Chapter One - Introduction

What is the content of this chapter?

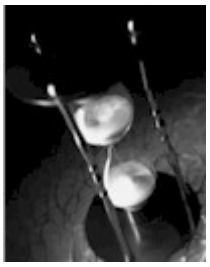
1. We begin with an account of the historical as well as the current developments within the world of energy exchange.
2. We follow with an introduction of the basic energy principles as they are applied to energy exchange systems.
3. We review the principles of refrigeration, a core principle behind energy exchange systems.
4. We introduce the basic Geothermal Exchange principles as a preparation to further work later in the manual.
5. We investigate the economic and marketing factors of the energy exchange industry.

What is the purpose of this chapter?

1. The history leads to the rationale for the existence, the use, and the advantages of energy exchange. If you are selling, marketing, in the business of providing energy exchange systems, or interested in Geothermal Exchange, this section explains why energy exchange systems are the system of choice.
2. Whether you install or not, it is useful to know the underlying principles of energy exchange systems in order to understand the complete picture. Energy is one of these basic principles that lives at the core of operating energy exchange systems.
3. Without knowledge of how refrigeration works, energy exchange remains a foreign concept. Get to know about this crucial element as it relates to energy exchange.
4. As a preparation to work later in the manual, this chapter introduces the basic components and describes the loops of Geothermal Exchange systems.
5. Is it useful to you to know the expectations of energy exchange systems and the benefits for each of the players in the Geothermal Exchange system? Yes, it is, and a review of the economics and marketing elements within the industry will serve you well.

Section One – The Historical Perspective

Time passes – energy exchange systems gain ground



Questions

What's it all about anyway?

How did we get to where we are?

Why choose energy exchange systems?

What's new? Where do we go from here?

Details

What's it all about anyway?

How did we get to where we are?

To some degree, our industry is one that is searching for a name. Known variably by Geothermal, Ground Source Heat Pumps, GeoExchange™, Thermal Exchange, or Energy Exchange, there is some confusion as to exactly what describes what. To get a solid handle on this, we look back at what is at least the basic history. The refrigeration concept does actually go back quite a long way, and the concept of moving heat around with the refrigeration process goes back pretty much just as far.

Briefly, the starting point for what energy exchange is all about goes back to the end of the 17th century. Lavoisier installed a thermometer in deep vaults under the Observatoire in Paris and scientifically proved that a steady underground temperature existed at a depth of twenty-seven metres below street level.

In 1838, very exact measurements of temperature in the ground were started at the Royal Edinburgh Observatory.

Lord William Thomson Kelvin used this data to develop his work. Temperature variation in 8.1 m depth was measured to be 1/20 of the surface variation, and in 16.2 m depth the value is only 1/400. In 1848, Kelvin determined that there is a sliding temperature scale for many materials, and as they move from phase to phase, significant amounts of heat are either accepted or rejected. He established the concept of absolute zero (- 273°C) as the temperature at which molecular energy is a minimum. We'll discuss this

more later, since it is a major part of the refrigeration process, but for now, it is worth knowing that what we address in this manual is the process of using the refrigeration process to put heat where we want it.

In the 20th century, Robert C. Webber experimented in his home, capturing the heat given off by his freezer. One development lead to another and he got rid of his coal furnace, providing us with the first ground-source heat pump installation recorded to be operational (1945). Also in the 20th century, Willis Carrier (1876-1950) is known as the man who invented modern air conditioning.

Our story continues but the short version is that in the following years, ideas were shared on how reliably we can use the earth as heat source and heat sink for heat pumps. Dr. James Bose is a leader in this direction, establishing the International Ground Source Heat Pump Association (IGSHPA), based on the campus of Oklahoma State University.

IGSHPA is highly recognized for its contribution to ground source heat pump research, development, and training. Jim Bose pursued the challenges within the industry, assembled a group of people who became more and more excited about what they called Geothermal, and all its possible applications. They ran with the name Geothermal, and as such, the word (and what it stood for) grew a following, and certainly name recognition.

In 2003, under the initiative of Natural Resources Canada (NRCan), a Canadian national organization grew to become the Canadian GeoExchange Coalition (CGC), intending to work with all stakeholders in the geoexchange industry for the purpose of building an infrastructure that nurtures healthy growth, credible service, training, certification, and the distribution of beneficial information.

The term Geothermal has been and is applied to the concept of tapping into a “hot spot” in the earth, where heat can be pulled from. This is definitely a plus if you are in a heating dominant climate, or even looking to generate electricity with steam that can be produced by running water down, but that is not what this manual is about. We are looking instead at the idea of using the earth as a heat sink – land or water where we can either draw heat out of or reject it into, depending on the ambient temperatures. The term Geothermal also refers to this type of heat movement. In Canada, the term GeoExchange™* or Earth Energy Systems are used for the same type of heat movement.

As you already know or will discover, “geo” (earth) is not always appropriate because we do not necessarily use the earth in some innovative applications, and design around diverse methods of energy exchange. In this manual, the term Energy Exchange is used as we move through explanations, processes, and information about energy exchange systems.

* The trademarked term 'GeoExchange™' is a quality-assurance designation managed in Canada by the Canadian GeoExchange Coalition and owned by the Geothermal Heat Pump Consortium.

Why choose energy exchange systems?

So why is it that energy exchange is so popular right now? What is it that draws *you* here, and what is it that makes the interest and growth rate of energy exchange systems so phenomenal? Possibly the draw for you is much the same as it was for many others. This is a unique industry in that it is both environmentally and economically attractive.

Many things in our lives become a matter of choice – do we buy the car that is spacious and comfortable, but uses a lot of fuel, or do we go for the one that does not use a lot of or any fuel (or pollute as much), but sacrifices space, or, in some cases, even safety? We may be overstating that a little bit, but the fact remains that energy exchange is one of the new breed of technologies that has everything going for it, with the possible exception of short term balking at the installation cost. It is environmentally sensitive, and definitely one of the green technologies, but it has the additional huge advantage of being a seriously cost effective way of heating and cooling environments. Remember that with energy exchange, we are not burning anything, particularly if the electricity that we are using to run the heat pump is hydro-, or even solar-generated. Of course this means that we are treading more lightly on the planet, but it also means that we are achieving serious efficiencies, since we are only moving heat around. You will learn more about the term COP later, but the acronym stands for coefficient of performance, and it is not at all unreasonable to anticipate COP's of 3.0 to 4.0, meaning that for every kilowatt of energy that we put into it, we get the heating or cooling equivalent of three or four back out – yes it really is, or can be if it is well designed, 300% - 400% efficient! Energy prices seem to indicate that they will continue to be a burden in the foreseeable future of the 21st century (they approximately doubled from 1999-2006). What effects will that have on the economic feasibility of energy exchange (EE)?

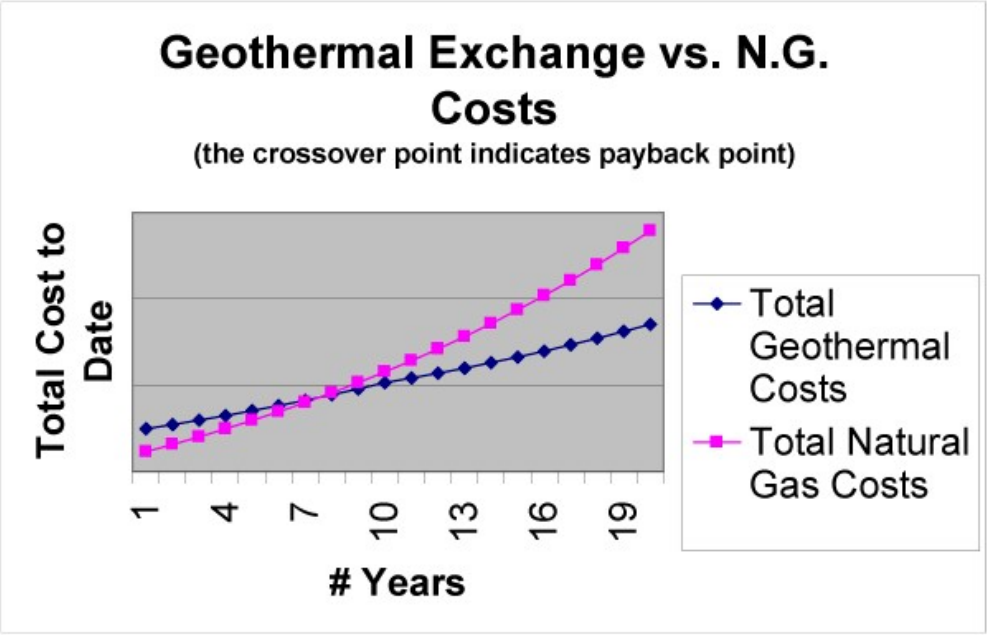


Figure 1: Life Cycle Comparison Costs

What's new? Where do we go from here?

Once we get our heads around the concept of moving heat from where we do not want it to places that we do, we can accomplish amazing outcomes. Here are some of examples of applications that go beyond the simple "geo" concept of using the earth as a heat storage medium: