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GEOTHERMAL ENERGY: UTILIZATION AS A HEAT PUMP

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ABSTRACT:

Geothermal (or Geo-exchange) is a type of HVAC System (Heating, Venting, and Air-Conditioning).The earth absorbs almost 50% of all solar energy and remains a nearly constant temperature of 10°C (50°F) depending on geographic location. Working with an underground loop system, a geothermal unit utilizes this constant temperature to exchange energy between the building and the earth as needed for heating and cooling. Geothermal is the most efficient Air-conditioning system because the ground temperature stays stable and has no regard for the above ground ambient temperature. A geothermal heat pump simply takes advantage of this low temperature energy source and pumps it up to a usable level to cool/heat the building. Geothermal Heat Pumps draw energy out of the ground which stays relatively constant year round. According to the Environmental Protection Agency , geothermal heat pumps can reduce energy consumption—and corresponding emissions—up to 44% compared to air source heat pumps and up to 72% compared to electric resistance heating with standard air-conditioning equipment. GHP systems have relatively few moving parts, and because those parts are sheltered inside a building, they are durable and highly reliable. The underground piping often carries warranties of 25–50 years, and the heat pumps often last 20 years or more

Keywords – Energy efficiency ratio, Geocool , Geothermal , Geothermal Heat pump , HVAC

1. INTRODUCTION

Geothermal (or Geo-exchange) is a type of HVAC System (Heating, Venting, and Air-Conditioning).The earth absorbs almost 50% of all solar energy and remains a nearly constant temperature of 10°C (50°F) depending on geographic location. Working with an underground loop system, a geothermal unit utilizes this constant temperature to exchange energy between the building and the earth as needed for heating and cooling, [4]. In the summer, the system expels heat from buildings to the cooler earth via the loop system. This heat exchange process is natural and a highly efficient way to create a comfortable climate in buildings. In winter, the system reverses and water circulating inside a sealed loop absorbs heat from the earth and carries it to the unit. Here it is compressed to a higher temperature and sent as warm air to the indoor system for distribution throughout the building Geothermal is the most-efficient Air-conditioning system because the ground temperature stays stable and has no regard for the above ground ambient temperature. Geothermal Heat Pumps draw energy out of the ground which stays relatively constant year round.

1.1 Renewable Energy Sources used for Heating and Cooling

Solar thermal

Solar radiation. Heat exploited for hot water production or air heating system is made available to the heat transfer medium minus any optical and collector heat losses. Solar thermal can also be applied for space heating, space cooling and process heat generation. Passive solar energy used for space heating, cooling, and natural lighting of dwellings or commercial buildings is useful but not included in IEA

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statistical data or in this report.

1.2 Solid biomass:

Organic, non-fossil material of biological origin which may be used as fuel for heat production and or electricity generation. It includes wood chips, residues from forests or wood processing, purpose-grown energy crops (poplar, willow, eucalyptus etc.), agricultural crop and animal residues, and the biogenic fraction of municipal solid waste (MSW).

1.2 Charcoal:

The solid residue from the destructive distillation and pyrolysis of wood and other vegetal material. The net calorific value (lower heat content) of solid biomass feedstock material is usually used on the input side . The exception is charcoal where the material after carbonization is used to determine the heat value and not that of the original biomass source. Industrial and MSW use the net calorific value of the heat content of the proportion of the biomass material used for fuel.

1.3 Biogas:

Gases composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass and combusted to produce heat and/or power. The calculated lower heat content of biogas, includes gases consumed in the process but excludes fl are gases. Gasification of biomass under restricted air supply conditions produces synthesis gas (mainly CO and H2) that can be used for a range of applications.

1.4 Bio-fuels:

Liquid fuel produced from biomass transformation, mainly used in transport applications. The net heat value is determined from the finished product exiting the processing plant.

1.5 Waste: Combustible or wet organic materials arising from industrial, institutional, hospital and households including rubber, plastics, used lubricating oils and other similar materials are termed "wastes". They can be either solid or liquid in form, renewable or non-renewable, biodegradable or non-biodegradable. MSW produced by the residential, commercial and public service sectors comprises wastes that can be either incinerated in specific installations to produce heat and/or power or disposed of in landfills. Only the fraction derived from biogenic materials can be considered renewable, defined by the energy value of combusted biodegradable material expressed in terms of mass or volume. Organic, non-fossil material of biological origin which may be used as fuel for heat production and/or electricity generation. It includes wood chips, residues from forests or wood processing, purpose-grown energy crops (poplar, willow, eucalyptus etc.), agricultural crop and animal residues, and the biogenic fraction of municipal solid waste (MSW).

1.6 Charcoal: The solid residue from the destructive distillation and pyrolysis of wood and other vegetal material. The net calorific value (lower heat content) of solid biomass feedstock material is usually used on the input side . The exception is charcoal where the material after carbonization is used to determine the heat value and not that of the original biomass source. Industrial and MSW use the net calorific value of the heat content of the proportion of the biomass material used for fuel.

1.7 Biogas: Gases composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass and combusted to produce heat and/or power. The calculated lower heat content of biogas, includes gases consumed in the process but excludes fl are gases. Gasification of biomass under restricted air supply conditions produces synthesis gas (mainly CO and H2) that can be used for a range of applications.

1.8 Biofuels: Liquid fuel produced from biomass transformation, mainly used in transport

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2. Solar radiation.

Heat exploited for hot water production or air heating system is made available to the heat transfer medium minus any optical and collector heat losses. Solar thermal can also be applied for space heating, space cooling and process heat generation. Passive solar energy used for space heating, cooling, and natural lighting of dwellings or commercial buildings is useful but not included in IEA statistical data or in this report.

2.1 Geothermal

Heat contained in or discharged from within the Earth’s crust, mainly by heat conduction, but also in the form of hot water or steam at particular locations. It is exploited at suitable sites for electricity generation after transformation, or directly as heat for geothermal heat pumps, district heating, bathing/swimming, greenhouse heating, aquaculture pond heating, agricultural drying, industrial process heat, etc. The energy content is measured by subtracting the heat of any fl uid re-injected from the heat of the fl uid or steam upon its extraction. A distinction is made between deep geothermal and shallow geothermal Section.

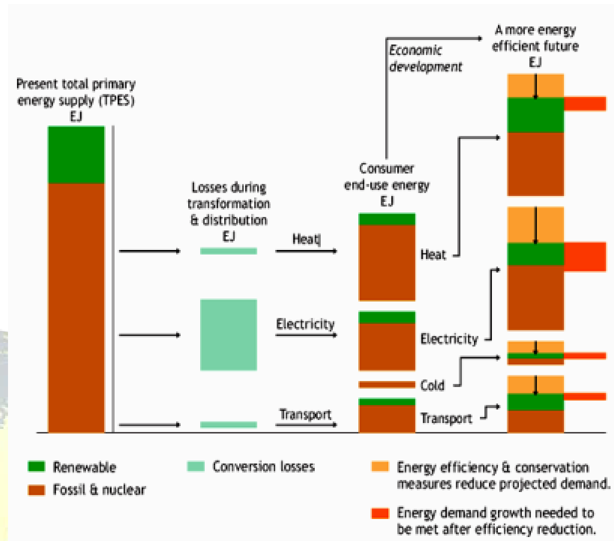

Figure 1 Representation of the present energy system (left three columns) and the potential for transition to a more efficient energy system in the future (right column) as economic development occurs. (Indicative and not to scale).

2.2 Heat Pumps

Heat pumps play an important role for space and water heating in the building and industry sectors. They are used to transport heat against the natural direction of thermal energy (from low to high temperatures). This process needs energy input from electricity or heat. The amount of heat that a heat pump can supply depends on the amount of energy that is in the original heat source, usually from natural surroundings of the air, water or ground.

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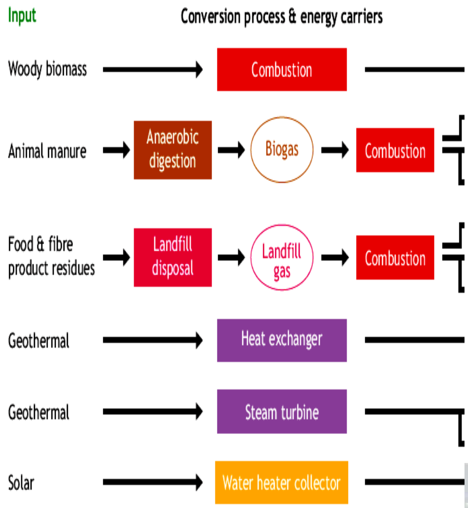

Figure 2 Examples of renewable energy as combined heat and power (CHP).

3. TYPES OF GEOTHERMAL SYSTEM INSTALLATIONS.

3.1 Closed-Loops:

A closed loop is one in which both ends of the loop's piping are closed. The water or other fluid is recalculated over and over and no new water is introduced to the loop. The heat is transferred thru the walls of the piping to or from the source, which could be ground, ground water, or surface water. A heat is extracted from the water in the loop the temperature of the loop falls and the heat from the source flows toward the loop. While there are several loop configurations used in closed loop operation, generally two types of closed loops are utilized by the industry - vertical and horizontal.

Vertical loops utilize bore holes drilled to an average depth of 250 feet. Once the loop pipe is inserted into the bore, it is grouted using a Bentonite mixture for maximum thermal conductivity. When space is a limited, vertical loops are the most common type of geothermal loop installed.

Horizontal loops utilize trenches dug to an average depth of four to six feet. As one of the more cost effective loops to install, horizontal loops are commonly found in open fields, parks or under parking lots.

Lake loops utilize a "slinky" assembly of geothermal loop piping placed at the bottom of a pond, lake, or other large body of water. An extremely cost effective loop system, lake loops are an easy alternative if the option is available.

3.2 Well (Open) Loops:

Most commonly known as "Open Loop", well systems pump water out of a nearby body of water or water well, and then discharge the water into an-other body of water or water well. Well systems usually employ a plate heat exchanger inside the building to keep the building water loop separated from the well water. This prevents any contaminates from affecting unit performance and extends system life. Well systems are often the most efficient as the well water is always at the same temperature year-round.

4. Air-Conditioning Tonnage (Tr)& Energy Efficiency (Eer) Using Geothermal:

A typical "Air Conditioner" operates as follows. Heat is transferred from the enclosure components by circulating air around and through them, the air is then cooled, dehumidified and returned to the enclosure without the admission of air from the out doors. The heat is removed from this air within the air conditioner and discharged by means of a vapor compression refrigeration cycle. This takes place in a hermetically sealed system, utilizing either an air-cooled or water-cooled condenser coil. A schematic diagram of a typical Air Conditioner is illustrated (Fig.1) energy prices and in the load demands resulting in frequent power crisis, Geothermal Space conditioning system finds itself as a solution. The specialty of a geothermal system when compared to a normal Air conditioning system is: It gives a more cooling area than the normal system; there by reducing the tonnage required which in turn reduces the capacity installed providing benefit

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economically in the capital cost to the client(Fig.2 , Fig.3). The run time system of the system reduces considerably, thereby reducing the power consumption by the system and reducing the energy bills thus resulting in savings in the client behalf as well as on the Power supply companies.

5. GEOTHERMAL VS CONVENTIONAL AIR CONDITIONER:

Comparisons between Geothermal and conventional air source units are convoluted because of the sharp decrease in efficiency of air source equipment as a function of outside air temperature. Manufacturers of air source equipment are quick to post impressive EER and SEER (Seasonal Energy Efficiency Ratios) numbers on their "high efficiency" models, but a closer examination of the actual performance data shows that these lofty numbers do not correlate well under realistic installed conditions (Chart 1).

A typical example of a 3-ton air source unit shows manufacturer's EER as 12.0. However, a closer look at performance values yields a calculated EER value of 10.5, at rated conditions. This would represent a daytime temperature of about 32.2° C. When the outside temperature rises to 37.7°C, the air source EER drops to 9.2, which represents a reduction in efficiency of 12%. If outside temperature rises to 43.3° C, the air source EER drops even further to 7.7, which represents a reduction in efficiency of 27%. This means that the unit is requiring 27% more electricity to yield the same cooling [7]. As indicated in the table 1, Geothermal systems for air conditioning are considerably more efficient than the conventional air source units. Simple calculations show that energy costs for a Geothermal are nominally 40% less than air source; 50% less than air source at 100 degrees; and can be as much as 55% less than air source as temperatures rise further

5. BENEFITS – ADVANTAGES:

1. High Efficiency and Stable Capacity
2. Comfort and Air Quality
3. Simple controls and Equipment
4. Low Maintenance Cost
5. Low Cost Water Heating
6. No Outdoor Equipment
7. Packaged Refrigeration Equipment
9. An earth-coupled heat pump can be applied practically anywhere for residential, commercial and industrial heating & cooling systems.
10. An earth-coupled heat pump system has the lowest operating cost of any space heating or cooling system.
11. GHPs are safe and clean because there are no combustion flames, no flues, and no odors; just safe, reliable operation year after year. And compared to most conventional HVAC systems, GHPs deliver constant comfort and improved humidity benefits

6. DISADVANTAGES:

1. High initial investment for a water supply or loop system.
2. Coordination of trades can be a problem during installation as two or more additional contractors are involved for well driller-trenching- plumbing.
3. Public education. Many consumers are distrustful of heat pumps due to past bad experiences with air-to-air heat pumps. Consumers need to be made aware of the fact that a geothermal unit does not have a defrost cycle and that the compressor sits inside.
4. Most people are afraid to get involved in a new technology

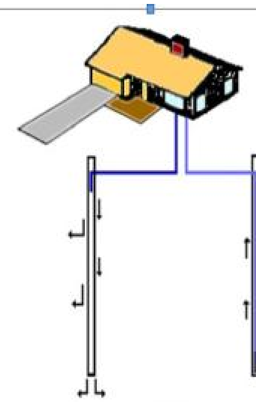


Figure 4: Geothemal energy

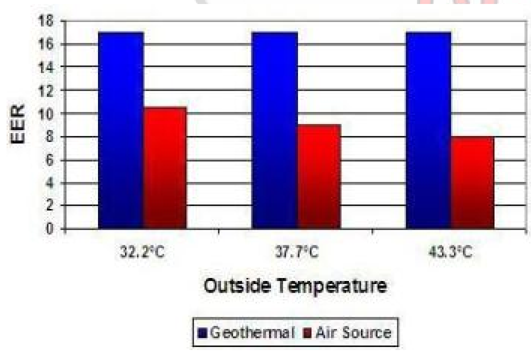
TABLES:

TABLE 1 : EER Comparison Geothermal v. Air source cooling

Outside Temperature	32.2°C	37.7°C	43.3°C
Geothermal	**17**	**17**	**17**
Air Source	**10.5**	**9**	**8**

Ambient heat transferred to a useful temperature level using a heat pump is renewable (although fossil-fuel or nuclear primary energy inputs are often used to generate the electricity needed to drive the appliance). The same is true for shallow geothermal heat that is used via heat pumps.

When a renewable source is used to produce heat and another product such as electricity, the source is split into a fraction used for heat and a fraction used for the other product. If heat is produced by a renewable and a non-renewable source (as for the co-firing of biomass with coal in a CHP plant), the heat output should be split proportionally into renewable and non-renewable fractions.



7. Comparison of input and output side definitions of renewable heat

Input Output

Renewable heat is the energy content of a renewable source that is converted/transferred* into useful heat.

Output

Useful renewable heat output is the heat coming from conversion/transfer* of a renewable energy source that is used by an end user or in a follow-up conversion process

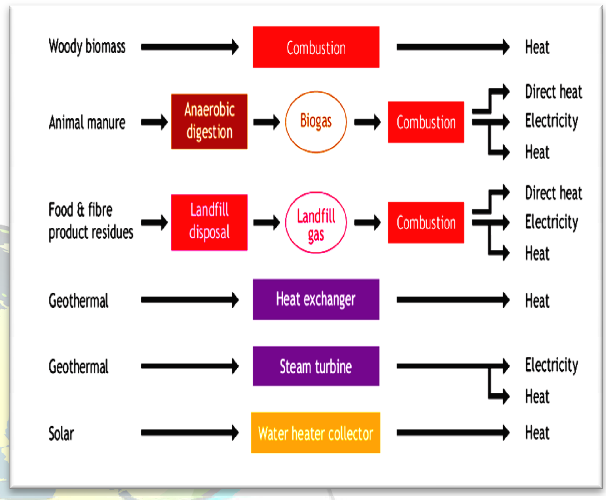


Figure5: Examples of renewable energy resource inputs selected to show how they can provide useful heat outputs as direct heat

8. CONCLUSIONS

The biggest benefit of GHPs is that they use 25%–50% less electricity than conventional heating or cooling systems. This translates into a GHP using one unit of electricity to move three units of heat from the earth. According to the EPA (Environmental Protection Agency), geothermal heat pumps can reduce energy consumption—and corresponding emissions—up to 44% compared to air source heat pumps and up to 72% compared to electric resistance heating with standard air-conditioning equipment. GHPs also improve humidity control by maintaining about 50% relative indoor humidity, making GHPs very effective in humid areas. Geothermal heat pump systems allow for design flexibility and can be installed in both new and retrofit situations. Because the hardware requires less space than that needed by conventional HVAC systems, the equipment rooms can be greatly scaled down in size, freeing space for productive use. GHP

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systems also provide excellent "zone" space conditioning, allowing different parts of your home to be heated or cooled to different temperatures. Because GHP systems have relatively few moving parts, and because those parts are sheltered inside a building, they are durable and highly reliable. The underground piping often carries warranties of 25–50 years, and the heat pumps often last 20 years or more. Since they usually have no outdoor compressors, GHPs are not susceptible to vandalism On the other hand, the components in the living space are

Easily accessible, which increases the convenience factor and helps ensure that the upkeep is done on a timely basis. Because they have no outside condensing units like air conditioners, there's no concern about noise outside the home. A two-speed GHP system is so quiet inside a house that users do not know it is operating: there are no tell-tale blasts of cold or hot air.

REFRENCES

[1] *Geothermal India cooling India from Ground Up –How Geothermal Cooling works* 5 may 2012, pp1-5 , http://www.geothermalindia.com/how_it_works.html

[2] *The Geothermal Concept – Climatemaster's a homeowner's guide to geothermal heating and cooling comfort systems* 29 March 2007 D , http://www.climatemaster.com /downloads / geothermal-concept.pdf

[3] *GeoCool Geothermal Heat Pump for Cooling-and Heating along European Coastal Areas Coordinated* by Javier Urchueguía in the name of the Co-ordinator Institution Final Report February 2, 2003 to February 2, 2006

[4] *Clauser, C., 2006. Geothermal Energy, In: K. Heinloth (ed), Landolt-Börnstein, Group VIII: Advanced Materials and Technologies*, Vol. 3: Energy Technologies,Subvol. C: Renewable Energies, Springer Verlag, Heidelberg-Berlin, 493-604.

[5] Rafferty, K. (February 2001). *"An Information Survival Kit for the Geothermal Heat Pump Owner."* Geo-Heat Center, Oregon Institute of Technology.

[6] *"Geothermal Heat Pumps Make Sense for Homeowners."* (PDF 224 KB). (1998).DOE Geothermal Technologies Program.

[7] *"Heat from the Earth: Geothermal Heat Pumps."* (October 1996). The Family