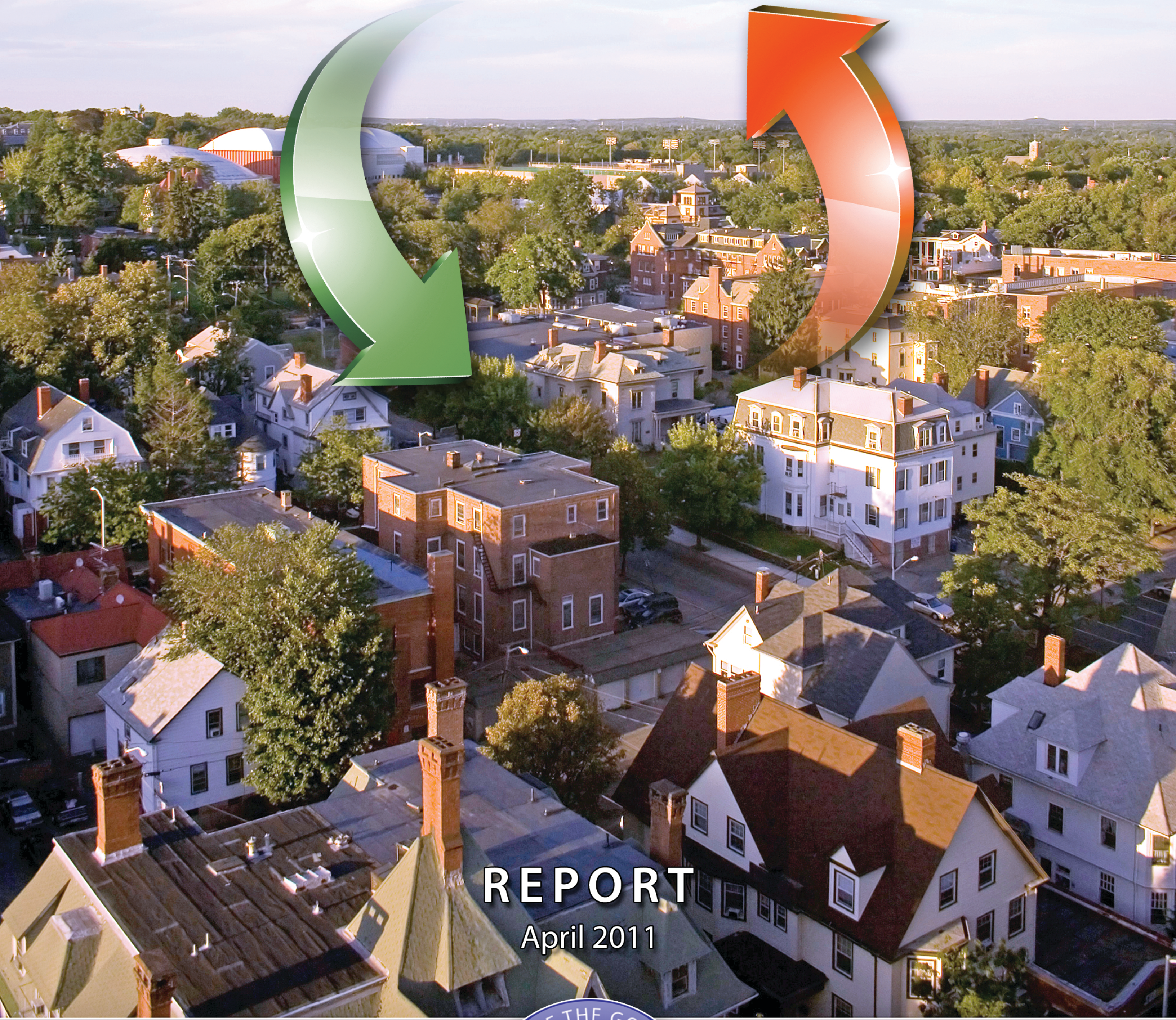
RESIDENTIAL GEOTHERMAL HEATING & COOLING SYSTEMS IN MAINE



REPORT

April 2011

Paul R. LePage
Governor
State of Maine

OFFICE OF THE GOVERNOR
MAINE

Kenneth C. Fletcher
Director
Governor's Office of Energy
Independence and Security

STATE OF MAINE
OFFICE OF THE GOVERNOR
22 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0001

PAUL R. LEPAGE
GOVERNOR

KENNETH C. FLETCHER
DIRECTOR
OFFICE OF ENERGY
INDEPENDENCE AND SECURITY

April 2011

Honorable, Senate Chair Michael D. Thibodeau
Honorable, House Chair Stacey Allen Fitts
Joint Standing Committee on Energy, Utilities and Technology
115 State House Station
Augusta, Maine 04333-0115

RE: Geothermal Report

Dear Senator Thibodeau and Representative Fitts:

The 124th Legislature enacted *RESOLVE Chapter 161 LD 1222*, *Resolve*, *To Promote Geothermal Energy* whereby the Governor's Office of Energy Independence and Security (OEIS) is required to examine policy options and develop recommendations to promote and provide incentives for the installation of residential geothermal heating and cooling systems, particularly in multifamily residences.

The OEIS is s submitting these findings and recommendations to the Joint Standing Committee on Energy, Utilities and Technology. The report purports to:

- Provide an overview of geothermal energy in Maine;
- Examine policy options to promote geothermal energy; and
- Develop recommendations to promote and provide incentives for installation of residential geothermal heating and cooling systems, particularly in multifamily residences.

If you have any questions regarding the report, please do not hesitate to contact us.

Sincerely,

Kenneth C. Fletcher

Kenneth C. Fletcher
Director
Governor's Office of Energy Independence and Security

ACKNOWLEDGEMENTS

Erika Lloyd, Project Manager at Woodard & Curran, served as the primary author of this report and coordinated and communicated with the stakeholder group.

Jeffrey Marks, Deputy Director, Governor's Office of Energy Independence and Security, is responsible for managing and editing the report.

Special thanks to John Kerry, former Director of the OEIS for his leadership and oversight.

I would like to particularly thank the stakeholder group for their participation, information sharing, and expert input for this report.

Ross Elliott, Woodard & Curran, designed the cover.

Ken Fletcher
Director
Governor's Office of Energy Independence and Security

This page intentionally left blank.

TABLE OF CONTENTS

SECTION **PAGE NO.**

LIST OF TABLES

TABLE **PAGE NO.**

This page intentionally left blank.

EXECUTIVE SUMMARY

The word "geothermal" frequently invokes a vision of Old Faithful geyser at Yellowstone National Park, erupting and spewing hot water high into the air from deep within the earth. Some identify geothermal as a natural resource confined to the western region of the United States, far from residential, commercial and industrial locations. In reality, there is potential to power, heat and cool millions of homes and businesses across this country with geothermal energy. Currently, U.S. installed capacity for direct heating purposes totals 470 megawatts (MW) or enough to heat 40,000 average-sized houses (Geo-Heat Center, Oregon Institute of Technology). In Maine, where approximately 70-80 percent of homes are dependent on foreign sources of petroleum to heat their homes, geothermal energy is an often-overlooked tool in the renewable resource portfolio for achieving energy, economic and environmental improvements. In the United States as a whole, the sale and use of geothermal heat pumps has increased significantly since 2000 due to various governmental policies, market incentives and economic activities.

A major impediment to the more widespread use of geothermal energy for residential applications is the often-significant up-front costs of installing the systems. This obstacle is even more pronounced for low-income families who are usually the ones in greatest need of low-cost heating and power. State and federal tax credits and public and private financing options, including low-income loans, can be important drivers for homeowners to fuel switch from traditional oil boilers and furnaces in order to adopt renewable energy systems, including geothermal. Appropriate financing mechanisms can help avoid the burden of paying one large up-front sum for installation in favor of a monthly payment process that could eventually pay for the cost of the system through energy savings achieved. Proper education of the homeowner and accurate information as to the types of economically viable and environmentally benign geothermal exchange systems available along with possible government incentives are crucial to a homeowner's course of action.

Geothermal (or ground-source) heat pumps placed in service starting in 2009 are eligible for a federal tax credit for 30 percent of the cost, with no maximum. These credits are effective through December 21, 2016. In order to be eligible for the tax credit, geothermal heat pumps must meet Energy Star criteria. Currently, the criteria for Energy Star geothermal heat pumps are for a closed-loop system, 14.1 EER (energy efficiency ratio) and a coefficient of performance (COP) of at least 3.3; for an open-loop system, 16.2 EER and 3.6 COP; and for a direct expansion system, 15 EER and 3.5 COP. In addition, the geothermal heat pumps must include a desuperheater, which helps heat water, or an integrated water heating system.

The Governor's Office of Energy Independence and Security (OEIS) believes that this federal incentive is a good start toward integrating cost-effective, energy efficient and environmentally-beneficial geothermal systems into Maine's residential sector. However, in order for the federal incentive to be more successful, a series of steps should be taken to supplement it:

1. Implement the New Well Drillers and Pump Installers Rule. Clear, concise regulations and licensing procedures will lend additional legitimacy to the environmental, energy and economic benefits of geothermal systems.

2. Increase Education and Outreach about Geothermal Systems. In a State where energy efficiency and other forms of renewable energy, including wind, solar and biomass, receive (and deservedly so) consumer and policymaker attention, it is important to promote a broad portfolio of available and appropriate energy resources for residential, commercial and industrial heating, cooling and electricity needs.

3. Provide Increased Attention and Access to Low-Interest Loans for Geothermal Projects. The inclusion of geothermal as an option in education, outreach, energy financing and other programs and policies, particularly for low-income citizens, will at a minimum provide a full picture of the benefits and barriers to installing a geothermal system in a residential setting.

4. Support the Use of Geothermal Systems in the Maine Property Assessed Clean Energy Program (PACE). PACE financing supports energy efficiency and renewable energy projects by providing up-front capital to overcome the initial costs of buying new equipment or renovating homes. PACE financing allows property owners to benefit from energy savings immediately while spreading the cost of improvements over a number of years. While the initial program focuses on weatherization (i.e., air sealing and insulation) in residences, its structure allows a broader inclusion of renewable energy sources like geothermal.

1. INTRODUCTION

1.0 INTRODUCTION

The State of Maine is dependent on unreliable, insecure and expensive foreign oil to heat homes, businesses and other buildings. In fact, Maine citizens are nearly 80 percent dependent on oil to heat their homes and are increasingly vulnerable to rapid price escalations, fossil fuel supply curtailments and infrastructure disruptions. In addition, combustion of fossil fuels for heating purposes damages the environment, threatens public health and undermines the state's economic vitality. The State of Maine Comprehensive Energy Action Plan attempts to reduce, to the degree feasible, this inordinate addiction and dependence on oil by diversifying our energy profile and increasing the emphasis on cost-effective energy efficiency, conservation and cleaner and more sustainable indigenous renewable energy resources. In order to accelerate the transformative process from a state dependent on foreign fossil fuels to one that develops and uses renewable energy technologies, the OEIS supports increased use of geothermal systems in residential applications, including multi-family buildings.

Geothermal heat pumps utilize a renewable resource. Direct-use geothermal resources apply heat "directly" without generation of electricity, including for space heating of individual buildings or districts, warming greenhouses and swimming pools, and industrial processes (California Geothermal Energy Collaborative, University of California at Davis, 2010). In Maine, geothermal heat pumps are the more common systems, as they use underground heat relatively close to the surface rather than deep underground reservoirs. They provide space heating and domestic hot water and cooling to buildings, transferring warmth from underground to houses in the winter and warmth from the house to the underground in the summer. Stakeholders compared the cooling application to that of a refrigerator, which keeps food cool by drawing heat from the interior and expelling it outside.

While the State of Maine energy profile will not change overnight, the State of Maine Comprehensive Energy Plan seeks to securely position the state for the future with renewable, indigenous energy resources like biomass, biofuels, wind, solar, tidal power and geothermal. Geothermal heat pumps have been used in Maine since the 1970's for both commercial and residential applications and it is estimated that there are more than 500 residential geothermal homes in Maine (Logan, 2010b). Despite its current use and potential future, the industry faces a number of challenges. Homeowner awareness of geothermal technologies as a possible solution to their heating needs and costs is limited. The upfront costs of installing geothermal heat pumps are formidable. The accompanying costs, including siting, surveys and drilling, may be a factor in whether to adopt the systems in single-family and multi-family homes. The training and education of some of the industry professionals who are, or could be, installing systems may be inadequate. The relative affordability of conventional heating resources, such as heating oil, kerosene, propane, natural gas and even wood and wood pellets are currently more economic.. Anecdotal evidence of negative experiences with geothermal technology may also be discouraging homeowners to fuel switch to geothermal. In addition, property access and size may also be factors.

These barriers must be addressed and overcome before widespread use of geothermal systems in Maine comes to fruition. If and when oil prices rise above $100/Bbl or $4.00/gallon at the pump,, as they did in 2008, Maine must be prepared with alternatives and maintain the momentum for alternatives if and when oil prices drop again. While we live in a free-market energy arena and the state and federal governments are confronted with acute budget shortfalls, it may be necessary to incentivize homeowners to purchase geothermal systems.

1.1 PURPOSE OF REPORT

The purpose of this report is to provide information and recommendations pursuant to *LD 1222 Resolve, to Promote Geothermal Energy*.

This report will consist of the following:

- Brief overview of geothermal energy;
- Examination of policy options to promote geothermal energy;
- Development of recommendations to promote and provide incentives for installation of residential geothermal heating and cooling systems, particularly in multifamily residences;

1.2 STAKEHOLDERS

Pursuant to its directive, the OEIS conferred with and obtained input from representatives of various stakeholders, including but not limited to the Department of Environmental Protection, Efficiency Maine Trust, project developers, industrial users, engineering firms, and well drillers.

The following is a list of individuals contacted:

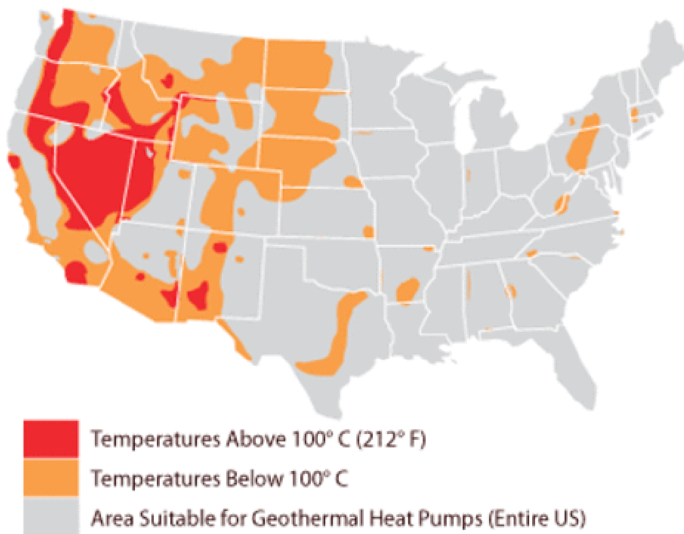
Ian Burnes, Efficiency Maine Trust
Malcolm Burson, Department of Environmental Protection
Robert W. Commeau, Energy Saving & Auditing
Jeff Gagnon, Gagnon Heating & Air Conditioning Inc.
Ike Goodwin, Goodwin Well & Water, Inc.
John Logan, Water Energy Distributors, Inc.
Dale McCormick , Maine State Housing Authority
Tom Myette, Midnight Oil
Robert Stratton, Department of Environmental Protection

The OEIS prepared this report with guidance and information provided by the stakeholders and, pursuant to LD1222, the report represents factual information and some recommendations. However, some content and opinions expressed in the report may not reflect the position of every stakeholder.

2. GEOTHERMAL ENERGY

2.0 DEFINITION

Geothermal energy is simply the natural heat from the earth which continuously flows outward from its core and provides a clean, renewable and sustainable source of energy (US DOE, 2010a). Geothermal energy can be used in different ways, including for electricity production; for residential, industrial and commercial direct heating purposes; and home heating and cooling using geothermal heat pumps (GHP) (GEA, n.d). Generally geothermal energy is associated with geysers and hot springs where volcanic activity produces high temperatures above boiling point near the earth's surface. High-temperature geothermal reservoirs exist mostly in the western United States. See Figure below.

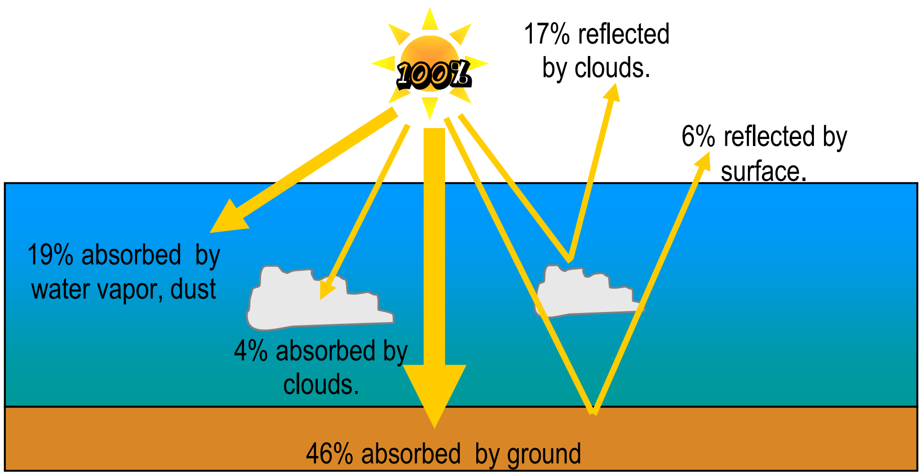


Source: Geothermal.info, 2008

Regardless of where you live in the United States, low-temperature geothermal energy can be used to heat and cool your home using GHP. The U.S. Environmental Protection Agency (EPA) and the Department of Energy (DOE) consider GHPs among the most environmentally friendly and efficient heating and cooling technologies available today (IGSHPA, 2010a). The EPA concluded in a 1993 report that geothermal technologies would help in reducing national energy use and pollution and at the same time provide reliability, comfort and savings to the consumer (IGSHPA, 2010a).

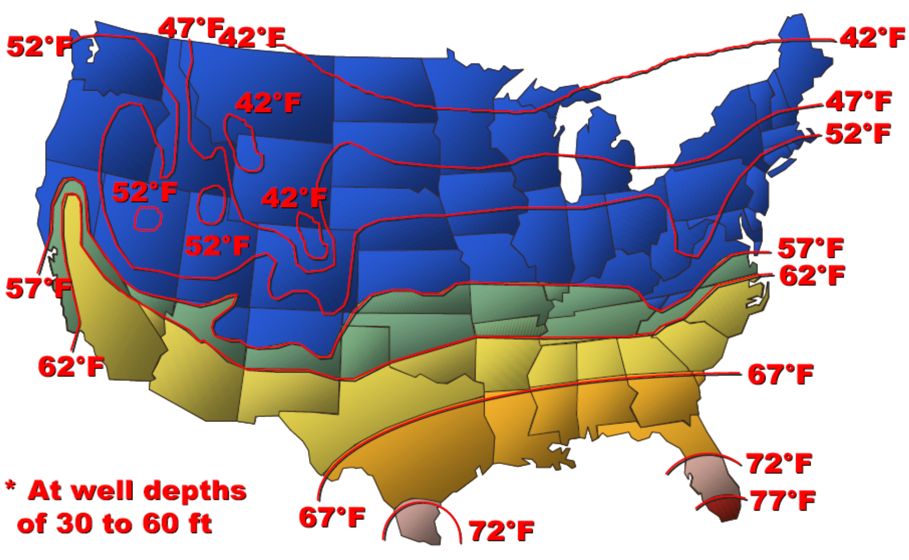
2.1 GEOTHERMAL HEAT PUMPS

Geothermal heat pumps (GHP) have been used since the late 1940s and are sometimes also referred to as GeoExchange Systems, earth-coupled, ground-source, or water-source heat pumps (US DOE, 2010b). Low temperature or shallow geothermal energy used in homes uses the solar heat stored in the ground at relatively shallow depths, <1000 feet below the surface (Lovekin, 2010). As seen in the figure below, 46 percent of the solar heat is absorbed by the ground (Ellis, 2010)



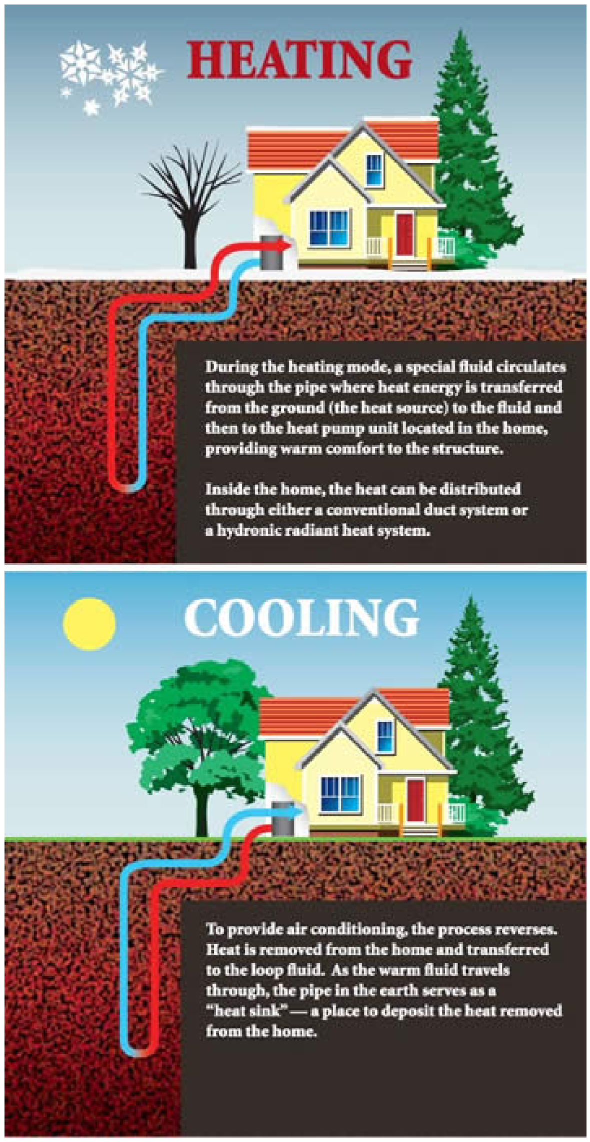
Source: Ellis, 2010

GHPs circulate water or other liquids through pipes buried in a continuous loop, either vertically or horizontally, in areas around the building and use the Earth's relatively constant temperature at depths of 10 to 300 feet (GEA, n.d). Depending in where you are in the United States, the Earth's underground temperature is between 42° – 80° F all year (Ellis, 2010), see figure below.



Source: Ellis, 2010

For heating, the system extracts heat from the earth through the loop and disperses it through a conventional duct system. The process is reversed for cooling; the system pulls the heat from the building and moves it back into the earth loop.



Source: Tri-State, 2011

Alternatively, the heat from the building can also be used to heat hot water. Compared to traditional heating and cooling systems, GHPs use 30-60 percent less electricity because "the electricity which powers them is used only to collect, concentrate, and deliver heat, not to produce it" (GEA, n.d.). GHPs take the place of two home appliances, the furnace and the air-conditioner. "Furnaces must create heat by burning a fuel -- typically natural gas, propane, or fuel oil. With geothermal heating systems, there's no need to create heat, hence no need for chemical combustion" (GeoExchange, n.d.(b)).

A geoexchange system is made up of three major components:

1. a heat pump;
2. an underground heat exchanger; and
3. a distribution system.

The geothermal heat pump moves the energy between the building and the fluid in the earth's underground heat exchanger. In residential installations, the heat pump is usually located inside the building to protect it from the environment and vandalism. The underground heat exchanger extracts energy from the earth when heating and acts like a heat sink to store energy in the earth when cooling. The types of heat exchangers are discussed in the next section of this report. The distribution system consists of either air ducts or hydronic radiant floor tubing (GeoExchange, n.d.(a)) to provide comfort control for the building. Most residential installations use conventional duct work to disperse hot or cold air and to provide humidity control or radiant floors, both of which are compatible with geothermal heat pumps. Heat distribution in existing homes in Maine is predominantly baseboard, for which geothermal heat pumps many times do not provide hot enough water at around 180F (Water Energy Distributors, Inc.).

2.2 TYPES OF GEOTHERMAL EXCHANGE SYSTEMS

There are two basic types of geoexchange systems:

1. Closed-loop systems; and
2. Open-loop systems.

There are many factors that are considered in determining which systems are the most economical and efficient and which type of GHP is best suited for a particular installation:

- Climate;
- Seasonal variation in ground/soil temperature;
- Soil type and conditions, including its heat capacity and thermal conductivity as well as soil porosity and moisture content;
- Depth to bedrock and bedrock type;
- Average groundwater level and flow rate;
- Groundwater quality;
- Available land area;
- Actual location and proximity to salt water;
- Size of the building;

- System demands; and
- Local installation costs.

The following subsection will briefly describe the different types of ground loop systems.

2.2.1 Closed-Looped Systems

Closed-looped systems use a series of continuous underground pipe loops in which both ends of the pipe loops are connected to the heat pump, therefore creating a sealed closed loop. Water or a mixture of water and an environmentally friendly anti-freeze solution circulates through the pipe loops to transfer heat from the earth to the heat pump when heating or transfers heat from the heat pump to the earth when cooling.

Horizontal

In horizontal closed loop systems, the loops are placed in a horizontal trench dug below the frost line. The number of pipes in each trench and the number of trenches needed will vary and depend on the size of geoexchange system installed and the type of soil in the installation area. It requires trenches at least four feet deep and the pipes are typically 400-600 feet long per ton of heating and cooling capacity (GeoExchange, n.d.(a)). The energy unit (ton) is equal to 12,000 BTUs per hour. The average house requires 2.5-3.5 tons (or 30,000 – 42,000 BTUs) per hour to heat or cool the home.

The most common layouts for horizontal closed loop systems either use two pipes, one buried at six feet, and the other at four feet, or two pipes placed side-by-side at five feet in the ground in a two-foot wide trench (US DOE, 2010b). DOE states that this type of installation is generally most cost-effective for residential installations, particularly for new construction where sufficient land is available (US DOE, 2010b).

In minimized trenching areas, the Slinky™ method of looping pipe is used. Slinky coils are spring-like coils of polyethylene pipe which are used to increase pipe surface area and therefore the heat exchange per foot of trench (GeoExchange, n.d.(a)). This allows more pipes in a shorter trench, which cuts down on installation costs and makes horizontal installation possible in areas where it would not be with conventional horizontal applications.

Source: Ellis, 2010

Source: Capital Electric Cooperative, n.d.

Horizontal ground loops have limited application in Maine for two reasons: First, the ground temperature of our soils tends to approach freezing during the winter. In order to achieve reasonable performance, and also prevent the system from freezing solid during the peak heating season, it will be necessary to install the ground loop significantly more than four feet deep. Secondly, a large portion of Maine is covered by glacial till formation, which is expensive to excavate (Goodwin, 2010).

Vertical

In instances where land area is limited or a large system is required, a vertical closed-loop system may be appropriate. Vertical loops are also used to minimize the disturbance to the existing landscaping and where the soil is too shallow for trenching. For a vertical system, holes (approximately four inches in diameter) are drilled about 20 feet apart and 100–400 feet deep (US DOE, 2010b). Two pipes are put into the well and are connected at the bottom with a U-bend to form a loop. A horizontal pipe (*i.e.*, manifold) connects the vertical loops placed in trenches and connects to the heat pump in the building. As with the horizontal and the pond closed-loop system (see below), the number of loops and the depths of wells needed depend on the size of the building, system demands, the ground temperature and other variables.

Source: Ellis, 2010

Source: Geo4VA, n.d.(b)

Generally, vertical loops are more expensive to install. However compared to the horizontal loops, they require fewer pipes because the earth deeper down is warmer during the winter and cooler during the summer (GeoExchange, n.d.(a)).

Pond/Lake

If the installation site is near an adequate water body, a stream, river or pond, the geoexchange system can take advantage of the higher heat transfer capabilities of water over soil and bedrock. From the building, a supply line pipe is run to the water and heat exchange pipe is coiled into circles and placed on the bottom or at least eight feet under the surface to prevent freezing (US DOE, 2010b). The coils should only be placed in a water source that meets minimum volume, depth, and quality criteria. The DOE states that this may be the lowest cost option (US DOE, 2010b).

Source: Ellis, 2010

Source: EMREG, n.d.

Just as in ground loops, the fluid circulates through the pipes in a closed loop system. Designed properly, pond loops have no adverse impacts on the aquatic systems (GeoExchange, n.d.(a)). This information is provided for technical benefit. It must be noted that the discharge of pollutants to lakes and ponds (Class GPA waters) is prohibited by Maine law, except as provided in 38 MRSA, §465-A(1)(C). Heat is considered a pollutant (38 MRSA, §436-A(4-A)) based on potential impacts to the natural aquatic environment. This has been interpreted to include either heat gain or loss. As geothermal exchange systems by design result in the transfer of heat, they are currently prohibited in Class GPA waters in Maine (Stratton, 2011).

2.2.2 Open-Looped Systems

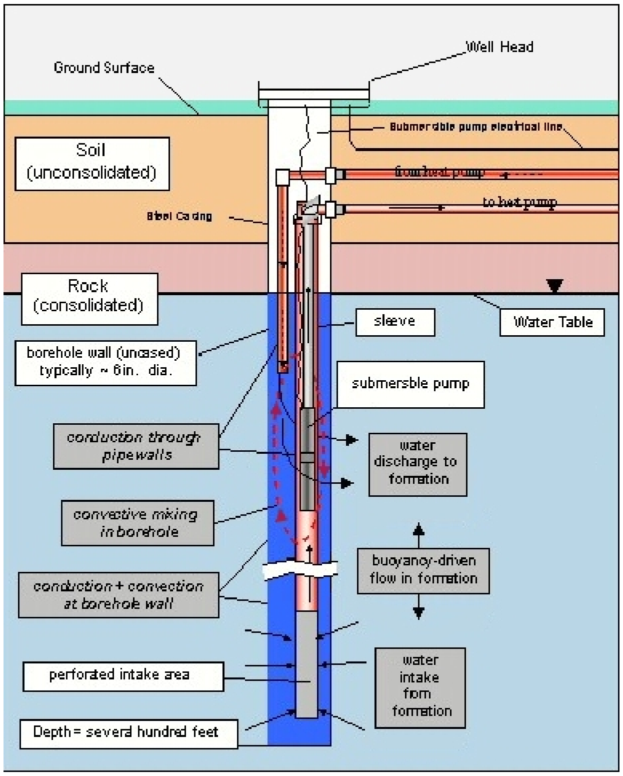
The other type of geoexchange system is an open loop system. This type of system uses groundwater extracted from an aquifer through one well that passes through the heat pump's heat exchanger and once it has circulated through the system, the water returns to the ground through surface discharge, the well, or a recharge well. Wells are typically 6 inches in diameter (Water Energy Distributors, Inc.). There are two types of open looped systems: Open to Recycle, also referred to as doublet earth coupling (Water Energy Distributors, Inc.), and Standing Column Well. The Open To Recycle open loop system takes constant temperature water (around 50°F in New England) from the earth in the winter and returns the water after it has circulated through the system to surface discharge (typically 8°F colder). An Open to Recycle system can discharge the water to the ground surface, as long as it is in compliance with MDEP regulations, but it is more commonly returned back into the same aquifer through a recharge well. This is in fact the most responsible method of recycling the water pumped from the well because there is no net depletion of the ground water aquifer, whereas disposal directly to the ground surface will result in a net ground water withdrawal (Goodwin, 2010). In the summer, the return water is typically 10°F warmer (Water Energy Distributors, Inc.). Please see the section below on regulatory options available.

Source: GeoPro Design, 2009

This option is generally practical only where there is an adequate supply of relatively clean water, and all local codes and regulations regarding groundwater discharge are met. Potential risks of open loops include groundwater quality problems, namely pH and grit that damage machinery even with filtration, and possibility of electrolysis if not installed correctly, which can corrode and disintegrate equipment in weeks (Myette, 2010).

Standing Column Well Systems

In the Northeastern part of the United States, standing column wells have become an established technology. Typically standing column wells are six inches in diameters with a surrounding 8-inch casing into the bedrock to assure a separation of surface water and pure ground water (Water Energy Distributors, Inc.). The well can be as deep as 1,500 feet (GeoExchange, n.d.(a)). Water is withdrawn from the bottom of the well (about 45^{O}F in winter and 60^{O}F in the summer (Water Energy Distributors, Inc.), circulated through the heat exchanger, and ultimately returned back to the top of the water column into the aquifer through the same well (Goodwin, 2010).



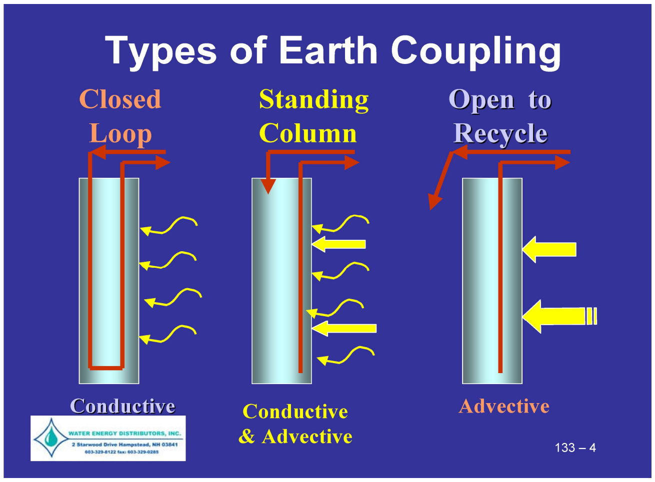
Source: Geo4VA, n.d.(a)

For this system to operate efficiently, the standing column well must be designed and installed properly. The basic standing column well requires that the well produces a flow that fills with well with water, because all of the water pumped from the well for the heat pump is returned directly back into the well with no net ground water withdrawal (Goodwin, 2010). However, the well does have to be drilled deep enough to provide sufficient heat transfer capacity. A properly designed standing column well will function very well with a yield as low as 0.5 gallons per minute (gpm) (Goodwin, 2010). If the water table is too deep where the standing column well is installed, the cost for pumping the water would be enormous

If the well does produce sufficient flow of water, then there is the option of using one or two modifications to the basic standing column well design. The first modification would be to "bleed" off a small percentage of the returning water, usually ranging between 5-10%. Also, if additional bore temperature stabilization is needed, the "bleed" concept can be used (Water Energy Distributors, Inc.). Discharging the bleed water may require permitting conditions but the quantities are small. Alternatively, the "bleed" water can also be responsibly disposed of using a recharge well, returning the water back into the same aquifer. Please see the section on regulatory options available below. The second modification would be to use the well for domestic water. "Under normal circumstances, the water diverted for building (potable) use is replaced by constant-temperature ground water, which makes the system act like a true open-loop system. If the well-water temperature climbs too high or drops too low, water can be "bled" from the system to allow ground water to restore the well-water temperature to the normal operating range" (GeoExchange, n.d.(a)). Both of these modifications will result in a lower overall cost of the initial installation as well as make the operating efficiency even higher (Goodwin, 2010).

The regulatory requirements through MDEP for reinjection or discharge of extracted groundwater can include: (1) being exempt from licensing requirements, (2) an expedited license by rule process with submittal of a registration form only, or (3) an individual Waste Discharge License and required compliance with drinking water standards. The determination is based upon the types and levels of pollutants contained in the source waters and receiving waters, whether it is being re-injected into the source aquifer, discharged to a different aquifer, discharged to the ground surface, and, in the case of the latter, whether the water will be contained on the subject property and not contact a surface water of the State. As there are significant differences between these regulatory options and since project modifications are sometimes available whereby the regulatory requirements may be reduced, it is strongly recommended that interested parties contact MDEP's Division of Water Quality Management (Stratton, 2011).

As shown in the figure below, each type of earth coupling system has a slightly different approach to taking energy from the earth and returning the energy to the earth. During the winter in a closed loop system, the cold return solution in the well of approximately 30OF will be warmed using conductive flow, where the earth's energy will flow toward the well (Water Energy Distributors, Inc.). In the summer, the energy flow is reversed. In an open loop system, the process depends only on the advective flow, taking advantage of the constant ground water temperature in the ground or within bedrock fractures located only about 40-50 feet away from the bore hole (Water Energy Distributors, Inc.). The standing column well approach takes advantage of both the conductive and the advective heat transfer.



Source: Water Energy Distributors, Inc.

Conductive heat transfer is the transfer of thermal energy at a molecular level through a solid or fluid due to a temperature gradient, where as advective heat transfer is discharging some of the cold water out of the well to allow the well to recover with warmer water (Gagnon Heating & Air Conditioning, Inc., n.d.).

Advantages and Disadvantages of Systems

Geothermal Loop Type	Advantages	Disadvantages
Closed-Loop Horizontal	Trenching costs for horizontal loops usually are much lower than well-drilling costs for vertical closed-loops, and there are more contractors with the appropriate equipment; flexible installation options depending on type of digging equipment (bulldozer, backhoe, or trencher) and number of pipe loops per trench.	Largest land area requirement; performance more affected by season, rainfall, and burial depth; drought potential (low groundwater levels) must be considered in estimating required pipe length, especially in sandy soils and elevated areas; ground-loop piping can be damaged during trench backfill; longer pipe lengths per ton than for vertical closed loops; antifreeze solution more likely to be needed to handle winter soil temperatures.
Closed-Loop Slinky	Slinky loops require less land area and less trenching than other horizontal-loop systems, and installation costs may be significantly less.	Greater pumping energy needed than for straight horizontal-loops; backfilling the trench while ensuring that there are no voids around the pipe coils is difficult with certain types of soil, and even more so with upright coils in narrow trenches than with coils laid flat in wide trenches.
Closed-Loop Vertical	Requires less total pipe length than most other closed-loop systems; requires the least amount of land area; seasonal soil temperature swings are not a concern.	Cost of drilling is usually higher than cost of horizontal trenching, and vertical-loop designs tend to be the most costly GHP systems; potential for long-term soil temperature changes if boreholes not spaced far enough apart.
Closed-Loop Pond	Can require the least total pipe length and can be the least expensive of all closed-loop systems if a suitable water body is available.	Submerged loops are likely to require more regulatory permitting than buried closed-loop systems; unless properly marked, can be damaged by boat anchoring. Currently prohibited in Class GPA waters in Maine (Stratton, 2011)
Open-Loop	Simpler design; lower drilling costs than for vertical closed-loop systems; more efficient performance by avoiding thermal degradation associated with heat transfer across pipe wall from ground or water body to antifreeze solution in closed-loop; lower installation cost if a supply well already exists for domestic water or grounds irrigation, with sufficient surplus production capacity to supply heat pump system.	Subject to local, state, and Federal groundwater and surface water withdrawal and discharge permitting; large water flow requirements may exceed local water availability; supply-side of heat exchangers subject to corrosive and abrasive agents, chemical scaling, and microbial fouling; main circulating pumps typically require more power in open loops than in closed loops; water discharge regulations may preclude single-well systems or constrain the design of standing-column systems; higher installation cost if a separate injection well is required for loop water discharge.

Source: Geo4VA, n.d.(b)

2.3 STANDARDS/LICENSING

To ensure the success of a geothermal system, it should be designed by and the piping should be installed by licensed professionals. Installers must have International Ground Source Heat Pump Association (IGSHPA) accreditation and designers must have certified geoexchange designer (CGD) national certification.

The Association of Energy Engineers (AEE) provides the Certified GeoExchange ® Designers with training provided by the International Ground Source Heat Pump Association. The following describes the Certified GeoExchange ® Designers Program:

> "AEE's Certified GeoExchange Designer (CGD) program is designed to recognize professionals who have demonstrated high levels of experience, competence, proficiency, and ethical fitness in applying the principles and practices of geothermal heat pump design and related disciplines, as well as to raise the professional standards within the field, and to encourage those involved in the design process through a continuing education program of professional development. The CGD certification is granted by the Association of Energy Engineers and sponsored by the Geothermal Heat Pump Consortium® (GHPC). Associated training programs are presented by the International Ground Source Heat Pump Association (IGSHPA)."

For more information, contact AEE at http://www.aeecenter.org/certification/.

Heating and air conditioning contractors, drilling companies and excavators can also take advantage of the multiple training opportunities that IGSHPA has to offer, such as IGSHPA Accredited Installer Training, IGSHPA Accredited Driller Training or Certified GeoExchange Designer Course. IGSHPA has over 20 years of experience in training and workshops, has set the industry standard for installation methods and training, is the sole source for industry standard publications and guide books, and has accredited thousands of installers. For more information, contact IGSHPA at http://www.igshpa.okstate.edu/training/training.htm.

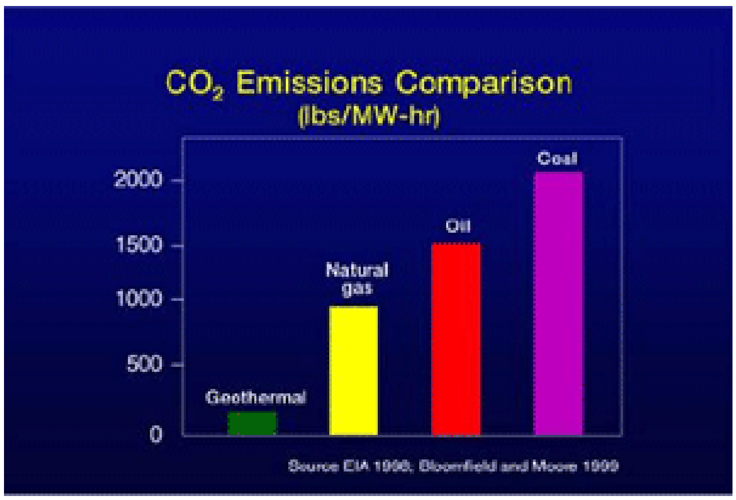
As of October 4, 2010, the Maine Water Well Commission requires additional IGSHPA accreditation and/or license for closed loop and open loop (both open to recycle and standing column wells).

Additionally, the Maine Groundwater Association has proposed newly revised Well Drillers and Pump Installers Rules (Maine Health and Human Services (MHHS) Public Heath CMR Chapter 232). The Maine Water Well Commission has reviewed and approved the revised rules and the rules were submitted to the Office of the Maine Attorney General for review in October 2010 and have been returned with a few minor comments. The Maine Water Well Commission is responding to those comments and expected to submit the rules to the Secretary of State's office by the time of publication of this report for formal rule making. It is anticipated that these revised rules will be in effect by the Spring 2011 Construction season (Goodwin, 2010). The revised rules include a chapter each on guidelines for open-loop and closed-loop geoexchange wells and clearly state the licensing requirements for both open and closed-loop systems for master, journeyman and apprentice installers.

Homeowners interested in a geothermal system must enlist reputable individuals with the appropriate certifications. The Geothermal Heat Pump Directory on the GeoExchange.org Web site (http://www.geoexchange.org) lists Maine geothermal heat pump contractors, manufacturers, drilling contractors, ground-loop installers, engineers, designers, distributors, architects, builders, utilities, training, financing, software and suppliers. It is recommended that homeowners screen both the contractors and the equipment manufacturers for a solid track record and obtain references. For a geothermal system to work properly and efficiently, all three of its components – the heat pump, the underground heat exchanger, and the distribution system – must be designed and installed properly.

2.4 BENEFITS

There are many benefits to the use of a geoexchange system, particularly with residential installations. Geothermal energy is clean and it can be extracted from the earth without burning a fossil fuel such as coal, gas or oil, thereby reducing our dependence on foreign oil and decreasing harmful air emissions. As demonstrated in the chart below the carbon dioxide (CO_2) emissions in lbs/MW-hr is significantly less in geothermal systems than compared to natural gas, oil and coal.



Source: Geothermal Education Office, 1997.

Additionally, geothermal systems require 25-50 percent less electricity than conventional heating and cooling systems and improve humidity control by maintaining about 50 percent relative indoor humidity (www.energysavers.gov). Properly designed and installed geothermal systems have a typical 30-60 percent annual energy savings and reduced maintenance costs due to the durability and high reliability of the components. The underground pipes typically have a 25-50 year warranty and heat pumps generally last 20 years (www.energysavers.gov).

According to the IGSHPA, it is one of the most efficient residential heating and cooling systems available today. The EPA conducted a study, "The Next Frontier" (Office of Air and Radiation, 430-R-93-004), which determined that geothermal heating and cooling systems were much more efficient "than competing fuel technologies when all losses in the fuel cycle, including waste heat at the power plants during the generation of electricity, are accounted for. High-efficiency GHP systems are on average 48 percent more efficient than the best gas furnaces and more than 75 percent more efficient than oil furnaces. The best GHP systems even outperformed the best gas technology, gas heat pumps, by an average of 36 percent in the heating mode and 43 percent in the cooling mode" (Geoexchange, n.d.(a)). ISGHPA also notes that the heating efficiencies are 50 to 70 percent higher in geothermal systems than other heating systems and the cooling efficiencies are 20 to 40 percent higher than available air conditioners (IGSHPA, 2010). When combining the geothermal system with a hot water heating system, there is a savings of 50 percent on the water-heating bill due to the preheated tank water.

Geo-thermal heat pumps are rated by Coefficient of Performance (COP) when used for heat. COP is the ratio of energy input (kW) into the geothermal system to the total thermal energy output. An air to air sourced heat pump has a COP of ranging between 2.4 – 2.8, whereas a properly sized geothermal heat pump has a COP between 3.5 – 4.

Many heat pump manufacturers, local utilities, and lending institutions have special financing for homeowners who are installing GHPs. Overall, depending on geothermal design, a homeowner can recoup their initial investment in 2-10 years through lower utility costs (US DOE, n.d.).

2.5 BARRIERS

There are several barriers to promoting geothermal residential installations. First, a major barrier is the bad publicity of "failed" geothermal technology. These failures are usually associated with improperly sized systems, improperly designed systems or improperly installed systems. The examples of failed systems immediately overshadow the successful installations that have operated efficiently over a long period of time. This barrier is a hard one to overcome; however it can be accomplished through increased education and standards and rules that eliminate improperly designed or installed systems.

The second primary barrier is the lack of education to the contractors and the consumers. A general contractor not familiar with geothermal systems will most likely not promote installation of those systems. As with most alternative energy systems, geothermal systems have complex designs with multiple components and only some contractors are familiar with geothermal systems and therefore comfortable to talk to consumers about their specific options. The consumer is faced with "price" shopping versus "value" shopping (Myette, 2010). "Most consumers in Maine shop price and are unaccustomed to shopping value, and are even less accustomed to shopping value over time " (Myette, 2010).

The third major barrier is that geothermal systems do require an upfront capital investment, and typically geothermal systems are not included as increasing the value of your home in appraisals. Tightened credit markets have resulted in appraisals that are much more conservative and appraisers have little experience in appraising the value of alternative energy systems (Myette, 2010). Therefore, the investment in a geothermal system is not secured and consumers cannot incorporate their investment into their mortgage.

The initial capital costs of geo-thermal systems generally exceed conventional systems. However, when taking into account efficiency, lower operating costs (fuel and maintenance) and a longer lifetime expectancy, the lifetime costs are typically less (Lovekin, 2010). As already discussed, the financials for geoexchange systems depend on several factors including system size and configuration, electricity costs, and the availability and cost of conventional fuels. Typically, smaller residential systems have paybacks between three and ten years (Lovekin, 2010). The most important factor affecting payback is the market price of conventional fuels, *i.e.* higher fuel prices indicate a quicker payback period (Lovekin, 2010). See the table below for typical cost and payback periods for various geothermal systems.

System Type	$/ft² heat space	Total $	Applications	Typical Payback	Notes
Residential home (2,500 ft²) – Horizontal system	$9-$11	$20,000-$25,000	Residential homes	3 – 8 years	Payback typically shorter than vertical systems
Residential home (2,500 ft²) – Vertical system	$15-$25	$30,000-$45,000	Residential homes	5 – 10 years	Higher Drilling costs could lead to longer paybacks
Commercial system – Horizontal system	$15-$25	Varies Depends on application and size of building	New multi-unit residential builds, warehouses, ice rinks, institutional buildings	Immediate – 8 years	Horizontal, open loop systems typically have the shortest payback. When integrated with payback waste heat recovery can be immediate
Commercial system – vertical system	$30-$40	Varies Depends on size of building	New multi-unit residential builds, condos, commercial space, institutional buildings	2 – 10 years	Vertical systems most expensive but often required due to the lack of available space

Source: Lovekin, 2010

Geothermal heat pump systems are most cost effective when designed for heating and cooling; however most homes in Maine are not designed for central air conditioning.

This page intentionally left blank.

3. INCENTIVES

3.0 FEDERAL INCENTIVES

Residential geothermal heat pumps that are installed between January 1, 2009 and December 31, 2016 may be eligible for a tax credit equal to 30 percent of installed cost without cap, as provided under the *American Recovery and Reinvestment Tax Act of 2009* (ARRA). In addition, if a homeowner is not able to use the entire tax credit in the year the system was installed, they may carry the unused portion of the credit into the next year. Federal incentives can also be combined with grants and other rebates from state, county and local governments that encourage the use of renewable energy.

Residential Credit Provisions (Source: FHP web site)

- Installed after January 1, 2009 and before December 31, 2016.
- According to the Internal Revenue Service (IRS) guidance, the federal tax credit is tied to the Energy Star specification that is in effect at the date of purchase.
- Energy Star encourages the use of a heat recovery module but this is not required under the guidelines effective December 1, 2009.
- Installed in a residence (not limited to primary residence).
- For purposes of Energy Star qualification, geothermal heat pumps include the following: open loop, closed loop, and Direct GeoExchange (DGX)and are powered by a single phase current.
- The taxpayer has to file IRS Form 5695 to receive the credit.

For more information see Database of State Incentives for Renewables & Efficiency DSIRE) Residential Renewable Energy Tax Credit at http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US37F&re=1&ee=1 or Water Energy's web site http://www.northeastgeo.com/index.cfm/homeowners/tax-credits/.

3.1 INCENTIVES IN MAINE

Bangor Hydro has offered rebates of $400/ton for geothermal installation in residential homes since September 2009. Bangor Hydro has had 6 new installations totaling 32.5 tons, with several still pending (Luther, 2010) http://www/bhe.com/EnergySolutions/HeatCool.cfm. Bangor Hydro also offers a reduced space heat rate, with a 3 cent reduction on usage in excess of 700 kWh per month from October 1, 2010 through April 30, 2011. This electric equipment heating reduction program was first introduced in 1995 and Bangor Hydro still offers this program http://www.bhe.com/rates/heat_rates.cfm. "We even have one customer now and one installing geothermal heat pumps in a Thermal Storage type of installation, whereby they use a water to water heat pump to heat a concrete slab floor of home/garage and only operate the heat pump on off-peak periods to take advantage of our Electric Thermal Storage off peak rates of 2.2 cents/kWh " (Luther, 2010).

The Efficiency Maine Home Energy Savings Program (HESP) offers energy efficiency incentives for homeowners. The incentive amount depends on the anticipated energy savings and is open to all Maine residents regardless of income. The homeowner must get an energy audit by an approved auditor and complete the recommended energy efficiency improvements to be eligible for rebates. The HESP is primarily focused on weatherization measures, like insulation and air sealing, but a new heating system, in conjunction with weatherization measures, that achieves a certain reduction in heat and hot water consumption, will qualify. (Efficiency Maine, n.d.)

The Efficiency Maine Trust also recognizes geothermal systems, including geothermal heat pumps, in its 2011-13 Triennial Plan. The Triennial Plan is intended to provide a planning strategy for energy efficiency and alternative energy programs and technologies. The Plan seeks to show the "real benefits and costs" of geothermal technologies and complement federal incentives for Energy Star geothermal systems that have the capability to "meet homeowners' total heating loads." (Efficiency Maine Trust, 2010)

4. RECOMMENDATIONS

4.0 SUMMARY AND CONCLUSIONS

Shipments of geothermal heat pumps grew more than 40 percent in 2008 across the nation, partially because of the high prices of traditional petroleum-based heating fuels (EIA, 2008). And, the enactment of *the Emergency Economic Stabilization Act of 2008* provided an additional policy push of long-term tax incentives to encourage the use of renewable energy technologies, including geothermal heat pumps for homes and businesses.

Geothermal Heat Pump Shipments by Model Type, 2000 - 2009
(Number of Units)

Year	Model Type				
	ARI-320	ARI-325/330	ARI-870	Other Non-ARI Rated	Total
2000	7,808	26,219	-	1,554	35,581
2001	NA	NA	NA	NA	NA
2002	6,445	26,802	-	3,892	37,139
2003	10,306	25,211	-	922	36,439
2004	9,130	31,855	-	2,821	43,806
2005	9,411	34,861	-	3,558	47,830
2006	10,968	47,440	-	5,274	63,682
2007	8,112	66,863	809	10,612	86,396
2008	23,204	91,402	783	5,854	121,243
2009	22,009	87,717	759	4,957	115,442

ARI-320 = Water-Source Heat Pumps.
ARI-325 = Ground Water-Source Heat Pumps.
ARI-330 = Ground Source Closed-Loop Heat Pumps.
ARI-870 = Direct Geoexchange Heat Pumps.
NA = Not available. No survey was conducted for 2001.
- = No data reported.
Source: U.S. Energy Information Administration, Form EIA-902, "Annual Geothermal Heat Pump Manufacturers Survey."

Source: EIA, 2008

Today, there are now more than 750,000 geoexchange installations in the United States. The current use of geothermal heat pump technology has resulted in the following emissions reductions and energy consumption reductions (GeoExchange, n.d.(a)):

- Elimination of more than 4.4 million metric tons of CO2 annually;
- Elimination of more than 1.2 million metric tons of carbon equivalent annually;
- Annual savings of nearly 6 billion kWh;
- Annual savings of 30 trillion Btus of fossil fuels; and
- Reduced electricity demand of nearly 2 million kW.

The current use of geothermal heat pump technology is comparable to reducing the US reliance on imported fuels by 16.1 million barrels of crude oil per year, or in other terms taking 971,000 cars off the road or planting 289 million trees (GeoExchange, n.d.(b)).

As Maine residents continue to face rising heating costs and tighter budgets, policymakers must carefully review more efficient ways to heat Maine homes and businesses through clean alternative energy sources, including geothermal systems and heat pumps. The high investment costs of installing renewable energy systems justify increased attention to potential incentives for their increased use.

The original concept draft of LD 1222 created a tax incentive program for geothermal energy to address the needs of residents who live in areas where solar and wind power were not viable options. Under the proposed geothermal energy tax incentive program, homeowners who install geothermal heating and cooling systems would be eligible for a one-time tax credit of a percentage of the total investment for residential ground loop or ground water geothermal heat pump installations, with a maximum credit for a single residence. Given the budget limitations facing state government, the Standing Committee on Utilities and Energy was reluctant to provide state tax incentives for geothermal energy users. The American Recovery and Reinvestment Act of 2009 also provided enhanced and extended tax credits for geothermal systems at the federal level, further discouraging the immediate impetus to provide state tax incentives for geothermal systems for homes. Further, the Maine State Housing Authority reported on its Home Energy Loan Program, which provides low interest loans for home energy improvements for low- to moderate-income households, and found that no homes installed geothermal heating systems under the program. (Maine Office of Policy and Legal Analysis, 2010)

At the time of publication of this report, the State of Maine faces a significant budget shortfall for 2011-2013 and the Maine Legislature is not likely to consider tax credits for geothermal installations in residential settings, including multi-family homes. At the same time, federal stimulus dollars, tax incentives for geothermal and strong state renewable standards continue to fuel growth in the geothermal industry and maintain momentum for renewable projects. "Recovery Act funding is going to make a huge difference over the next year to push projects to completion and create more jobs," said Karl Gawell, Executive Director of the Geothermal Energy Association upon release of its new "Green Jobs Through Geothermal Energy" report. "It is critical that we continue to support these sound policies despite the rancor of several short-sighted initiatives which seek to strip away these tools to help grow our economy."(Jennejohn, 2010)

4.1 RECOMMENDATIONS

The OEIS supports the federal tax credit of 30 percent of the cost (including installation and labor costs), with no upper limit, for geothermal heat pumps as the most effective existing public policy to promote and provide incentive for the installation of residential geothermal heating and cooling system, including multi-family residences. The tax credit is in effect through December 31, 2016. All Energy Star qualified geothermal heat pumps are eligible for the tax credit. The existence of the federal tax credit and the current financial situation in Maine State Government argues against legislative initiatives to establish a separate financial incentive for geothermal energy system. However, the OEIS recommends reconsideration of this issue when the State's economic outlook improves as a potential component of a sound energy, environmental and economic policy.

In the meantime, the OEIS believes that existing regulatory, financial and education programs are available to provide support for geothermal systems in single- and multi-family residences.

Implement the New Well Drillers and Pump Installers Rule

In 2009, the Maine State Legislature enacted "An Act Relating to Geothermal Heat Exchanger Wells" (PL, 2009) directing the Maine Water Well Commission to adopt rules establishing a license structure for geothermal well drillers and well pump installers. Current rules relating to geothermal well construction, installation, and licensing were deferred until the Commission adopts these final rules.

An appropriate and consistent licensing structure for well drillers and geothermal pump installers will provide a high level of credibility to well drillers and geothermal heat well pump installers. The current proposed rule is supported by the industry and will offer consumers a level of assurance that geothermal professionals will approach their residential projects with professionalism and expertise. Some of the barriers to residential geothermal systems mentioned earlier, including training of installers, education of homeowners and negative perceptions brought about by a few problematic installations, can be at least partially overcome through a state-backed licensure process.

Increase Education and Outreach About Geothermal Systems

Closely related to licensure, increased education and outreach to contractors, well drillers, HVAC professionals, homeowners and other geothermal stakeholders are crucial to encourage the use of geothermal systems in residential settings. Energy improvements to houses and multi-family dwellings offer significant opportunities to reduce energy use and greenhouse gas emissions while saving money. However, geothermal systems have attracted relatively little attention from homeowners and policymakers as an important component in achieving energy security, environmental protection and economic well-being. Wind, solar and energy efficiency and weatherization appear to have overshadowed the important contribution that geothermal can make to the heating dilemma in Maine.

In order to properly educate Maine homeowners and contractors regarding geothermal energy, it will be important to assemble independent hard data on installation costs, energy saved and payback times, demand and maintenance and operation issues. The information must not only characterize the benefits to consumers, but also the economic benefits to drillers and installers, as well as the peak energy demand reductions for utilities. Accurate and updated information provided by contractors, state government agencies, non-profits and other "information" resources should be prepared to explain the high first cost of geothermal versus the payback time; limitations of geothermal systems versus other conventional and alternative clean energy options; and environmental and land use problems and solutions.

The Maine State Housing Authority, Efficiency Maine Trust and the OEIS should play coordinated key roles in this education and outreach effort., as should project developers, well drillers, engineers, renewable energy associations and other stakeholders. Efficiency Maine administers all energy efficiency and alternative energy programs and was created to help businesses and residents all over Maine use energy resources more efficiently, reduce energy costs, and lighten the impact on the environment from the burning of fossil fuels. Efficiency Maine's energy savings programs reduce the use of natural gas, propane, oil and electricity through energy efficiency improvements and the use of renewable resources, such as wind, solar, geothermal and biomass. They offer a wide range of programs providing incentives, training and technical assistance to residents, businesses and contractors. Efficiency Maine also offers the HESP to provide incentives to home owners who conduct a home energy audit and make home improvements to increase energy efficiency. The OEIS is responsible for planning and coordinating state energy policy and serves as the primary energy advisor on policy options, development and implementation to the Governor and Legislature. The OEIS also develops the state energy plan, conducts studies and provides financing and technical education and outreach for business, non-profits and government entities to pursue energy efficiency, conservation and renewable energy project opportunities. Both of these agencies have the expertise and outreach capabilities to ensure geothermal is a key tool in a broad portfolio of clean energy solutions.

Another resource is the recently formed New England Geothermal Professionals Association (NEGPA). It's an organization to publicize and help educate the public and is an advocate for geothermal possibilities in New England. For more information please contact Martin Orio (martin@northeastgeo.com) or visit the NEGPA web site (http://negpa.org/).

Provide Increased Attention and Access to Low-Interest Loans for Geothermal Projects

Approximately 40 percent of Maine households are qualified as "low-income" according to Maine Housing criteria. In 2007, the Maine State Housing Authority created the Home Energy Loan Program (HELP) to provide low interest energy improvement loans to low to moderate income households. The HELP program offered, with no down payment, loans to cover home energy audits, insulation, air sealing and weather-stripping, windows and appliances, ventilation and moisture mitigation and new roofs. The program also covered heating system or replacements, including wood stoves, wood pellet systems, solar thermal hot water systems and geothermal heat pumps. The loans were available from a variety of financing institutions.

In a January 2009 report to the Utilities and Energy Committee, Maine Housing concluded the following: "Burdened with a long-term payback period (15+ years) and high installation costs (average $20,000 – 30,000+), geothermal heating systems are a stretch for most Maine homeowners, especially those that can't afford to wait for their energy efficiency investment to pay off." The report went on to state that, despite the "consumer choice" not to pursue geothermal systems through the HELP program, the overall loan program was a success.

Currently, Maine Housing offers a variety of programs to help low-income households reduce their electricity and energy use and assist with costs, including the Low Income Home Energy Assistance Program, Low Income Assistance Plan, and the Appliance Replacement Program. The Weatherization Program and Central Heating Improvement Program provides grants to reduce energy costs, including insulation, weather-stripping and repair or replacement of central heating systems, but the program has not been used for any geothermal projects.

The Multifamily Home Energy Loan Program (Multifamily HELP) offers 4.75% fixed rate financing to improve the energy efficiency of eligible affordable housing developments and reduce project operating costs. Property owners who make improvements identified in an energy audit may reduce energy consumption by 15-20% annually. Borrowers pay third-party fees such as the cost of the energy audit, title update, credit report, recording fee, and (in some cases) appraisal of the property. These fees may be included in the loan. Multifamily HELP loans may be used to finance:

- Heating system repair and replacement (including alternative fuel sources);
- Insulation, air sealing and weather stripping (required if replacing a heating system);
- Energy Star rated windows and appliances;
- Storm doors and storm windows;
- Ventilation and moisture controls; and
- Roof repairs (if the attic is insulated to R60).

Improvements financed with a Multifamily HELP loan must be recommended by a certified energy auditor and approved by Maine Housing. Work also must comply with Maine Housing's Green Standards (http://www.mainehousing.org/HOUSINGDEVConstructionServices.aspx). The cumulative Savings to Investment Ratio for all improvements financed with the Multifamily HELP loan must be 1 or greater.

In order to overcome the expectations that geothermal heating systems are "a stretch for most Maine homeowners" and "burdened with a long-term payback period and high installation costs," Maine Housing should maintain its focus on traditional weatherization activities, including air sealing and insulation, while also raising the profile of renewable energy systems, such as geothermal heating systems, in their outreach and education activities. This includes at least a mention of geothermal systems at education forums, expos and seminars, inclusion in information brochures, flyers and press releases and a section explaining the benefits (and costs) on the Web site.

Support the Use of Geothermal Systems in Maine PACE Program

The Efficiency Maine Trust is administering the Property Assessed Clean Energy (PACE) program to provide low-interest loans to pay for cost-effective energy efficiency improvements in homes and businesses. PACE works in conjunction with the Home Energy Savings Program, a revolving loan fund to help Maine homeowners finance the cost of insulating, air sealing, heating system upgrades and other improvements. Under the PACE program, a loan is taken by property owners to finance the cost of making qualified energy savings improvements to improve energy efficiency or upgrade or replace the heating system. Under the "cost-effectiveness" test, the total financial benefits of projects must be greater than the total financial costs over the useful lives of individual measures installed on the property. If the homeowner moves before the loan is paid off, the loan can be passed to the next homeowner.

A municipality must adopt a PACE ordinance to enable its residents to put PACE loans on their property, decide to raise its own funds or use the Efficiency Maine loan fund and develop a public outreach and education plan to raise awareness of home energy savings measures. The property owner is subject to strict underwriting requirements, consumer protection and quality assurance measures. The duration of the loan can vary but must be shorter than the expected useful life of the installed improvement and the annual payments should be less than the annual avoided costs of purchasing energy.

Efficiency Maine will determine which efficiency improvements and renewable energy installations will be eligible for PACE financing, but the initial loans are focused on energy efficiency retrofits rather than renewable systems. The OEIS recommends that PACE and the revolving loan fund not only include geothermal systems as eligible energy savings improvements, but include geothermal systems alongside other technologies, systems and improvements in all outreach, education efforts and interactions with municipalities, homeowners and loan originators.

During the stakeholder process to develop this report, it was pointed out that banks and appraisers are unaware of the return on investment (ROI) of renewable energy projects generally, and geothermal systems specifically, in the value of homes, loans and mortgages. Clean energy improvements, and the PACE loans that make them happen, can raise the value of homes. Please visit www.efficiencymaine.com/pace for the most current and updated information on the Maine PACE program.

This page intentionally left blank.

5. REFERENCES

Association of Energy Engineers (AEE); n.d. Certifications. http://www.aeecenter.org/certification/

Bangor Hydro, n.d. Heating and Cooling. http://www/bhe.com/EnergySolutions/HeatCool.cfm (July 2010).

Bangor Hydro, 2010. Heating Rates. http://www.bhe.com/rates/heat_rates.cfm (July 2010).

California Geothermal Energy Collaborative, University of California at Davis, 2010. Geothermal Resources: Geothermal Power Generation. http://cgec.ucdavis.edu/pages/resources.html (March 11).

Capital Electric Cooperative, n.d. Images – Econar looped example JPG. http://www.capitalelec.com/miscellaneous/images/econar_looped_exampl.jpg (2010).

Database of State Incentives for Renewables & Efficiency (DSIRE); n.d. http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US37F&re=1&ee=1 (July 12, 2010).

East Midlands Renewable Energies Group (EMREG), n.d. Ground Source Heat Pumps: How They Work. http://www.emreg.co.uk/index.php?pageID=40 (2010).

Efficiency Maine, n.d. Home Energy Savings Program FAQs. http://www.efficiencymaine.com/at-home/hesp_program/faqs (July 2010).

Efficiency Maine Trust, 2010, Triennial Plan of the Efficiency Maine Trust, 2011-2013. April.

Ellis, D., 2010. Geothermal Heat Pumps in Perspective. Geothermal Heat Pumps: Harnessing On-Site Renewable Energy to Meet Energy (Efficiency and Climate Change Goals PowerPoint Presentation). www.geoexchange.org (October 2010).

Energy Information Administration (EIA) (2008). Geothermal Heat Pump. http://www.eia.doe.gov/cneaf/solar.renewables/page/heatpumps/heatpumps.html (July 2010).

FHP Manufacturing. Geothermal Tax Credits: Commercial Residential. http://www.fhp-mfg.com/?p=tax_credits&q=2

Gagnon, J., 2010. Discussions with Jeff Gagnon. December 3.

Gagnon Heating & Air Conditioning, Inc. (n.d.). Geothermal Heating & Cooling Systems. http://www.gagnongeothermal.com/geothermal.htm (July 12, 2010).

GeoExchange, n.d.(a) http://www.geoexchange.org/ (July 2010).

GeoExchange, n.d.(b). GeoExchange Heating and Cooling Systems: Fascinating Facts. www.geoexchange.org/index.php?option=com_docman&task=doc_download&gid=17&Itemid=23 (July 2010).

Geo-Heat Center Oregon Institute of Technology. http://geoheat.oit.edu/.

GeoPro Design, 2009. Residential Geothermal Basics. http://www.geoprodesign.com/en/Page/residential-geothermal-basics

Geothermal.info – Geothermal Energy Investing: What is Geothermal?, 2008. Map of USA Geothermal Power Hotspots. http://geotherma.blogspot.com/2008/08/what-is-geothermal-globe-netcom-article.html (July 2010).

Geothermal Education Office,1997. http://www.geothermal.marin.org/ (July 12, 2010).

Geothermal Education Office (2000). Geothermal Energy. http://geothermal.marin.org/geopresentation/sld119.htm (July 12, 2010).

Geothermal Energy Association (GEA), n.d. Geothermal Basics – 1.3 What are the different ways in which geothermal energy can be used? http://geo-energy.org/Basics.aspx (July 12, 2010).

Geo4VA, n.d.(a). Ground Loop Configuration and Installation. http://www.geo4va.vt.edu/A2/A2.htm#A2top (July 2010).

Geo4VA, n.d.(b). Direct Exchange (DX Loops). Virginia Tech http://www.geo4va.vt.edu/A2/A2.htm#A2sec3 (July 2010).

Goodwin, I.; 2010. Discussions with Ike Goodwin. November 12.

International Ground Source Heat Pump Association (IGSHPA), 2010a. What is Geothermal? – Residential. http://www.igshpa.okstate.edu/geothermal/residential.htm (July 12, 2010).

IGSHPA, 2010b. Training: http://www.igshpa.okstate.edu/training/training.htm (July 12, 2010).

Jennejohn, D., 2010. Green Jobs through Geothermal Energy Report; Geothermal Energy Association (GEA). October.

Logan, J., 2010a. Discussion with John Logan (Water Energy Distributors, Inc.). September 20.

Logan, J., 2010b. Geothermal Systems Installed in Maine, Executive Summary – John Logan, Water Energy Distributors, Inc.

Lovekin, D., 2010. Geoexchange (Fact Sheet) Energy Under Foot; July 21.

Luther, C.; 2010. Email from Calvin Luther. September.

Maine Office of Policy and Legal Analysis, 2010. LD 1222: An Act to Promote Geothermal Energy in the State. January.

Myette, T., 2010. Discussions with Tom Myette. September 21.

New England Geothermal Professionals Association (NEGPA), http://negpa.org/

Public Law (PL), 2009. Chapter 153 LD 860: An Act Relating to Geothermal Heat Exchange Wells. May 18.

Stratton, R., 2011. Email from Robert Stratton to Erika Lloyd (Woodard & Curran). January 10.

Tri-State Generation and Transmission Association, Inc. (Tri-State), 2011. Tapping Into The Earth For Energy Savings – Ground-Source Heat Pumps Taking Root Across The Region. http://www.tristategt.org/NewsCenter/NewsItems/Ground-SourceHeatPumps.cfm

United States Department of Energy (US DOE) Energy Efficiency & Renewable Energy, n.d. www.energysavers.gov (July 2010).

US DOE: Energy Efficiency & Renewable Energy, 2010a. Exploring Ways to Use Geothermal Energy. http://www.energysavers.gov/renewable_energy/geothermal/index.cfm/mytopic=50004 (July 2010).

US DOE: Energy Efficiency & Renewable Energy, 2010b. Geothermal Heat Pumps. http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12640 (July 2010).

Water Energy Distributors, Inc. http://www.northeastgeo.com/index.cfm/homeowners/tax-credits/ (July 12, 2010).

This page intentionally left blank.