a fear of incorporating a non-mainstream, heating and cooling technology into building projects is endemic throughout the supply chain and the customer base. Architectural and engineering communities, the HVAC industry, and end-users of energy, be they commercial building owners and tenants or homeowners alike, are not inured to this technology. If there is little demand for the technology, then HVAC suppliers will either not carry the product or limit consumer choice to a single product line. Where the GSHP option is not top of mind for suppliers, then it is not part of the customer offer. The current, weak, marketing infrastructure for this system choice further reduces its visibility in the HVAC market.

Other factors also impede market penetration in Canada. First cost-competitiveness issues are a major barrier. The often-higher initial cost for a GSHP system is attributable to the installation of the earth connection component of the system, which becomes an irrelevant consideration for conventional heating and cooling systems. The installed cost of a closed earth loop component may be as much as half the cost of the whole system. The technology is often overlooked in the building design process because it requires site-specific, engineering design, which is perceived to be an added cost to the project. It becomes less risky and more cost efficient for architects and engineers to default to using conventional designs and practices. Consumers also view the GSHP option as more expensive than HVAC systems, which use conventional fuels. For commercial applications entailing new construction projects, however, the GSHP option could be equally as competitive as a conventional choice, since the equipment costs associated with boilers, chillers, and cooling towers are eliminated. A GSHP investment is attractive if life-cycle costing is applied, because of a longer life expectancy of the equipment compared to conventional systems, a substantial reduction in operating and maintenance costs, and the displacement of energy costs required to fuel conventional systems.

The aforementioned reasons notwithstanding, the efficient and effective marketing of GSHP systems is obstructed by something as mundane as the lack of a common descriptor for this technology and the lack of a definitive industry composition and distribution channel. This precipitates confusion in the marketplace. As a heating and cooling technology, it has been variously called a ground-source heat pump system; earth energy system; ground-coupled heat pump system; geothermal system; geothermal heat pump system; a GeoExchange™ system. Such confusion with nomenclature makes definition of the industry itself, problematic. Because the system is comprised of different components requiring different pockets of technological expertise (heat pump and earth loop equipment manufacturing, distribution and sales, system design and sizing, system installation, air-handling, drilling and excavation, geological analysis) defining the composition of the GSHP industry is challenging: who/what comprises the GSHP heating and cooling industry? The industry structure raises a challenge to the marketing

of this technology. The GSHP industry is a small and largely undeveloped industry in Canada. Added to the industry's limited size and fragmented nature, the channels of distribution for GSHP systems are neither clear-cut or consistent and different channels are used to supply the commercial, versus the residential, sector. For the commercial sector, a heat pump manufacturer may go through a distributor/wholesaler who in turn sells either to a contractor or directly to a customer. At other times the manufacturer may bypass a distributor and sell directly to a dealer or the manufacturer's representative who in turn, sells directly to the customer. Alternatively, the manufacturer representative may sell directly to a contractor. For the residential sector, the manufacturer may distribute product equally through a distributor/wholesaler and through a dealer. The distributor/wholesaler may sell product equally through a contractor or directly to the customer or, dealers may sell directly to the customer. (MRCL, 1999) Added to this is the restriction of product choice due to low demand. According to one report, there are about 7 or 8 manufacturers serving the Canadian market with only a handful of Canadian manufacturers serving regional markets only. An estimated 90 per cent of the commercial market in Canada is served by three, major U.S.-based manufacturers. (MRCL, 1999) Some manufacturers are actually into building loop systems not manufacturing heat pumps. With respect to heat pump distributors, Marbek estimated that there are no more than 10 active GSHP distributors, most of whom may carry only a single line of GSHP product while carrying a wider selection of conventional heating and cooling products. It is estimated that there were no more than a total of 2200 ground-source heat pump units sold in Canada in 1997, mostly in the residential sector. (MRCL,1999) Given the weak infrastructure of the Canadian GSHP industry, it is clear that the industry itself does not have sufficient presence in the HVAC market to create a volume market for GSHP sales in Canada.

Despite the technological and financial barriers to increased adoption of GSHP systems, there are many benefits to choosing GSHPs. GSHP systems can significantly reduce energy consumption and corresponding emissions. The United States (U.S.) Environmental Protection Agency considers GSHPs one of the most energy-efficient, environmentally clean, and cost-effective space conditioning systems available. (U.S. EPA Report, 1993) Canada's cold climate and higher space heating requirements is a good motivator for exploring a space-conditioning device, which draws upon a free source of renewable energy and has little impact on carbon dioxide (CO^2) emissions stemming from its use. In 1998, over 80 per cent of energy end-use in the residential sector was for space heating and cooling and water heating. Almost 66 per cent of energy used in commercial[*] buildings was for space heating and cooling and water heating. Space heating accounted for 59.6 per cent of energy end-use in the residential sector and 52.4 per cent in the commercial sector. In 1998, the residential sector accounted for 16.8 per cent of secondary energy use in Canada and 15.3 per cent of emissions from total secondary energy use in 1998. The commercial sector accounted for 12.3 per cent of secondary energy use and 11.9 per cent of emissions from total secondary energy use. (NRCan OEE, 2000) Given the noticeable amount of energy used for space and water heating and space cooling relative to other end uses in the residential and commercial

[*] Commercial sector includes activities related to trade, finance, real estate services, public administration, education and commercial services (including tourism).

sector, the energy-related impacts on GHG emissions levels resulting from the installation of GSHP systems could be significantly restrained. To illustrate, over the twenty-year life of GSHP equipment then, every 10,000 units of typically sized residential GSHP systems will save more than 400,000 gigajoules of energy and reduce emissions by almost 25 kilotonnes of CO^2 equivalents. (NRCan OEE, 2000) A study by Caneta Research Inc. for one of the many discussion tables organized to tackle climate change in Canada indicated that for the range of building-related, energy-using technologies, there is unlikely to be a potentially larger mitigating effect on greenhouse gas emissions related to buildings, than from ground-source heat pumps. The same study of the total equivalent warming impact (TEWI) of GSHPs versus competing technologies indicated that 15 to 77 per cent reductions in CO^2 emissions could be achieved from the use of GSHPs. (CRI, 1999) If the source of electricity generation is not entirely fossil-fuel based, the emission advantage of heat pumps is further improved, since the electrical source itself emits fewer harmful emissions. (Cane and Garnet, 2000) A heat pump's COP can also offset the negative effect of power plant inefficiencies, leading to overall emissions that are lower than those produced by direct combustion of fossil fuels for heat. (Cane and Garnet, 2000)

The favourable economic impact resulting from energy, operational, and maintenance savings of GSHPs cannot be ignored. GSHPs can reduce energy consumption by as much as 50 per cent compared to conventional systems. One study found GSHPs in residential applications to be 48 per cent more efficient than a high efficiency gas system and more than 75 per cent more efficient than an oil system. (U.S. EPA Report, 1993). However, any economic analysis of GSHPs should be done in comparison with alternatives for both heating and cooling. GSHPs are particularly attractive in areas where the cost of heating fuels is high, and the cost of electricity for conventional cooling is high. With COP ratings of 3 or more, a GSHP system yields three times or more the heat energy for every kilowatt of electrical energy required for system operation. Using free energy from the earth and displacing a fossil fuel as a heat source, leads to significant savings in energy costs for space heating, given that 1999 fuel bills in Canada for the residential sector totaled $17 billion and for the commercial sector, $11 billion. (OEE, 2000)

However, in Canada, a recent phenomenon has surfaced to demonstrate the application of a geothermal heat pump system to more than just space conditioning: GSHPs are increasingly finding their way into ice arenas and recreational centres where geothermal systems are applied for ice-making, space conditioning, and domestic water heating. A showcase in point is the new arena in Val-des-Monts, Quebec. In conditions with a steady temperature state of about $5^{\circ}C$ or $6^{\circ}C$ at a depth of 3 metres or more, a GSHP system has been installed and integrated with the facility's HVAC electromechanical systems at an additional cost of 25 per cent over the cost of a conventional design. The arena's electricity costs amount to $26,000 compared to the $55,000 electricity bill for a conventional arena facility: a savings of more than 50 per cent! The GSHP system installed at Val-des-Monts can provide simultaneous refrigeration and heat far more effectively than a conventional system with separate heating and refrigeration devices. The GSHP system is designed with modular units to

provide heat or cold where required and any surplus heat or cold is accumulated in storage buffers for later use. Replication of innovative applications of GSHPs in arenas like the one at Val-des-Monts holds tremendous potential for contributing to GHG emission reduction in a country like Canada, where practically every small community will boast a community ice rink and hall.

Studies of GSHP installations in commercial buildings in Canada and in cold climates generally, have shown most payback periods for GSHPs in the 4 to 8 year range. (MRCL, 1999) However from the perspective of life cycle costing, life cycle costs for a GSHP system can be competitive with conventional HVAC alternatives due to its longer equipment life and lower operating and maintenance costs and sometimes lower first cost if the GSHP system eliminates the need for equipment which is normally part of the mechanical configuration of a conventional system such as boilers, chillers and cooling towers. A life-cycle cost analysis of GSHPs in new commercial construction (1997) showed GSHP to have a lower life cycle cost in all but 10 out of 135 GSHP installations when compared with either oil or gas systems. (MRCL, 1999) Still another study indicated that maintenance costs for GSHPs in commercial buildings in North America had a median cost of about 10 cents USD/m^2 about one half the costs of conventional space conditioning systems. Where in-house HVAC maintenance capability was available, GSHPs were found to have significantly lower maintenance costs compared to air-source and water-source heat pump systems whose costs were comparable to most conventional HVAC systems. (GHPC, 1999) As can be seen, GSHP technology provides many compelling reasons for mobilizing the market and for developing a robust GSHP industry in Canada. The marketing barriers which have been identified can best be overcome if energy utilities are engaged in promoting GSHPs, as the utility Power Smart program to promote energy efficient product in Canada has aleady shown.

The promotion of this technology through energy utilities is critical to the accelerated deployment of GSHP systems. Not only is their mature infrastructure conducive to the diffusion of heating, cooling and power technologies but their established credibility vis-à-vis their customers will help address the current lack of consumer confidence in GSHPs, which is still considered as an innovative technology in Canada. Many utilities already have established marketing alliances with the conventional HVAC industry in the promotion of energy efficient technologies and have traditionally promoted them through financial incentive programs, undertaken mostly for demand side management reasons. However, besides direct incentive programs, there are other innovative business models for promoting GSHPs, which can be considered by utilities, especially electric utilities that present a totally different value proposition for them. An alternative to a rebate program model might be to examine the merits of, for example, offering a GSHP leasing program or selling comfort services to ensure customer retention for the long term. At the same time, the market for GSHP would be sustained. While utility rebate programs do help to reduce the first cost for customers, further market deployment of GSHP systems would be difficult to maintain should the rebates be terminated.

Before energy utilities can be engaged to assist in the acceleration of the GSHP market in Canada, it is necessary to take stock of the current operating environment of Canadian utilities and identify the drivers to which an increase in the use of GSHPs can be an effective and profitable response for the utility business. Major operational drivers affecting the utility business today resonate with the environmental imperative of reducing GHG emissions related to energy and with the restructuring of traditional energy utility industries which has resulted in the unbundling of the production, transmission, distribution and retail business components.

Environmental considerations have propelled providers of electricity and gas to assume increasing stewardship over the sustainable development of their activities while giving environmental and social costs a new prominence in total resource costing decisions for utilities. Market deregulation and industry restructuring in the electricity and gas sectors has escalated the competitiveness of the electricity and gas markets leading to greater business innovation in what is otherwise a pragmatic, market economy. Utilities are being forced to look at innovative methods of maintaining their profitability and deriving new sources of revenue to enhance their traditional lines of business. Since the promotion of GSHP technology is an opportunity to create new sources of revenue for utilities, the business case for promoting GSHPs is not solely driven by demand-side management considerations. Utilities are being driven to shift the focus from return on equity to more competitive performance measures of increased profitability.(ADLI,1999) Changing market conditions are forcing a re-examination of the utility business. Utilities today must be responsive to more educated customers with higher expectations from their energy providers as consumers look for cost savings, value-added services, and reduced environmental impacts. As well as meeting the changing needs of their customers, the very way in which electricity is generated, transmitted, distributed, marketed, and sold has other implications for a traditional electrical utility. (ADLI, 1999) Changes may be necessary to the size, location and type of electricity generation or a decision for new transmission infrastructure would be made not so much from the standpoint of reliability than for economic reasons. Market uncertainties make new equipment purchase decisions riskier for utilities.

The unbundling of products and services from traditional energy providers precipitated by the start of deregulation of the electricity and gas markets in Canada, rearranges utility and customer relationships, which is conducive to fostering the market for GSHP. The promotion of GSHP technology could assist energy retailers to apply new business models capable of reducing their costs to meet customer expectations and simultaneously provide them with a new product/service line to maintain growth and market share and increase profitability. Utilities with an energy services line could also profit from additional sources of income derived from contracts for maintenance and operating services, and leasing and financing services, which tend to have higher profit margins than strict commodity or equipment sales. (ADLI,1999) Nevertheless, a GSHP program would still be of interest to vertically integrated, electrical utilities because of its potential commercial impact on other parts of the electricity business. For the transmission and distribution components of a vertically integrated electric utility, a GSHP program can increase efficiency without compromising reliability and customer

responsiveness due to flatter electrical loads precipitated by the use of GSHP systems. A steadier electrical throughput in the transmission line, results in improved asset utilization for the "wires" business. Improved load factors would also benefit the generation side of the business if producers begin to target the more lucrative U.S. market for generating revenues from peak demand sales. An increased ability to manage electrical demand would also reduce the strain on generating capacity and avoid the need to field the high costs of building additional capacity. Excess capacity at home could also provide for increased revenues for Canadian utilities by allowing sales to be redirected to the profitable U.S. markets. For wholesalers and distributors of electricity, a flatter load shape brought about by the increased use of GSHPs would reduce overall procurement costs since fewer purchases would have to be made at peak demand rates. Since little or no GHG emissions are attributable to the use of GSHPs apart from the electricity required for their operation and, in an era of increasing competition, a GSHP program may be attractive to energy utilities from the standpoint of participating in emissions trading schemes which are currently being piloted in Canada.

A GSHP program can readily be implemented by utilities who also supply energy services because entering the GSHP market would be easier. For most energy utilities, adding a GSHP line to the core business of providing energy and related services would not be too disruptive to their normal operations. Energy services contractors can benefit from including GSHP as part of a multiple service offer to customers which combines both supply and demand side services. For electric utilities, a GSHP program could increase sales of electricity through acquiring additional electric appliance load. For gas marketers, the technology constitutes a low entry barrier to the GSHP market since the gas industry already has knowledge and expertise in pipe and excavating technology. In a changing and unpredictable industry environment like that of the energy business today, any strategy which would enable a business to diversify its revenue stream and mitigate risk for its shareholders, should be worthy of further consideration. It becomes clear that the value proposition of a GSHP program for energy utilities rests directly with the program's impact on costs and revenues for the overall utility business. But what about the GSHP market potential in Canada?

The former Canadian Earth Energy Association reported that approximately 30,000 GSHP units had been installed in Canada in the nineties, with 20 per cent of the installations in the commercial/institutional sector, many in schools. Annual sales peaked in the early 1990s, primarily as a result of a utility incentive program in the province of Ontario. During this program, approximately 6,700 residential GSHP were installed in Ontario. 1997 sales of GSHPs in the non-residential sector are estimated to be between 600 to 750 units and between 900 and 1500 units in the residential sector. Almost 40 per cent of residential sales were reported for Ontario. (MRCL, 1999) The total number of GSHP systems installed is actually smaller than the number of GSHP units given that commercial-sized systems usually consist of a much larger loop used in conjunction with several heat pump units. There is no typical commercial system as the system size varies with the building size and characteristics. Systems range from a residential-sized system averaging 3 tons of capacity for small buildings to much larger-scaled commercial systems with several hundred units exceeding 1,000 tons of capacity. While no precise

measure of the potential size of the market for GSHP systems in Canada has been made, it is believed to be significant, covering a large part of the space conditioning and water heating market. In the residential sector, for example, there is a trend towards increased energy demand for water heating and space cooling which would result in increased GHG emissions attributable to energy use for these applications. Since energy demand in the commercial sector is a function of commercial activity and indirectly the economy, (e.g. building starts), there is also a trend towards increased energy demand in the commercial sector. The climate variations in Canada provide the ideal conditions for energy users to be receptive toward a technology with the capability of providing space heating and cooling and water heating, all from a single system.

A recent study indicated that the market potential of GSHPs would be about one half of the total available market in new construction and HVAC replacement in both residential and non-residential sectors of Canada, when factors are accounted for such as percentages of innovative technology adopters and average cost of GSHP systems in relation to total building construction costs. (GHPC, 2002) Given this, it is estimated that the total Canadian market for GSHP could reach $1.6 billion per year. A 20 per cent annual growth could place the GSHP market potential in Canada at $2.8 billion over five years. (GHPC, 2002)

CONCLUSION

The promotion of GSHP technology through the utility channels is critical to the accelerated deployment of non-mainstream technologies, like GSHP systems. A collaborative effort among Canadian electric and gas utilities which would draw upon their existing service infrastructure, the GSHP industry, and government, would be an effective method for the rapid diffusion of GSHP heating and cooling systems in the buildings sector in Canada. A precedent which attests to the success of government/industry collaboration has been set by the U.S.'s Geothermal Heat Pump Consortium, Inc. (GHPC) in Washington, D.C. Established in 1994 as a public/private partnership among the U.S. Department of Energy, the U.S. Environmental Protection Agency, and electric utilities, the GHPC has made significant progress in influencing the GSHP or GeoExchange™ market in the U.S. and abroad. The GHPC program in the U.S. has resulted in the installation of more than 500,000 units and an average increase of 20% annually since its inception. Electrical demand has been reduced by 1.3 million kW; energy savings have amounted to 4 billion kWh and 20 billion Btus of fossil fuels annually; and more than 3 million tonnes of CO^2 emissions have been avoided over a six year period. (GHPC, 2001)

A similar strategy with energy utilities is contemplated for Canada, in order to develop the Canadian GSHP market and respond to national objectives relating to the reduction of GHG emissions through the increased use of renewable energy and the creation of a strong renewable energy industry in Canada. The formation of a utility-led coalition to promote ground-coupled heating and cooling systems would be instrumental in providing the necessary stimulus for the GSHP market. An over-arching objective for such a coalition would be to develop the market in Canada for GSHP as an economic, environmentally friendly, renewable energy technology and, in the process, create a self-

sustaining GSHP industry. The coalition would become the forum in which marketing barriers would be overcome and the GSHP industry strengthened in Canada. Utility programs will stimulate the demand for GSHP equipment and qualified system designers and installers. This in turn will strengthen the GSHP industry as system manufacturing and sales transactions become more efficient and quality assurance requirements are satisfied through proper training and accreditation of system designers and installers. The indirect outcome of this activity would be the creation of more jobs and export opportunities for Canada while simultaneously mitigating energy-related impacts on GHG emissions.

The barriers to market acceptance of an innovative technology like GSHPs can be better addressed collectively under a coalition of key industry players and market influencers, rather than through a disaggregated promotional effort on the part of individual stakeholders. The GSHP coalition would be a forum which would leverage stakeholder resources in order to remove market barriers with respect to the technology's first-cost competitiveness, lack of market visibility, distribution inefficiencies and training and accreditation issues. To this end, the coalition could engage in marketing communications activities and ensure that training networks are in place to strengthen the sales and service expertise within the equipment, design and installation components of the GSHP supply chain. It could develop and implement model marketing programs and pilot projects to demonstrate alternative strategies for accelerating the GSHP market as the GHPC has done.

A Canadian coalition led by energy utilities, to promote GSHP, is a means to coalesce various stakeholders around a national marketing strategy. It would provide an opportunity to mutually satisfy the complementary objectives of all the stakeholders and create a win-win for the energy utilities, the GSHP industry, and for Canada. For the energy business, the value proposition of GSHPs, both from an economic and environmental perspective is solid. For a small and fragmented GSHP industry, the customer credibility and service infrastructure which utilities afford, will narrow the awareness and technology deployment gap between GSHPs and conventional systems. For Canadian energy consumers, a GSHP choice saves energy and money. For the environment, the installation of more GSHPs will assist in the mitigation of GHG emissions.

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