Public Interest Energy Research (PIER) Program

FINAL PROJECT REPORT

PROJECT NEGATHERM FOR GROUND SOURCE HEAT PUMPS:

Improving the Geothermal Borehole Drilling Environment in California

Prepared for: California Energy Commission

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PREFACE

The California Energy Commission's Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program conducts public interest research, development, and demonstration (RD&D) projects to benefit California.

The PIER Program strives to conduct the most promising public interest energy research by partnering with RD&D entities, including individuals, businesses, utilities, and public or private research institutions.

- PIER funding efforts are focused on the following RD&D program areas:
- Buildings End-Use Energy Efficiency
- Energy Innovations Small Grants
- Energy-Related Environmental Research
- Energy Systems Integration
- Environmentally Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Transportation

The California Energy Commission's Geothermal Program was created by Assembly Bill 1905 (Bosco) in 1981. The mission of the Program is to promote the research, development, demonstration, and commercialization of California's enormous earth heat energy sources. A major program goal is to continue to develop a portfolio of near to long-term R&D projects in California. During the first decade, the Program promoted California geothermal energy development by extending financial and technical assistance to public entities to support direct uses, planning, and mitigation projects. In 1992, the program was expanded to include financial assistance to private entities for research, development, and commercialization projects. The funding source is revenue paid to the United States government by geothermal developers from production on federal leases in California. Typically, there are funds available each fiscal year in the Program's Geothermal Resources Development Account (GRDA) for awards to qualifying applicants, and are provided as grants or loans.

The Program has cost-shared in research, development, and demonstration (RD&D) partnerships with over 160 public and private entities. It supports the development of new geothermal resources and technologies for low temperature uses and electricity generation while protecting the environment and promoting energy independence.

The Geothermal Program promotes funding for the following:

- RD&D projects that reduce the life-cycle cost of geothermal electricity generation.
- RD&D projects that reduce the uncertainty and cost of enhancing geothermal reservoir systems.
- Projects that mitigate the adverse impacts of geothermal development.
- Projects that provide significant environmental enhancement.

The work described in this report was conducted with funding as a GRDA Grant in the Geothermal Planning Category under the grant, *Project Negatherm for Ground Source Heat Pumps: Improving the Geothermal Borehole Drilling Environment in California, grant number* GEO-07-007, GroundSource Geothermal Inc.

For more information on the GRDA Program, please visit the California Energy Commission's Geothermal Program web site http://www.energy.ca.gov/geothermal/.

ABSTRACT

Project Negatherm: Improving the Geothermal Borehole Drilling Environment in California is a systematic effort to study the past, present, and the future of ground source heat pumps in California.

The large-scale adoption of sustainable ground source heat pumps within California would greatly help to reduce energy demand, greenhouse gases and ease pressure on both the natural gas infrastructure and the electrical grid. A ground source heat pump is the mechanical system engine for energy efficiency.

The Project Negatherm Report defines and breaks down the stumbling blocks to drilling ground-source heat pump boreholes by investigating specific regulatory, technological, and financial hurdles across California. Featuring surveys and interviews of consumers and key representatives of the drilling and ground source heat pump communities, this report pinpoints areas for improving interactions between government, utilities, business, educators, and the public and delivers detailed recommendations for regulatory reform, best practices and information sharing.

Keywords: Drilling, construction, environmental issues, ground source heat pump, CEC, GRDA, Negatherm, Federal, state, local, policies, permitting, tax incentives, carbon credits, regulatory barriers, financing, first cost, IGSHPA, CGEC, GHPC, CGC, NGWA, USGBC, CGA, zero net buildings, LEED, PACE, CaliforniaFIRST

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EXECUTIVE SUMMARY

Introduction

Ground source heat pumps can play an important role in reducing electricity demand and increasing efficiency in residential and commercial buildings, but have made little impact in California. Oak Ridge National Lab estimates that a moderately aggressive adoption of ground source heat pumps throughout American building practices would yield annual energy savings of 3.4 to 3.9 quad Btu. At current electricity prices, these represent savings between $33 and $38 billion in retail utility bills and far exceed current combined renewable energy contributions from solar photovoltaic, wind and geothermal power.

Until now, the challenge of increasing ground source heat pump use in California has been moving from theory to everyone's back yard. Additional challenges identified by the U.S. Environmental Protection Agency in 1993 remain today as a general lack of awareness- by consumers, industry, and government; high first costs; and regulatory hurdles. Project Negatherm identifies and suggest ways to overcome barriers to ground source heat pumps in California, especially with regard to borehole drilling. Awareness can be developed if lower costs and regulations are in place. First-cost barriers are eroding with tax credits and property assessment financing strategies, however, the regulatory issues in California have not yet been resolved.

A nationwide survey of ground source heat pump regulations conducted by the University of Idaho concluded that "the regulations which presently govern the design and construction of open and closed loop geothermal heat pump systems across the U.S. are a patchwork of appropriate and inappropriate responses to potential environmental problems." Currently, the regulatory landscape for ground source heat pump technology in California presents considerable obstacles for industry growth. Inconsistent permitting processes, confused work classifications, and fee schedule differences among local jurisdictions have a negative effect upon projects. The current training and licensing requirements have nothing to do with closed loop bores and everything to do with water well work. These hurdles can be overcome by recognition of the problem, a concerted effort toward reform, and leadership at the state level to create an appropriate environment for heat pump adoption.

Purpose

This project systematically studied the single biggest inhibitor to ground source heat pump adoption: drilling ground-loop boreholes. A Direct Use Resource Network working group framed the larger issues related to ground source heat pump acceptance, identified key advocacy subgroups, and identified activities that would contribute to increased market penetration. This project concentrates on the drilling contractors and conducts an in-depth study that focuses on the issues the drilling community faces and presents an action plan to move forward. Faster, cheaper, more reliable, less disruptive drilling is central to market acceptance, but current resources are relatively scarce, expensive, unreliable, and disruptive.

Objectives

Project Negatherm's objectives were to:

- Review relevant literature.

- Compile permit regulation in California's 58 counties, and other municipal districts and states.
- Develop methodologies for stakeholder interviews.
- Interview industry stakeholders.
- Convene an industry advisory board.
- Identify technical and financial hurdles.
- Conduct field research on commercial and residential projects.
- Research the latest innovative finance models.
- Devise and conduct surveys of consumers and driller groups.
- Develop a resource web portal containing project research findings for industry and consumers. The content and format of the portal are detailed in chapter 11, and when approved, the portal will be posted for public use.

Conclusions & Recommendations

Project Negatherm's key findings reveal a consistent message of undeserved obscurity and inadvertent barriers for ground source heat pumps. The ground source heat pump market has grown, although heat pumps have not yet had the impact on the space conditioning market that the U.S. EPA envisioned in 1993. Despite the fact that drilling is integral to ground source heat pump technology, there is little available literature that examines this topic in depth. In more recent reports, increasing emphasis is placed on the potential of ground source heat pump technology to reduce greenhouse gas emissions. While there are several clear and apparent obstacles to widespread market adoption of ground source heat pumps, authors display an increasing optimism about the potential they can play in the space conditioning industry.

Currently, California's regulatory landscape for ground source heat pump technology presents considerable obstacles for industry growth. Inconsistent permitting process and fee schedules across local jurisdictions can make a project economic or uneconomic by increasing project costs. Furthermore, the current licensing requirements may limit the number of drillers and the industry cannot keep up with increasing demand for their services. These hurdles can be overcome by concerted effort and leadership at the state level. Re-examining regulations and licensing requirements will resolve the uncertainties that characterize the system today.

In the early 1990s, ground source heat pump technology was actively explored as a demand management solution to rising energy prices. Assembly Bill 2334 (Cortese, Chapter 581, Statutes of 1996) set the stage for ground source heat pump borehole regulations. To date, however, the law has only been partially carried out. While Department of Water Resources Bulletin 74-99 contains draft standards for ground source heat pump boreholes, the general lack of state leadership in promulgating these standards has resulted in a lack of regulator knowledge of the technology at the local level, and a permitting process where procedures and fees can vary greatly.

Today, the industry is poised for a resurgence of interest, thanks in part to federal tax incentives in the American Recovery and Reinvestment Act of 2009 and increasingly green consumer sensibilities. However, despite California's status as a recognized leader in alternative energy, the regulatory landscape for ground source heat pump technology presents the following obstacles for the industry's growth:

- Inconsistent permitting process and fees can adversely impact already challenging GSHP project economics.
- Current licensing requirements may adversely affect drillers' ability to meet the demand for their services in the future.

Currently, all regulations for ground source heat pump boreholes are tied to water wells and they are treated the same. Ground source heat pump reform would begin with the recognition that a closed-loop borehole is not a water well. Closed-loop bores are drilled, a high-density polyethylene plastic u-bend tube is put in place, and then the hole is immediately grouted. The work to drill, install tubing, and grout the hole is completed in one day or less. Unlike more exploratory water well drilling, casing, and pump work, closed-loop boreholes for ground source heat pumps are about production and optimization.

The experiences of other states illustrate that regulations need not be an impediment to the ground source heat pump industry. Rather, the state can use them to educate regulators and level the playing field for drillers and consumers. Furthermore, many states have implemented a fixed-cost permitting system, standardizing a significant variable in ground source heat pump borehole project economics.

California is currently the home to 12.1 percent of the country's population, represents only 2.3 percent of ground source heat pump activity and is 15th in equipment shipments. Sales in 2008 represented a 73 percent increase in heat pump installed capacity, showing an upward trend on a very small base.

California progress in ground source heat pump regulation compared to other states. California has lagged substantially behind other states. Source: GroundSource Geothermal, Inc.

Key Distinctions	California	Missouri	New Jersey	Idaho	Washington	Oregon
Regulations	DWR **Draft** 74-99 (1999)	Heat Pump Construction Code (1996)	Water Well Standards (2001)	IDAPA 37.03.09 Construction Standards	Chapter 18.104 RCW Water Well Construction (2006)	Administrative Rule chapter 690, Division 240
Permitting	**LOCAL**	State	State	State	State	Permit not required; reports required.
Type of GSHP	Open & Closed Loop	Open & Closed Loop	Closed Loop	Closed Loop	Open & Closed Loop	Open & Closed Loop
Advisory Board with Industry Reps	**NONE**	Well Drillers Board	Well Drillers Examining and Advisory Board	Drillers Advisory Committee	Technical Advisory Group	Ground Water Advisory Committee
Driller Licensing	C-57 **4 Year** Apprenticeship	License 2 Year Apprenticeship	License 3 Year Apprenticeship	License 2.5 Year Apprenticeship	License 2 Year Apprenticeship	License 1 Year Apprenticeship
Well Log Data	**Up to Local Jurisdiction, not public**	Yes, web-based, not yet public	Yes, web-based & public	Yes, web-based & public	Yes, web-based & public	Yes, web-based & public
Fees	**Local Fees Vary**	Standardized Fee Schedule	Standardized Fee Schedule	Standardized Fee Schedule	Standardized Fee Schedule	Standardized Fee Schedule

Sixty-nine percent of California green consumers surveyed, representing those who within the next three years most likely anticipate doing a major home remodel similar to what Energy Upgrade California now calls an advance upgrade, have simply never heard of heat pumps. When provided some summary information, consumer interest spikes from three to twenty times across fourteen different attributes.

In its 2008 *Long Term Energy Efficiency Strategic Plan*, the California Public Utility Commission identified Heating, Ventilation, and Air Conditioning as a leading opportunity to improve energy efficiency and reduce peak power demand. As one of the most efficient heating and cooling technologies currently available, ground source heat pump technology can play a key role in meeting these goals.

Project Negatherm makes the following recommendations to promote ground source heat pumps to enhance California's energy efficiency capacity of buildings, reduce fossil fuel demand, contribute to greenhouse gas reduction goals, and build a sustainable statewide green collar workforce:

- Recognize ground source heat pumps publically as a key energy efficiency technology for California, by retrofitting the Governor's Mansion and/or the State Capital Building.
- Designate a statewide leader and champion for ground source heat pump technology.
- Consider formally closed-loop bores as something separate from water wells.
- Move jurisdiction for closed loop bores from the Department of Water Resources to the Energy Commission.
- Centralize state-level permit administration within the Energy Commission; other states have centralized state-level permit authorizations and benefited the market through doing so.
- Centralize and standardize permitting and fees for ground source heat pump boreholes at the state level.
- Create an educational ground source heat pump web portal in order to inform and build consumer confidence and create a central repository of related information.
- Direct the Contractor State License Board to carve out a closed-loop driller sub-classification from the C-57 water well drilling classification in the similar manner that the C-46 solar installer classification grew out of the electrician classification.
- Educate local permitting authorities about ground source heat pump work.
- Make well completion information accessible in a central database, as other states do currently.
- Direct the California Public Utilities Commission to devise a specific rate schedule to account for ground source heat pump's constant low-level usage of electricity.
- Give ground source heat pumps the same California Charter provision property as solar that sets aside heat pump installations from property tax assessment.
- Integrate ground source heat pumps formally within CaliforniaFIRST energy efficiency loading order as an approved and recognized technology. CaliforniaFIRST is a statewide joint powers authority sponsored by the California State Association of Counties and the League of California Cities with the mission to help local governments access low-cost financing for projects that provide a tangible public benefit, contribute to social and economic growth, and improve the overall quality of life in local communities.
- Encourage utility-based loop lease solutions and on-bill payment structures.
- Include measurable and verifiable energy efficiency (negawatts and negatherms) within portfolio standards and carbon markets.
- Enable ground source heat pump technology to count towards Renewable Electricity Standards.

- Enable utilities to aggregate greenhouse gas savings from ground source heat pump technology and be authorized to trade them on the secondary market.
- Streamline Title 24 and CalGreen accounting of the efficiency benefits of ground source heat pump technology and fund a software project to convert heat pump data to Title 24.
- Create split incentives between owners and renters in order to reach an as-of-yet inaccessible segment of the ground source heat pump market.
- Propose no sales tax on ground source heat pump equipment.
- Better support drillers transitioning away from stationary diesel equipment.
- Add green collar jobs by growing California's ground source heat pump jobs training (drillers, contractors, manufacturers).
- Develop coordinating capacities (drilling, bulk purchasing) within the industry in order to combat the lack of aggregation and capture economies of scale.

By removing barriers to borehole drilling, the ground source heat pump market in California would expand. The economic benefits are likely to include developing jobs in borehole drilling and other aspects of GSHP installation, increased sales of equipment and supplies to support these installations, and conservation of energy dollars which are now flowing out of the state. A domestic clean industry can be significantly expanded by facilitating ground source heat pump use in California.

Environmental benefits would include reduction of greenhouse gases from use of geothermal heat rather than heat created by burning fossil fuels. Other types of pollution generated from fossil-fueled power, such as water contamination and hazardous waste, could also be significantly reduced. Noise pollution in local areas could be reduced where steam boiler or gas turbines are used less. Reductions in air pollution would contribute to attaining state greenhouse gas reduction goals.

Note: All tables, figures, and photos in this report were produced by the authors, unless otherwise noted.

CHAPTER 1: Literature Review

Summary

The reports outlined in this literature review represent a timeframe of approximately fifteen years, spanning 1993 (U.S. EPA report) to 2008 (Hughes). The U.S. EPA report was a seminal report for the ground source heat pump (GSHP) industry in that it was one of the first documents to compare GSHP technology to existing space conditioning technologies on the market. The findings were striking: the U.S. EPA found that GSHP enjoyed high satisfaction rates, saved consumers hundreds of dollars annually despite higher first cost factors, and GSHPs had the lowest CO_2 emissions of all of the technologies analyzed.

As of 2006, after two moderately successful federal programs aimed at increasing GSHP market penetration (the National Earth Comfort Program and the Federal Energy Management Program's GHP technology-specific program), GSHP saw annual sales of approximately 80,000 units (46% vertical closed loops, 30% horizontal closed loops, 15% open loops). The GSHP market has grown, although GSHPs have not yet had the transformative effect on the space conditioning market that the U.S. EPA report envisioned in 1993.

- Most of the existing literature on GSHP provides overview information such as: types of GSHP systems available, estimated costs and payback times of GSHP systems and barriers to widespread market diffusion. There is consensus within the literature that GSHP is a proven technology and that key barriers include:
- High upfront costs
- Drilling, when it is sited in these reports, is most often described as a contributing component of the high upfront cost.
- Lack of consumer knowledge or confidence in GSHP systems
- Lack of policymaker knowledge of GSHP
- Lack of installer infrastructure and capacity/expertise
- There is a shortage of tradesperson and installers, including a limited supply of drillers.
- Lack of new technologies to improve GSHP system cost and performance (Hughes, Moonis)
- Local regulations (Moonis)
- The literature contains common suggestions to remediate these problems, which include:
- Cost/Benefit analysis of GSHP (Hughes)
- Federal emphasis and leadership (Hughes)

- Need for data collection/databasing (U.S. EPA, Long)
- Sales
- Soil thermal properties
- Universal access to GHP design and installation infrastructure (Hughes)
- Include GSHP in Renewable Portfolio Standards (Hughes)
- Reducing first cost through incentives/rebates/subsidies (U.S. EPA, Hughes, Halozan)

Despite the fact that drilling is integral to GSHP technology, there is little available literature that examines this topic in depth. In more recent reports, increasing emphasis is placed on the potential of GSHP technology to reduce greenhouse gas emissions. While there are several clear and apparent obstacles to widespread market adoption of GSHP, authors like Hughes display an increasing optimism about the potential GSHP can play in the space conditioning industry.

CHAPTER 2:
Advisory Board Action Plan

Summary

The purpose of the Project Negatherm Advisory Board (PNAB) is to provide input and make recommendations that will help guide the overall approach and direction of *Project Negatherm*. The Advisory Board's main functions are:

- To provide a forum for the collection and expression of opinions and recommendations on matters relating to the Ground Source Heat Pump (GSHP) industry.
- To review and comment on *Project Negatherm* task work and project deliverables that have been completed to date.
- To make recommendations on topics of interest or further inquiry for *Project Negatherm.*

Board Members

Action Plan

Board members will participate in a one-on-one discussion of project deliverables with *Project Negatherm* researchers and will provide input, either written or verbal, on the progress of the *Project Negatherm* report. *Project Negatherm* researchers will keep a written record of PNAB meetings and will use the findings to inform the report (Task 2.6).

Board Makeup

Six individuals have been identified for PNAB (more detailed biographical information can be found in the following section):

- John Geyer, Electric-Industry Marketing Consultant
- Augie Guardino, President, Guardino Well Drilling, Inc
- Liz Battocletti, Senior Associate, Bob Lawrence and Associates
- Daniel Bernstein, President, Gaia Geothermal
- Patrina Mack, Managing Partner, Vision & Execution
- Paul Bony, Director of Residential Market Development, ClimateMaster

While the majority of the board members have considerable experience in the GSHP and/or Heating, Ventilating, and Air Conditioning (HVAC) industry, board members from a variety of backgrounds have been selected in order to capture multiple perspectives on the GSHP/HVAC industry. This is intended to maximize the positive impact *Project Negatherm* can have within the industry, including both stakeholders and consumers.

Schedule

Board members received an online information packet consisting of completed and near-completed deliverables, responded to a meeting schedule matrix and participated in web meetings over a two-day period beginning March 17th, 2010.

Biographical Information

John Geyer

John Geyer is an electric-industry marketing consultant, based in Vancouver, Washington. Involved with renewable and efficient energy technologies since the oil embargo of 1973, John has been closely tied to U.S. utility industry changes since 1987 (i.e. deregulation and wholesale marketing). After 13 years of renewable energy work for U.S.D.A., Forest Service and nine years leading geothermal and wind programs for U.S. Department of Energy's Bonneville Power Administration, he has spent 20 years as an independent consultant. In the latter role, Mr. Geyer has been a West-wide leader in geothermal heat pump market development since 1992. His work since 1998 has focused exclusively on geothermal heating and cooling.

Mr. Geyer is founder and principal of John Geyer & Associates, Sound Geothermal and Northwest Geothermal corporations and co-designer of the Western Regional Training Center in Davis, CA. He is a Certified Geothermal Designer and national trainer for the International Ground Source Heat Pump Association. Mr. Geyer has served as factory representative for HDPE geothermal products from Chevron-Phillips Chemical Company's Performance Pipe, Wesflex Pipe Manufacturing, Superlon Pipe Manufacturing and as territory sales manager for other geothermal products and services. While not aligned with any single heat pump manufacturer, he provides turnkey soil conductivity testing, training and design support to architects and engineers.

John Geyer was a member of the Geothermal Direct Use Network (DUN, CEC MFS 06-01) Strategic Group in 2007.

Augie Guardino

Augie Guardino is President of Guardino Well Drilling, Inc., overseeing contracts, purchasing, accounts receivable, project completions and all pumping system and service work.

Guardino Drilling operate a modern fleet of equipment which includes late model large and medium size air-rotary, mud-rotary, casing hammer and combination drilling equipment, large and small shale shakers with new Geo Loop geothermal grouting and looping machinery and limited access equipment.

Historically, Guardino Well Drilling has primarily focused its drilling to domestic, agricultural and monitoring wells throughout the Bay Area and California - over the past twelve consecutive years they have drilled over 70% of the water wells in Santa Clara County. They have experience working with local governing agencies on site-sensitive properties where accessibility, drill spoils and fluids containment is as important as the drilling itself.

Guardino Well Drilling has completed ground source heat pump drilling projects for direct exchange, radiant and forced air applications in the Bay Area and Northern and Central Coast of California, and also drills and finishes "test wells" for thermal conductivity testing.

Mr. Guardino is a Past President (2007 - 2008) of the California Groundwater Association (CGA) and is currently on the Board of Directors of the National Ground Water Association. He has a Bachelor of Arts degree in Geography and Planning from California State University, Chico (1996) and received IGSHPA certification while attending the training at the IGSHPA facilities on the campus of Oklahoma State University in Stillwater, Oklahoma

Liz Battocletti

Elizabeth (Liz) Battocletti is a senior associate with Bob Lawrence and Associates of Alexandria, Virginia. Ms. Battocletti has over 12 years of experience in the research and analysis of geothermal applications including power generation, direct use, and heat pumps. She specializes in resource assessment, marketing, small business and project development, and project financing for geothermal technology, small businesses, and various projects. In addition, she assists clients in identifying and applying for federal grants and loans, most recently under economic stimulus legislation. Ms. Battocletti was principle investigator of the Geothermal Direct Use Network (DUN, CEC MFS 06-01) Strategic Group project in 2007.

From 2003 to the present, Ms. Battocletti created and maintained the popular Geothermal-biz.com website. She has authored many publications including the Geothermal-biz.com and “Green Green;” electronic newsletters summaries of Geothermal’s economic, environmental, and social benefits for several states; “An Introduction to Geothermal Permitting;” the Geothermal Small Business Workbook; the Geothermal Money Book; two editions of the Geothermal Financing Workbook; as well as numerous other reports.

Prior to joining BL&A, Ms. Battocletti worked for The Citizens Network for Foreign Affairs, Inc., for which she helped obtain close to $100 million in U.S. government foreign assistance contracts, enabling the company to grow from a staff of four with an annual budget of $250,000 to a staff of over 80 in nine offices around the world with an annual budget of over $10 million. She launched the Enterprise & Leadership Initiative, the Agribusiness Volunteer Program, and the Food Systems Restructuring Program, which provided technical assistance to farmers and agribusinesses in Russia and Ukraine.

Daniel Bernstein

Daniel Bernstein, president of Gaia Geothermal, has been working in the international geothermal HVAC industry since the late 1990s. He has trained designers throughout Asia, Europe, the Middle East and North America and has presented his C02 emissions reductions research results in a number of regional and national forums.

Based in Silicon Valley and East Asia, Gaia Geothermal has been developing advanced software tools for the industry since 1998. With a technical team of physicists and environmental scientists from UC Berkeley and Johns Hopkins University, Gaia strives to provide the global commercial and residential geothermal HVAC industry with the world's most accurate, advanced, flexible and user-friendly software tools.

Gaia Geothermal, LLC works with all members of the geothermal community- from multinational engineering firms and university engineering programs to residential designers and installers- to reduce our collective atmospheric carbon footprint.

Mr. Bernstein has a master's degree in international environmental policy from the Johns Hopkins School of Advanced International Studies and received his undergraduate degree from Pomona College while studying physics, chemistry and biology.

Patrina Mack

Patrina Mack, Managing Partner of Vision & Execution, consults with established and emerging technology companies in the U.S., Europe, Russia and Israel. Vision & Execution works with clients to optimize their product and business strategy to enhance customer adoption and market penetration. She has more than 20 years experience in business-to-consumer and business-to-business product, marketing and operational strategy and implementation. Her industry expertise spans the Internet, telecom, software, cleantech, financial services, and consumer products. Vision & Execution clients include Agilent, Cisco, Intuit, Macromedia, Nuance, Oblicore, Visa, Voxify and Wind River.

Ms. Mack serves as Western Regional Director for the Product Development and Management Association and as mentor to CA Cleantech Open and TechCoire. She is a certified New Product Development Professional through the PDMA. In addition to her consulting practice she leads workshops and teaches courses in the areas of Green NPD: Design for the Environment, NPD 2.0 and Developing Products Customers Want to Buy.

Prior to founding her consulting practice in 1999, Ms. Mack was responsible for the global launch of NetGravity's SaaS solution. NetGravity, one of Forbes' ASAP Dynamic 100 Companies, introduced the first ad serving software. At her previous company, AirTouch, she was responsible for identifying market opportunities for PCS wireless, international licenses and new services. Ms. Mack started her career consulting with Urban Wallace & Associates serving the consumer products and financial services industries.

Paul Bony

Paul Bony is the Director of Residential Market Development for ClimateMaster, which includes responsibility for technical installer and loop installation training, utility relations, and other GHP market development efforts. He became involved in the GHP industry in the late 1980's as a utility demand side program developer. Paul has extensive hands-on experience in the ground source heat pump installation business, having started and served as the Operating Manager of a utility owned GHP installation company. He also has expertise in the promotion and market development of GSHPs at the national, regional, and local level.

Paul has managed the development of several innovative GHP financing tools including loop leases, a second mortgage "Co-Z Energy Plan" and a ground breaking Geo loop utility tariff. Paul's energy efficiency and renewable energy market development efforts have earned the Association of Energy Services Professionals' "Achievement in Energy Services" Award, the US Environmental protection Agency's Excellence in ENERGY STAR Outreach award, and recognition from the Alliance to Save Energy.

Paul has served on the Electric Power Research Institute's Demand Side Management Advisory Committee, the Cooperative Research Network's Energy Efficiency and Demand Response Advisory Group, the Board of the California Utility Energy Forum, and the Colorado GeoPowering the West state wide working group.

He earned his M.B.A. from University of Nevada, Reno with Beta Gamma Sigma honors, and a B.S. with honors from Kansas State University's College of Agriculture. He also completed the NRECA Management Internship Program (MIP). He is also an IGSHPA certified GHP trainer.

CHAPTER 3:
Certification and Licensing Analysis

Summary

The *Licensing and Certification Analysis* examines California state and local regulations as they pertain to Ground Source Heat Pump (GSHP) systems[1]. The issue of well driller licensing is also explored. However, before delving into state regulations and certifications, it is essential to have a basic understanding of the GSHP system. A typical GSHP system has three main components[2]:

- The loop field – a series of pipes, typically constructed of high-density polyethylene (HDPE) that circulates a fluid between the ground source heat pump unit and the earth to transfer heat.
- The Ground Source Heat Pump unit – an electric heat pump that exchanges heat between the fluid in the earth loop and the air that conditions the home/building.
- The air delivery/distribution system – standard ducts that deliver conditioned air throughout a home or building.

Due to the nature of the technology, GSHP systems encounter a number of regulatory issues, including but not limited to: drilling, permissible fluids used in the GSHP loop field, and borehole sealing. This report focuses on the drilling required to install the first component of the GSHP system, the loop field. In California, these boreholes are called geothermal heat exchange wells (GHEW), however, for the purposes of this report they will be referred to as Ground Source Heat Pump Boreholes (GSHPB).

Construction of a GSHP loop field includes, in continuous order, drilling of the GSHPBs, placement of the loop to the bottom of the boreholes with the grout tremie, grouting of the boreholes from the bottom of the loop well to the surface, and finally, connecting the loop tube ends to the loop field assembly or to the heat exchanger[3].

The loop field can be constructed in either a "vertical" or "horizontal" configuration; horizontal loop fields are drilled at an average depth of 4 to 6 feet, while vertical loop fields require boreholes that have an average depth of 250 feet[4]. Due to their shallow depths, horizontal loop fields are often not required to go through the local permitting process. However, boreholes for GSHP systems (unless they are open loop systems as described below) must be grouted and

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[1] There are several different types of GSHP systems (horizontal, vertical, open-loop, and closed-loop) and the type and degree of drilling required can vary according to the type of installation.

[2] http://www.eia.doe.gov/cneaf/solar.renewables/page/ghpsurvey/ghpssurvey.html

[3] www.ngwa.org/ASSETS/.../Vertical_LoopsPosition_Paper2010.pdf

[4] http://www.climatemaster.com/index/comm_geothermal_index

sealed to facilitate heat transfer and prevent ground water contamination. Thus, despite the fact that GSHPBs are not drilled to extract water from the earth, in the state of California GSHPBs fall under the regulatory watch of water well standards.

Also of note is the distinction between "open" or "closed" loop GSHP systems. Closed loop systems continuously circulate a fluid between the heat pump and the loop field, without the loss of fluid. Open loop systems are designed to take advantage of local water sources by withdrawing water from a well or pond, passing it through a heat exchanger, and then returning the warmed/cooled water to an aquifer or well. Both open and closed loop systems are allowed at the state level, however many local jurisdictions in California prohibit open loop systems and as such they will not be a main focus of this study.

Statewide regulations pertaining to GSHPBs are under the purview of the Department of Water Resources (DWR). However, the permitting of GSHPBs in California is delegated to local jurisdictions. In 1999, the DWR drafted statewide GSHPB standards that established guidelines intended for local jurisdictions for drilling and sealing boreholes as well as the use of particular loop fluids in GSHP systems. However, these standards were never finalized nor widely distributed. As a result, local jurisdictions, if they are aware of the draft standards, can elect to use them in their permitting process or they can refer to pre-existing water well standards for guidance.

Other states such as Missouri and New Jersey have a more developed regulatory process for GSHPBs. Missouri implemented a Heat Pump Construction code in 1991 and New Jersey regulates both GSHPBs and heat pump installers. This report highlights the regulations in both Missouri and New Jersey with an eye to key lessons that can be drawn out of their experiences.

As it stands today, the regulatory landscape for GSHP technology in California presents considerable obstacles for industry growth. The inconsistent permitting process and fee schedules across local jurisdictions can make or break project economics. Furthermore, the current licensing requirements for GSHP drillers may mean that drillers cannot keep up with increasing demand for their services. These hurdles can be overcome by concerted effort and leadership at the state level. Re-examining regulations and licensing requirements will resolve the uncertainties that characterize the system today.

Regulatory History of GSHPB in California

In response to rising energy costs, the California Energy Commission (CEC) began to explore GSHP technology in the early 1990s. At the time, not much was known about the application of GSHP technology within California. The CEC convened a number of meetings with several organizations including the International Ground Source Heat Pump Association (IGSHPA), HVAC industry participants, and the Electric Power Research Institute (EPRI) to further investigate the technology[5].

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[5] At this time, utilities were not yet deregulated and there was increasing interest in GSHPs on their behalf as a demand side management solution. In fact, both the Sacramento Municipal Utility District (SMUD) and Southern California Edison had programs to subsidize GSHP systems.

As a result, an interagency task force consisting of the EPArtment of Water Resources (DWR), the California Energy Commission, the State Water Resources Control Board (SWRCB), the Contractors' State License Board, and others formed to examine issues such as: who was qualified to drill the boreholes needed for GSHP systems, the level of expertise required for GSHP projects, knowledge of groundwater resources, installation requirements, and well construction standards[6]. Ultimately, the task force initiated legislation to protect groundwater sources from contamination during the drilling process for GSHP systems.

Assembly Bill (AB) 2334

The resulting legislation was AB 2334, authored by Dom Cortese, Chair of CA Assembly Water, Parks & Wildlife Committee. The bill was introduced on February 15, 1996, and was supported by the CGA, CEC and California Environmental Health Association (CEHA). The bill passed without a single no vote and was signed into law on September 15, 1996 by then Governor Pete Wilson.

Key elements of AB 2334 are outlined below[7]:

- Defines "geothermal heat exchange well" as any uncased artificial excavation that uses the heat exchange capacity of the earth for heating and cooling, in which excavation the ambient ground temperature is 30 degrees Celsius (86 degrees Fahrenheit) or less, and which excavation uses a closed loop fluid system to prevent the discharge or escape of its fluid into surrounding aquifers or other geologic formations.
- Requires that drillers have a C-57 Water Well Contractor’s License for geothermal heat exchange well projects.
- Requires anyone drilling, altering, abandoning, or destroying a geothermal heat exchange well to report specified information to DWR within 60 days of completion.
- Requires DWR to develop recommended standards for the construction, maintenance, abandonment or destruction of geothermal heat exchange wells and by July 1, 1997 to submit the recommended standards to the SWRCB.
- Authorizes a local agency with authority over geothermal heat exchange wells to adopt temporary regulations applicable to geothermal heat exchange wells that the local agency determines to be consistent with the intent of existing DWR standards.
- Requires the SWRCB, by January 1, 1998, to adopt a model geothermal heat exchange well ordinance to implement DWR's recommended standards. Requires the SWRCB to circulate the model ordinance to all cities and counties.
- Requires each county, city, or water agency where appropriate, by April 1, 1998, to adopt a geothermal heat exchange well ordinance that meets or exceeds the recommended standards developed by DWR. If an appropriate local agency fails to

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[6] Mike Mortensson CGA slides, July 8, 2009

[7] Baker, Anne. AB 2334 Bill Analysis, <http://info.sen.ca.gov/pub/95-96/bill/asm/ab_2301-2350/ab_2334_cfa_960416_180711_asm_comm.html>

adopt such an ordinance, the model ordinance adopted by the SWRCB shall take effect on May 1, 1998, and shall be enforced by the county or city.

After AB 2334 passed, the Interagency Task Force (DWR, CEC, SWRCB, CGA and representatives from the GSHP industry) met to develop standards for GSHPBs. The draft standards, Bulletin 74-99, were completed in April 1999 and were to be included in a revision of Bulletin 74-81/74-90. However, these standards were not adopted as final nor were they sent to the SWRCB[8].

State of California Regulations

Today, regulation of the boreholes for GSHP systems falls under the larger rubric of water well standards. The state agency responsible for providing guidance on water well and borehole drilling is the California EPArtment of Water Resources (DWR). DWR drafted California's original water well standards in 1968, and these standards have been updated periodically through a series of "bulletins." The full California Water Well Standards are currently not contained within one document, but updates to the original standards can be found in the following three DWR documents:

- Bulletin 74-99 – April 1999. Draft standards for geothermal heat exchange wells.
- Bulletin 74-90 – June 1991. Supplement to Bulletin 74-81.
- Bulletin 74-81 – December 1981. Update to 1968 water well standards.

A review of the different types of wells covered by the California Water Well Standards (definitions can be found at the end of this section) reveals that GSHPBs do not fall neatly into any of the categories. In fact, Bulletin 74-99 contains the first mention of geothermal heat exchange wells and the following table provides an outline of many, though not all, guidelines contained in Bulletin 74-99.

Table 1: California EPArtment of Water Resources - Bulletin 74-99

Driller Qualifications	C-57 Water Well Contractor's license required, which requires 4 years of apprenticeship.
Reporting	Report of Completion must be submitted within 60 days of construction.
Location	Bulletin 74-90 specifies setback distances. Geothermal heat exchange wells that are sealed their entire length may be placed closer to contaminant or pollutant sources.
Exclusions/Exemptions	Allows for exemption due to unusual

[8] Conversation with Carl Hague, former DWR employee.

	circumstances. Shallow construction systems – the enforcing agency may prescribe additional regulations when the fluid is circulated in a loop in a shallow system.
Sealing the borehole	Full-length sealing is required to prevent surface contamination or to prevent contaminated water from one aquifer from mixing with waters of another aquifer. The enforcing agency may waive the requirement for full-length sealing in vertical borehole systems provided the agency prescribes alternative sealing methods that meet minimum standards.
Sealing materials	Approved: Bentonite Slurry, other grout as approved by Bulletin 74-90 or other grout considered a Best Available Technology and has been approved by industry organizations. Not approved: cement, drilling mud or cuttings.
Heat Pump Loop Materials	Approved: high density polyethylene pipe Not approved: PVC (polyvinyl chloride) pipe.
Loop Fluids	Low toxicity and biodegradable. Pure water should be used whenever possible. Acceptable freeze protection additives include propylene glycol and ethanol.
Fee Schedule	None (Locally administered)

Title 24 – California's Building Efficiency Standards

While Title 24, California's building efficiency standards for residential and non-residential buildings, does not directly pertain to permitting GSHPBs, it deserves mention as it is an additional inhibitor to the deployment of GSHP technology. The Title 24 standards identify GSHP systems as an alternative HVAC system and provide minimum mandatory efficiencies for the technology. However, GSHP system designers have noted that the software used for Title 24 compliance gives short shrift to GSHP systems as the analysis techniques inaccurately evaluate the energy and peak power savings of GSHP systems[9]. Typically, compliance with Title 24 standards can be measured with one of several certified software programs[10]. However, in order for GSHP systems to qualify for the incentive funding that the technology deserves, it is

[9] Conversations with Lisa Meline (July 22, 2009) and Phil Henry (October 2, 2009).

[10] Certified programs include: EnergyPro, Micropas 7, Perform 2005, eQuest/D2Comply

necessary to use two pieces of software instead of just one. At issue aren't the standards themselves, but the lack of an adequate algorithm to evaluate the technology.

Title 24 standards are renewed every three years and a new set of standards (2008) was recently adopted and will take effect January 1, 2010.

Local Permitting Process

While the state currently provides water well standards and GSHPB guidelines, local jurisdictions are ultimately responsible for permitting GSHPBs in the state of California. Besides the 58 counties, the research identified 11 additional local jurisdictions[11] in California and the draft standards contained in Bulletin 74-99 exist as guidelines that these jurisdictions can elect to utilize in their permitting process. It is also not unusual for counties with particular geologic circumstances or contamination concerns to have local ordinances on top of DWR standards. However, due to the lack of coordinated policy at the state level, local jurisdictions are often unaware of the existing Bulletin 74-99 guidelines. As a result, even the terminology for GSHPBs is inconsistent. As the pie chart below illustrates, there is little consensus when it comes to naming the boreholes required for GSHP systems.

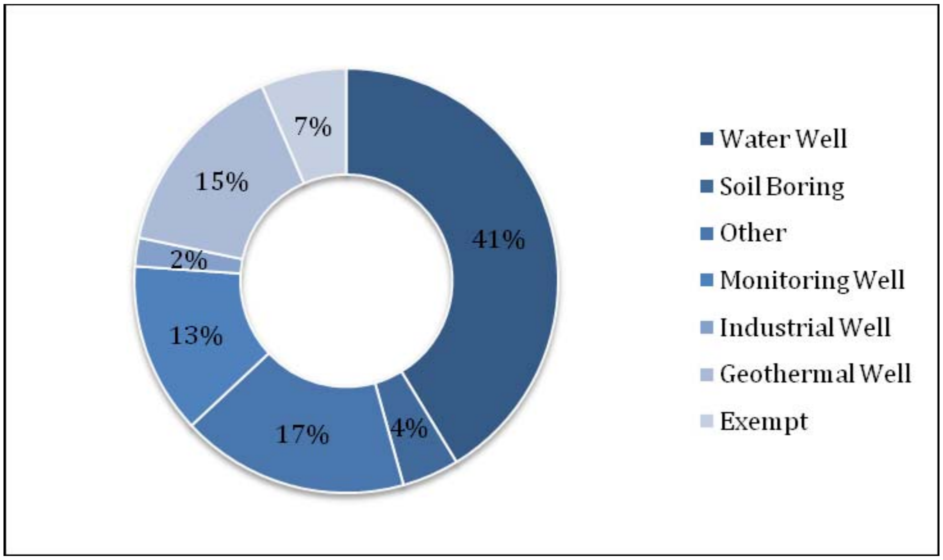
Local fee schedules for GSHPB permits are also highly inconsistent. Fees vary greatly, ranging from $0 to $4,100;[12] some local jurisdictions have no fee, while others implement a flat fee, and still others require a fee for every well drilled. To further complicate matters, different fee schedules may coexist within county lines. For example, Alameda County has three distinct jurisdictions with three distinct permitting fee schedules ranging from no fee to $520 per well. In addition, several local jurisdictions contacted did not yet have procedures or fee schedules for GSHPBs.[13]

[11] There are 58 counties in the state of California and 11 additional jurisdictions including: the City of Berkeley, Alameda County Water District (Fremont, Newark, Union City), Zone 7 Water Agency (Pleasanton, Dublin, Livermore, Sunol), City of Long Beach, City of Vernon, City of Pasadena, City of Anaheim, City of Fountain Valley, City of Buena Park, City of Orange, City of San Clemente.

[12] Pleasanton, Dublin, Livermore, Sunol, Mono County and the City of Orange have no permitting fees. Imperial County requires a $3,500 conditional use permit for all wells drilled in the county in addition to a $600 well permit.

[13] Kings County, City of Long Beach, City of Pasadena, Nevada County, San Benito County, Stanislaus County.

Figure 1: Borehole Classification by Local Jurisdiction

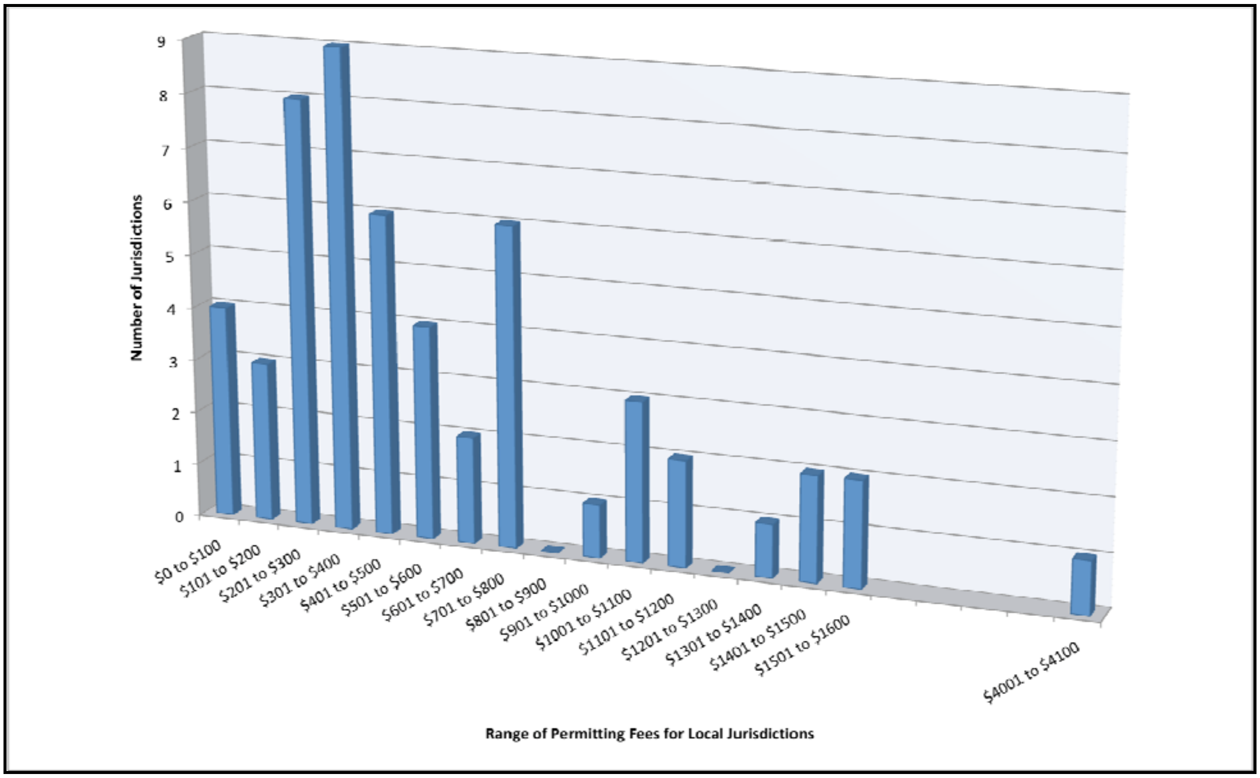


Forty-one percent of local permitting entities currently consider boreholes the same as water wells.

The chart below presents a distribution of the range of fees a typical three-ton, three borehole residential GSHP system might incur in different jurisdictions throughout the state of California.[14]

[14] 54 local jurisdictions throughout the state of California are represented in this histogram.

Figure 2: Local permitting fees for a 3-ton/3 borehole residential GSHP system



Local permit fees vary greatly by location.

In this scenario, permitting fees amount to over $500 in nearly half of the local jurisdictions represented[15]. A clear outlier is Imperial County, which requires a $3,500 conditional use permit for all drilling in the county, in addition to a $600 well permit.[16] Imperial County considers ground source heat pump boreholes in the same classification as water wells.

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[15] Permitting fees amount to over $500 in 23 out of 54 local jurisdictions represented.

[16] Conversation with Jim Minnick, Planning Division Manager, March 4, 2010.

Table 2: GSHPB Permit Fees for Residential GSHP by Region

Permit Fees	North[17]	South[18]
Under $100	8.8%	5.0%
$100 to $500	52.9%	40.0%
$500 to $1000	11.8%	45.0%
Over $1000	26.5%	10.0%

When fees for the hypothetical three-ton, three-borehole residential GSHP system are broken down by geographic location, region does not appear to be determining factor for fee schedules. The estimated median permit fee charged for the three ton, three-borehole system in Northern California is $405 while the median permit fee in Southern California is $574.

Most counties in California have little experience with GSHP systems and permit GSHPBs on an ad hoc basis. This has led to a considerable amount of variation in the permitting process. However, there are several counties that are actively involved with GSHP technology, including Plumas and Sonoma counties.

Plumas County has permitted hundreds of GSHPBs thanks to an ongoing GSHP program started by the Sierra-Plumas Rural Electric Cooperative (PSREC) in 1993[19]. To date, PSREC has installed over 2,500 tons of GSHP systems in its service area[20], 90-95% of which are within Plumas County. In addition, PSREC refers other counties in their service area to Plumas County when GSHP projects arise due to the county's depth of experience in permitting GSHPBs.

Sonoma County has identified GSHP systems as a means by which the county could reduce its natural gas usage[21] and is taking steps to facilitate the deployment of GSHP systems within its jurisdiction. To this end, county has included GSHP systems in its Sonoma County Energy Independence Program (SCEIP), categorizing it as a residential energy efficiency measure

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17 Includes the following jurisdictions: Zone 7 Water Agency, Alameda County Water District, City of Berkeley and Counties of Mono, Del Norte, Sierra, Modoc, Trinity, Solano, Yuba, Lassen, Shasta, Humboldt, Siskiyou, San Joaquin, Amador, Alameda, Lake, Sacramento, Sonoma, Mendocino, Marin, Plumas, El Dorado, Napa, Tehama, Alpine, San Francisco, Butte, Placer, Calaveras, Glenn, Tuolumne, Contra Costa.

18 Includes the following jurisdictions: Cities of Orange, Anaheim, San Clemente, Counties of Madera, Mariposa, Merced, Riverside, San Bernardino, Monterey, Fresno, Santa Barbara, Santa Cruz, Orange, Kern, Vernon, Ventura, Los Angeles, San Luis Obispo, Imperial.

19 Conversation with David Cline, Plumas County, October 13, 2009.

20 Plumas County accounts for 90-95% of all Sierra-Plumas Rural Electric Cooperative GSHP installations (email correspondence with Sharon Schwilling, August 20, 2009 and October 8, 2009).

21 Conversation with Tim Anderson, Sonoma County Water Agency, October 8, 2009.

eligible for SCEIP funding[22]. In addition, the Sonoma County Water Agency recently approached State Senator Wiggins to amend existing legislation, SB 730, to include a program called the *Sonoma Energy Efficiency Pilot Project Act of 2010.* The pilot project is designed to grant rebates for the installation of energy efficient heating and cooling systems, including GSHPs. SB 730 has passed the Senate and will be taken up by the State Assembly in early 2010.

According to the DWR, they have been receiving more inquiries into GSHPBs within the last year and the agency is in the process of trying to distribute Bulletin 74-99 to local jurisdictions for guidance purposes. While Bulletin 74-99, if widely distributed, may provide guidance and a common vocabulary for regulators, the fact remains that it is silent when it comes to the topic of permitting fees. As such, even if the DWR succeeds in informing local jurisdiction of Bulletin 74-99, without guidance on GSHPB fee schedules, permitting costs will remain a significant hurdle for GSHP projects in many jurisdictions.

Ideally, the DWR would like to update all of the standards for four types of wells and place them into one comprehensive document[23]. However, budgetary issues may preclude them from doing so in the near-term.

Regulations and Permitting in other states

For comparison purposes, it is helpful to look at the way other states have structured their regulations; the states chosen for this comparison are: Missouri, New Jersey, Idaho, Oregon and Washington. While Missouri shares little in common with California in demographic and geographic terms, it was chosen as a comparison state because it has a growing GSHP industry and a construction code specific to GSHPs. New Jersey was chosen as the second comparison state due to the similarities it shares with California, among them: high median household income, a high cost of living, and a high volume of well permit applications per year.

Idaho, Oregon and Washington were also surveyed to get a sense of how neighboring western states are regulating GSHPBs. Both Idaho and Washington have recently revised their standing water well regulations to include GSHPB-specific standards; Washington revised their water well construction standards in 2006, adopting language for "Ground Source Heat Pump Borings," and Idaho followed suite in 2009, adopting specific standards for "Closed Loop Heat Exchange Wells." Key components of each state's regulations, with emphasis on closed-loop GSHP systems, are outlined below.

[22] Sonoma County Energy Independence Program
<http://sonomacountyenergyaction.org/downloads/sceip_allowable_technologies.pdf>

[23] Interview with Eric Hong at the Department of Water Resources June 3, 2009.

Figure 3: California Regulation Compared to Five Other States

Key Distinctions	California	Missouri	New Jersey	Idaho	Washington	Oregon
Regulations	DWR **Draft** 74-99 (1999)	Heat Pump Construction Code (1996)	Water Well Standards (2001)	IDAPA 37.03.09 Construction Standards	Chapter 18.104 RCW Water Well Construction (2006)	Administrative Rule chapter 690, Division 240
Permitting	**LOCAL**	State	State	State	State	Permit not required; reports required.
Type of GSHP	Open & Closed Loop	Open & Closed Loop	Closed Loop	Closed Loop	Open & Closed Loop	Open & Closed Loop
Advisory Board with Industry Reps	**NONE**	Well Drillers Board	Well Drillers Examining and Advisory Board	Drillers Advisory Committee	Technical Advisory Group	Ground Water Advisory Committee
Driller Licensing	C-57 **4 Year** Apprenticeship	License 2 Year Apprenticeship	License 3 Year Apprenticeship	License 2.5 Year Apprenticeship	License 2 Year Apprenticeship	License 1 Year Apprenticeship
Well Log Data	**Up to Local Jurisdiction, not public**	Yes, web-based, not yet public	Yes, web-based & public	Yes, web-based & public	Yes, web-based & public	Yes, web-based & public
Fees	**Local Fees Vary**	Standardized Fee Schedule	Standardized Fee Schedule	Standardized Fee Schedule	Standardized Fee Schedule	Standardized Fee Schedule

Compared to other states, California does not have coherent GSHP regulation.

GSHP Industry Standards

The International Ground Source Heat Pump Association (IGSHPA), established in 1987 and located in Stillwater, Oklahoma, is the industry's most established trade association. IGSHPA was formed to advance ground source heat pump (GSHP) technology on local, state, national and international levels. To that end, IGSHPA has offered professional GSHP accreditations for over ten years and publishes GSHP design and installation manuals.

The National Ground Water Association (NGWA) and American Ground Water Trust (AGWA) are also actively involved in setting GSHP industry standards. Both associations have developed requirements for borehole drilling, grouting, and pipe fusing to ensure ground water protection. NGWA has recognized the need for sU.S. EPArate standards for geothermal drilling and recently unveiled its revised, "Guidelines for the Construction of Vertical Boreholes for Closed Loop Heat Pump Systems" in December 2009. The technical guidelines cover loop field design, test holes and samples, borehole construction, piping, borehole grouting, loop field identification, and permanent loop piping decommissioning. It also includes appendices on heat transfer fluids, tables of related interest, a glossary of technical terms, and organizations with related interest[24].

Driller Accreditation and Licensing

As previously mentioned, IGSHPA holds trainings and accreditations that are the current industry standard for the GSHP industry. IGSHPA recently started offering a training program specifically tailored to drillers, and participants who complete this program become "Accredited Vertical Loop Installers." Topics covered in the IGSHPA driller-training program include[25]:

- GSHP System Design and Layout Basics,
- System Materials
- Pressure Drop Calculations
- Thermal Conductivity
- Drilling Processes
- Containment Procedures
- Grouting Concepts
- Air and Debris Purging
- Pipe Joining Techniques
- Project Bidding
- Partnerships

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[24]http://www.goodcompanyassociates.com/files/manager/TFIC_GCA_Geothermal_Report_FEB2010_COMPLETE.pdf

[25] http://www.igshpa.okstate.edu/training/drillers.htm

According to IGSHPA's online Business Directory, approximately 35 California drillers are IGSHPA "Accredited Installers" and/or "Vertical Loop Installers".

Other organizations with training and certification programs for the GSHP industry include the Association of Energy Engineers (AEE), North American Technician Excellence, Inc. (NATE), the National Ground Water Association (NGWA), GSHP manufacturers, the U.S. Department of Energy via the ENERGY STAR program, and licensing/regulatory agencies in individual states[26].

In California, drillers must be C-57 licensed well drillers in order to drill GSHPBs. This certification requires applicants to complete a four-year apprenticeship and pass an examination offered by the Contractors State License Board; GSHP applications are not a topic covered in the current examination. Out of the states surveyed in this study, California's driller licensing requirements required the longest (4-year) apprenticeship.

Analysis

Ground Source Heat Pumps are a proven technology that has been in use for over 60 years; however, the market for these systems remains small compared to its potential. The industry has been beleaguered by limited and intermittent attention on behalf of regulators; current regulations are no more established than they were in 1999, when the first draft standards were developed for GSHPBs.

In California, the GSHPB regulatory process has proceeded haphazardly. In the early 1990s, GSHP technology was actively explored as a demand management solution in response to rising energy prices. AB 2334, passed in 1996, set the stage for GSHPB regulations, however to date, the law has only been partially carried out. While Bulletin 74-99 contains draft standards for GSHPBs, the general lack of state leadership in promulgating these standards has resulted in a dearth of regulator knowledge of the technology at the local level as well as a Byzantine permitting process in which procedures and fees can vary greatly.

Today, the industry is poised for a resurgence of interest, thanks in part to federal tax incentives in the American Recovery and Reinvestment Act of 2009 and increasingly green consumer sensibilities. However, despite California's status as a recognized leader in alternative energy, the regulatory landscape for GSHP technology presents the following obstacles for the industry's growth:

- Inconsistent permitting process and fees can adversely impact already challenging GSHP project economics.
- Current licensing requirements may adversely affect drillers' ability to meet the demand for their services in the future.

[26]http://www.goodcompanyassociates.com/files/manager/TFIC_GCA_Geothermal_Report_FEB2010_COMPLETE.pdf

The experiences of other states such as Missouri and New Jersey illustrate that regulations need not be an impediment to the GSHP industry. Rather, they can be a means by which the state can educate regulators and level the playing field for drillers and consumers alike. Furthermore, both Missouri and New Jersey have implemented a fixed-cost permitting system, normalizing a significant variable in GSHP project economics.

As they stand today, California's regulations cast a shadow of uncertainty about the permitting process and the technology itself, which can both deter consumers and drillers from the industry and lead to unpredictable project economics.

Recommendations

The following regulatory recommendations would greatly benefit adoption of ground source heat pumps in California:

- AB 2334 assigned responsibility for drafting and distributing Bulletin 74-99 to the DWR and the State Water Resources Board. However, Bulletin 74-99 1999 was not finalized nor widely distributed. A decade has passed and today there is renewed interest in GSHP technology. Thus, there is the need for a concerted, statewide effort to demystify the regulatory landscape and enable local jurisdictions to better review, permit and approve GHEWs. Due to its history with the technology, the CEC is well positioned to take the lead with GSHPs and move forward with the following action items:
- Determine if Bulletin 74-99 should be finalized and/or updated
- Review Title 24 standards to ensure that the benefits of GSHP systems are accurately accounted.
- Consider establishing fee schedules or guidelines for geothermal heat exchange wells/ground source heat pump boreholes
- Inform and educate counties about GSHPBs
- Resume dialogue with stakeholders (utilities, drillers, DWR, local jurisdictions)
- Create a web-based resource that would contain information for regulators, drillers and consumers.
- Consider revising C-57 licensing requirements or creating a sU.S. EPArate GSHP license.
- Conduct further research into California applications of GSHP technology (track performance data, create case studies).

CHAPTER 4:
Interview Methodology

Summary

Approximately 20 leading industry stakeholders, both within and outside the state of California, will be identified and interviewed in depth. Interviewees will be pre-selected, identified as being preeminent in their field, and will represent various constituencies of the ground source heat pump industry, including but not limited to: manufacturers, heads of drilling companies, leaders of professional associations, engineers, contractors, utility representatives and government regulators. Discussion topics will be distributed to interviewees prior to the actual interview and subsequent interviews will be open-ended and qualitative. These interviews will be conducted either in person or via phone, and will be informed by a discussion guide.

The goal for this segment of the survey is to elicit views from within the industry as well as gain insight from leading industry figures that have both a history and a vested future with GSHP technology. The specific topics of discussion are outlined in the "Topics" section below.

Survey Respondents

Survey populations:

- Leading GSHP industry stakeholders.

Sample Frame:

- Representatives of GSHP market sectors, including manufacturers, drillers, engineers, heads of professional associations, utilities and regulators.

Sample:

- Volunteer respondents in all cases.

Sample Size:

- Approximately 20 GSHP stakeholders will be interviewed.

Possible Survey Error:

- Respondents to the stakeholder interviews will be volunteer respondents whose responses will be used to approximate the views of industry leaders.

Topics

The following topics will be incorporated into the stakeholder interviews:

- Branding: The Ground Source Heat Pump Identity Crisis
- Industry leaders perspective on consumer decision-making
- Barriers to adoption of GSHP technology
- Regulatory, Awareness, Financial, Other

Stakeholder Interview Questions

Introductory Questions

- In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?
- What is your current responsibility and authority regarding GSHPs?
- How long have you worked in this, or a closely related field?

Industry Branding

- What terminology do you use to describe the industry/your product and why is that your preference?
- In your experience, do industry participants and consumers use the same terminology when referring to this industry?
- And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?
- What terminology do you think would be most appropriate for this industry and why?
- How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

Industry leaders' perspective on consumer decision-making

- Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?
- What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

- How have your customers become aware of GSHPs/learn of your product?
- What do you think the primary motivation was for consumers who purchased GSHP systems?
- Have you observed any similarities in consumer demographics?
- If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?
- What are some suggestions that you have to better inform consumers of this industry?

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

- For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?
- What barriers, if any, have you experienced due to lack of awareness of GSHP technology for residential applications?
- What barriers, if any, have you experienced due to lack of awareness of GSHP technology for commercial applications?
- For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?
- For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?
- Do you believe that GSHP systems are priced too high, too low, or just right?
- When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?
- When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?
- For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP? (If needed probe for: time, space, and permitting)
- How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

Drilling

- Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?
- Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers?" What changes need to be made in order to attract and retain more drillers to the GSHP industry?
- Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?
- How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?
- Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

Stakeholder Interviewees

The chart below lists the leading GSHP industry stakeholders identified as interviewees for this study.

Category	Contact	Title	Organization
Contracting/Engineering	Matt Ebejer	Vice President	Syska & Hennessy Group
Contracting/Engineering	Lisa Meline	Owner	Meline Designs
Contracting/Engineering	Greg Schillianskey	Owner	All Year Heating and Cooling
GSHP Consultant	Phil Henry	Founder	GeoExchange Solutions
Drilling	Ray List	CEO	Enlink
Drilling	Jim Piasecki	Regional Manager	CETCO Drilling Products
Drilling	Randy Dockery	Supervisor	Gregg Drilling
Education	Brian Hayden	President	Heatspring Energy
Government	Carl Hauge	Retired but still active	Department of Water Resources
Government	Dennis Terhove	Safety Codes Officer	City of Calgary
Government	Roy MacBrayer	Deputy State Architect	State of California
Manufacturer	Andy Fracica	Marketing Director	WaterFurnace
Manufacturer	Mike Thomas	Regional Manager	ClimateMaster
NGO	Jim Bose	President	International Ground Source Heat Pump Association (IGSHPA)
NGO	John Kelly	Chairman	Geothermal Heat Pump Consortium

Utility	KC Spivey and Brian Bailey	Customer Energy Efficiency Dept, Emerging Technologies and GSHP Summer Intern	PG&E - Emerging Technologies Dept
Utility	Dave Bisbee	Project Manager, Customer Advanced Technologies Program	SMUD
Utility	Sharon Schwilling	Ground Source Heat Pump Program Administrator	Sierra-Plumas Rural Electric Cooperative

CHAPTER 5: Stakeholder Interviews

Summary

Over a period of approximately six months (July 2009 – February 2010), a diverse set of Ground Source Heat Pump Industry stakeholders were individually interviewed for approximately 60 minutes. Open-ended, qualitative interviews were conducted via phone to investigate the following issues:

- Industry Branding: The Ground Source Heat Pump Identity Crisis
- Industry Leader's Perspective on Consumer Decision-making
- Barriers to the Adoption of Ground Source Heat Pump Technology (Regulatory, Awareness, Financial, Other).
- Drilling

The purpose for this segment of the survey is to elicit views from within the industry as well as gain insight from leading industry figures that have both a history and a vested future with GSHP technology. Transcripts were generated from notes taken during the interview process.

In order to capture a wide variety of input, stakeholders from eight distinct categories were interviewed: Contracting/Engineering, GSHP Consultant, Drilling, Education, Government, Manufacturer, Non-governmental organization/trade association, and Utility. A list of interview participants can be found in the previous section of this report.

It is important to note that the number of participants is a large sample size for qualitative research; however, qualitative research is, by its nature, not quantitative or predictive. As such, the results of this survey cannot be generalized and this survey report is intended only to represent the opinions and insights of the individuals who were included in the survey sample.

This stakeholder interviews report is structured in a question/response format; survey questions are presented and then followed by a summary of stakeholder responses. Where appropriate, graphs and tables highlight stakeholder interview trends; in addition, excerpts are used to illustrate the variety of stakeholder perspectives.

The following is a summary of the survey results, organized by each issue area:

Industry Branding: Stakeholders from all GSHP industry sectors agreed that the terminology in the GSHP industry is inconsistent. While a total of six terms were used interchangeably to refer to the GSHP industry throughout the stakeholder interviews, an analysis of stakeholder responses revealed three predominant terms ("Geothermal System/Geothermal Heat Pump," "Geoexchange," and "Ground Source Heat Pump"). Several stakeholders pointed out that this inconsistency could create problems for GSHP market adoption.

Industry Leaders' Perspective on Consumer Decision-Making: A majority of stakeholders (72%) believe that public awareness of GSHP technology is low. Reasons given for this low awareness range from: lack of education/outreach, lack of industry leadership, and a lack of contractors offering GSHP systems.

Stakeholders were then asked what the three most important messages to convey to the public would be in order to generate positive sentiment for GSHP technology. Responses were tabulated according to how often each idea was mentioned by stakeholders. The top three messages are: 1) Environmental Impact 2) Energy Savings/Efficiency, and 3) Value Proposition/Cost Savings.

A similar tabulation was performed for the question of how consumers become aware of GSHP technology. The most commonly mentioned means of awareness is "contractors/home shows" (6 mentions) followed closely by "online" and "word of mouth/referrals" (5 mentions respectively).

When it comes to the primary motivation for consumers who purchased GSHP technology, 68% of stakeholders mention cost savings; when asked about their observations of GSHP consumer demographics, the most commonly noted demographic is "affluent homeowners."

Stakeholders had a variety of perspectives on how to increase public awareness. However, several stakeholder suggestions revolved around increasing GSHP presence at home shows and tradeshows. The importance of tax incentives was also a recurring theme throughout this line of questioning.

Barriers to the Adoption of Ground Source Heat Pump Technology (Regulatory, Awareness, Financial, Other): When asked to identify regulatory barriers, stakeholders overwhelmingly pointed to the local permitting process. Stakeholders expressed frustration with both the inconsistency of the permitting process at the local level as well as the cost of permitting.

When asked about economic barriers that the consumer faces, 84% of respondents stated that high upfront costs are the largest economic impediment for consumers. Interestingly, two ways local utility districts have combated this high upfront cost include bulk purchasing (Truckee Donner Public Utility District) and a loop-lease financing program (Sierra Plumas Public Utility District).

Interviewees were asked to identify other issues besides cost that factor into a consumers' decision to adopt GSHP technology. A variety of issues were listed but the issue with the most responses was "space/siting."

Finally, stakeholders across all industry sectors were in agreement that the size of the GSHP industry in California is small but growing and that the potential for future growth is good.

Drilling: Drilling was cited as the single largest cost component of GSHP systems in 13 of 19 interviews. In addition, 9 of 19 stakeholders agreed that GSHP industry currently faces a shortage of drillers.

When asked to characterize the permitting process for the drilling required for GSHP systems, stakeholders used adjectives such as, "Byzantine," "fractured," and "immature."

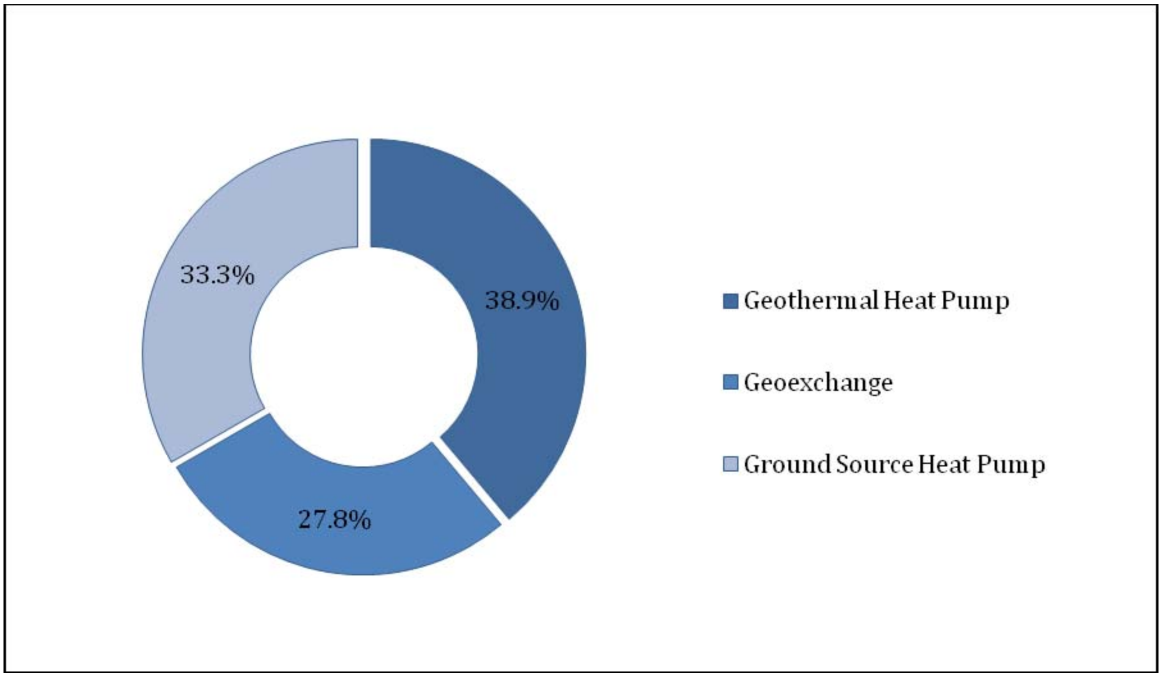
Industry Branding: The Ground Source Heat Pump Identity Crisis

The first series of questions in the *Stakeholder Discussion Guide* was designed to explore the issue of industry branding[27].

Question: What terminology do you use to describe the industry/your product and why is that your preference?

Response: In total, stakeholders listed approximately six different terms that they use interchangeably to refer to the GSHP industry. After tabulating the frequency of stakeholder responses, there are three predominant terms in use: "Geothermal System/Geothermal Heat Pump," (38.9%), "Geoexchange" (33.3%), and "Ground Source Heat Pump" (27.8%). However, respondents are divided nearly equally in thirds amongst the three terms.

Figure 1: Technology Name



There is no clear consensus on technology name.

In order to see if any different patterns were present, these terminology responses were divided by industry sector (see table 2). This revealed some clear preferences in terms of the different industry sectors surveyed. For example, of the Contractor/Engineers surveyed, all referred to their industry as "Geothermal", while Government and Utility respondents generally referred to the industry/product as "Ground Source Heat Pump." It is important to remember that the sample sizes used to draw these comparisons are small. However, stakeholder respondents are all seasoned GSHP or HVAC professionals with many years of industry experience.

[27] The full set of questions can be found in the Stakeholder Interview Transcripts, Appendix D.

Table 2: Terminology Breakdown by Sector

Industry Sector	Terminology Used by Respondents
Contractor/Engineer	“Geothermal” (3/3)
Drillers	No clear consensus
Government	“Ground Source Heat Pump” (2/3)
Manufacturers	No clear consensus
NGO	No clear consensus
Utility	“Ground Source Heat Pump” (3/4)
Education	“Geothermal Heat Pump” (1/1)

Question: Within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

Response: The majority of respondents (79%) described the terminology used within the industry as *inconsistent*. The following selection of stakeholder excerpts highlights the various perspectives on the different terminologies used within the industry.

In the U.S. the term “ground source” had been used for a number of years, since the 1970s thanks to IGSHPA. The other term is “geothermal” – this is the term of preference at federal government level. “Geoexchange” was an attempt to resolve confusion of the other terms but we only succeeded at adding a third term into the mix. It would be good to have one term that everyone uses. We came to the conclusion that the real problem is the term “heat pump”. It is the hardest to explain to people, there is confusion among consumers as to what it actually does. **GSHP Industry Association**

To me, Ground Source Heat Pump (GSHP) is very descriptive but people in California may associate the term “heat pump” with less efficient, less cost effective technology. I have known some people to react against the term heat pump. **California State Government**

I’ve changed from “geothermal heat pumps” to “ground-coupled pumps”. One of the issues when you use “geothermal” is that it brings up hot rocks, steam, that kind of thing. It is confusing for lay people, they think you are talking about some exotic form of using deep earth steam or hot water…“Earth coupled” helps explains ground source vs. air source. **GSHP Manufacturer**

The industry has an identity problem. I prefer the term “geoexchange” – it’s what the systems do, they are basically heat exchangers. The term geothermal conjures up the wrong image (deep geothermal). **California Driller**

I normally call it geothermal but it depends on the audience. I also use the terms “ground source” and “ground coupled”. People seem to be leaning towards “ground coupled”, but this term leads to closed systems. In some areas of the country we do open systems so using the term "ground coupled" limits the discussion. **California Contractor**

We use "geothermal" mostly because when people are starting to search online for the technology that seems to be where the most information is. I prefer "geoexchange" because "geothermal" can get confused with geysers and "geoexchange" makes it easier to sU.S. EPArate. However, for the search engines you have to include "geothermal". **California HVAC Contractor**

Question: How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

Response: When it comes to standardizing GSHP industry technology, a majority of stakeholders (53% or 10/19 respondents) agreed that standardizing the industry's terminology is important. The following excerpts highlight the key reasons given for the importance of standard nomenclature:

It [the terminology] is not consistent and it is a problem for market adoption. **California State Government**

Most people are using different terminologies, and this is one of the biggest problems they have - there is no consistency the terms people are using. I see terminology as a big problem. **GSHP Manufacturer**

Very important… consumers are not confident that "ground source" means the same thing as "geothermal". **GSHP Industry Association**

Industry Leaders' Perspective on Consumer Decision-Making

In the second section of the Stakeholder Survey, respondents were asked to consider a variety of questions that deal with consumer decision-making. Key observations are noted below.

Question: Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Response: A clear majority, (72%) of respondents, has found public awareness of the Ground Source Heat Pump Industry to be low. Approximately 28% of interviewees found public awareness of GSHPs to be about where they would expect given the industry's maturity and *none* of the stakeholders would characterize public awareness of GSHPs as "high". The following selection of stakeholder excerpts highlights the various reasons interviewees cited for low public awareness of the GSHP industry:

There is a lack of good, readily available information that is presented in a way that is contextually relevant for people. **GSHP Educational Institute**

There is a lack of understanding of this technology. There is also a lack of leadership in the industry compared to the solar industry. **California Driller**

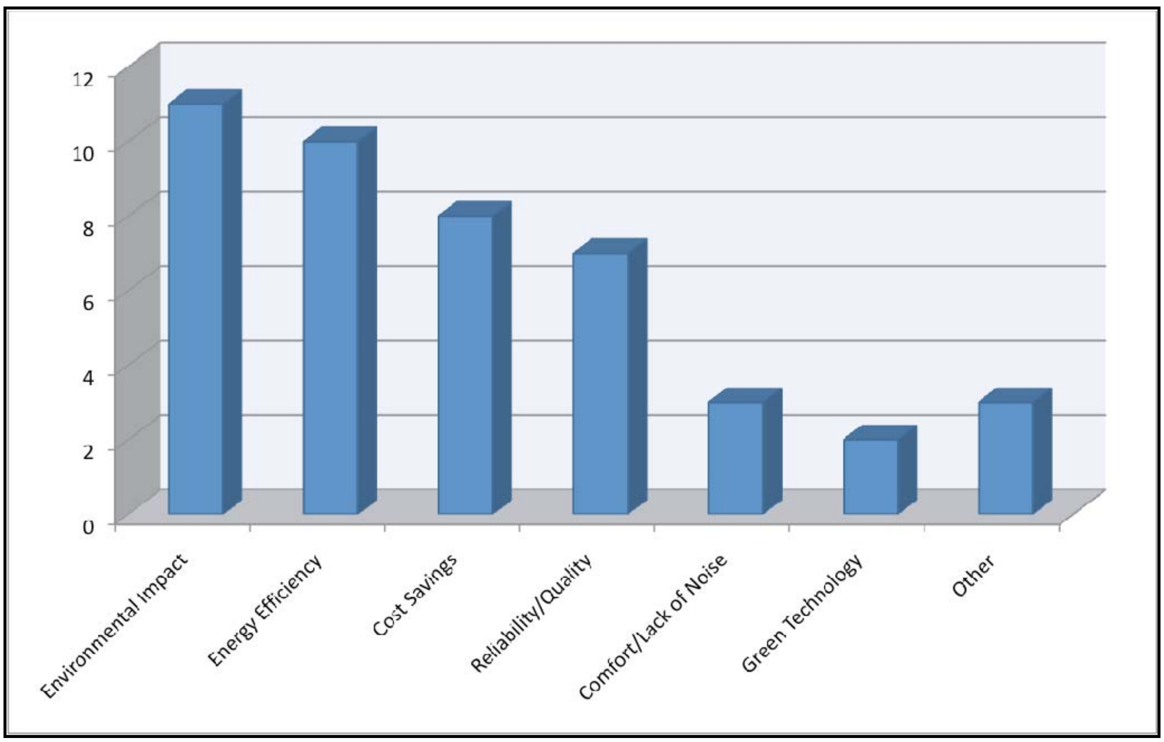
There are relatively few contractors that offer it. Contractors seem to be the number one way that technologies are communicated at the customer level. Usually when a call comes into me it's because a contractor has told them about it. **California Utility**

It has everything to do with a few key players in each community and whether they are marketing it or not. They have a high awareness in Truckee because I've done a lot to educate the community. What it comes down to are key players like utilities (electric) who put out the most effort to educate their customers. Manufacturers have made an effort, but they have a hard time getting into communities. **California Utility**

Question: What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

Response: The bar chart below illustrates the frequency of responses to this question. The top four responses are: 1) Environmental Impact 2) Energy Savings/Efficiency, 3) Value Proposition/Cost Savings and 4) Reliability/Quality.

Figure 2: The Most Important GSHP Attributes to Convey



Stakeholders ranked environmental impact, energy efficiency, cost savings and reliability as the most important selling factors.

Question: How have your customers become aware of GSHPs/learn of your product?

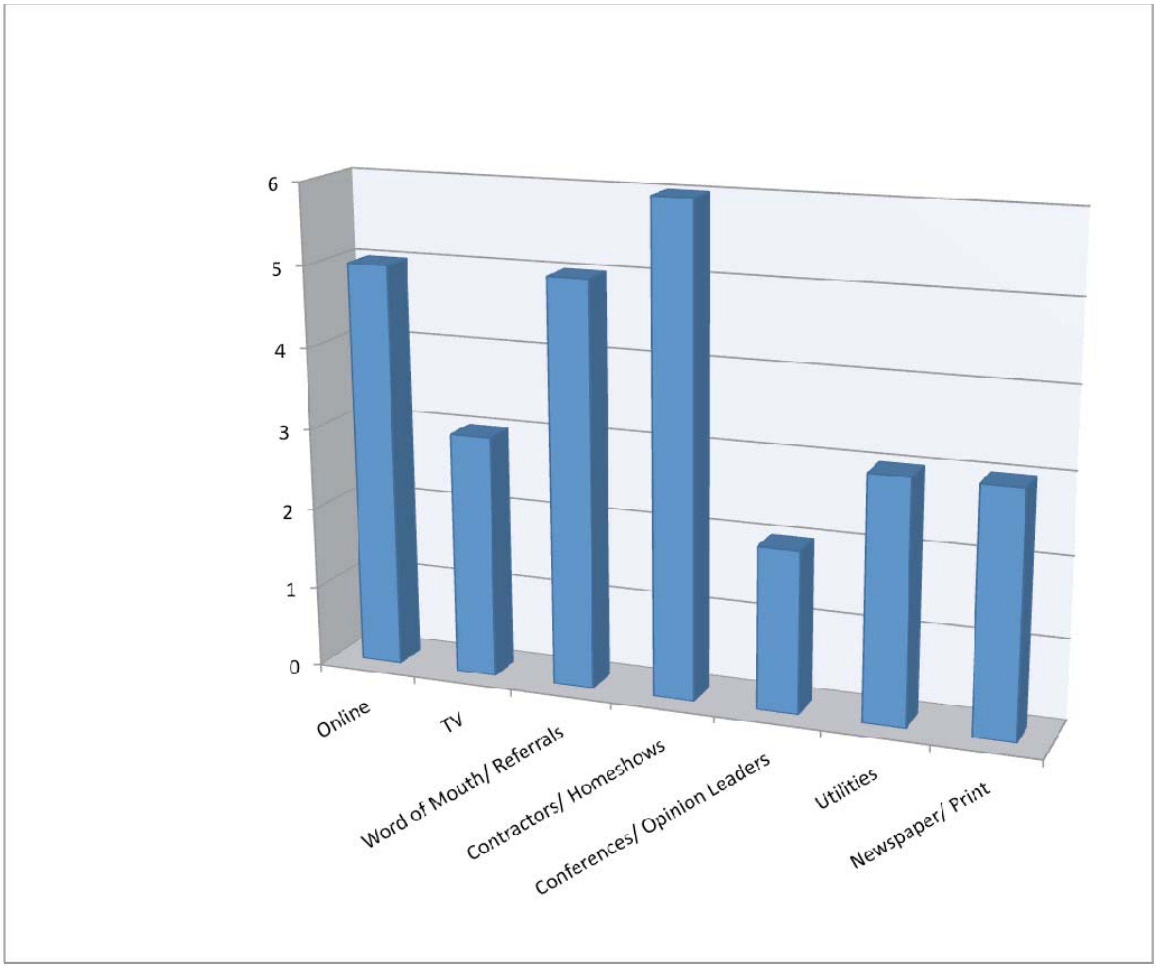
Response: As the bar chart below illustrates, customers appear to be learning about GSHPs from a variety of sources. "Contractors/home shows" were the number one cited means by which customers are learning about GSHPs but they were followed closely by "online" and "word of mouth/referrals."

Question: What do you think the primary motivation was for consumers who purchased GSHP systems?

Response: The following are the top cited motivations:

- Cost savings (mentioned 13 times)
- Environmental Impact (mentioned 7 times)
- Reliability (mentioned 2 times)
- Comfort (mentioned 2 times)

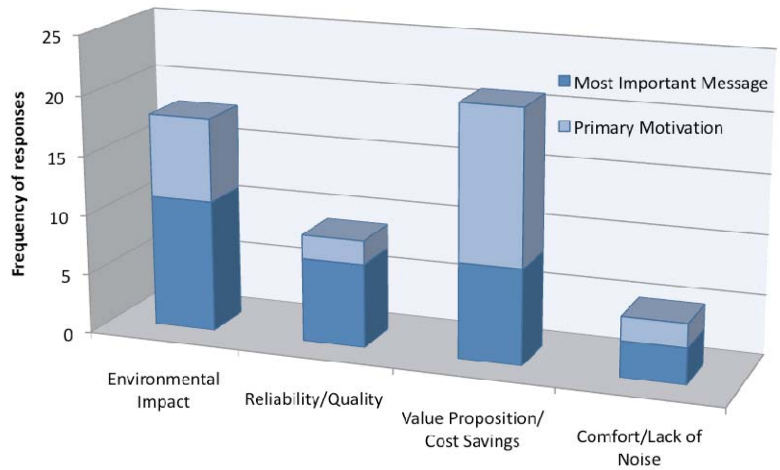
Figure 3: How Have Your Customers Become Aware of GSHPs?



Customers currently "pull" information about ground source heat pumps.

The graph below plots the two items above, (important messages vs. primary motivations) on the same bar chart. This reveals some insight into stakeholder perceptions of what the public messaging should be vs. what has encouraged customers to purchase GSHPs in the past.

Figure 4: Most Important Messages to Convey about GSHP Technology vs. Primary Motivation for Customers who Purchased GSHP Systems



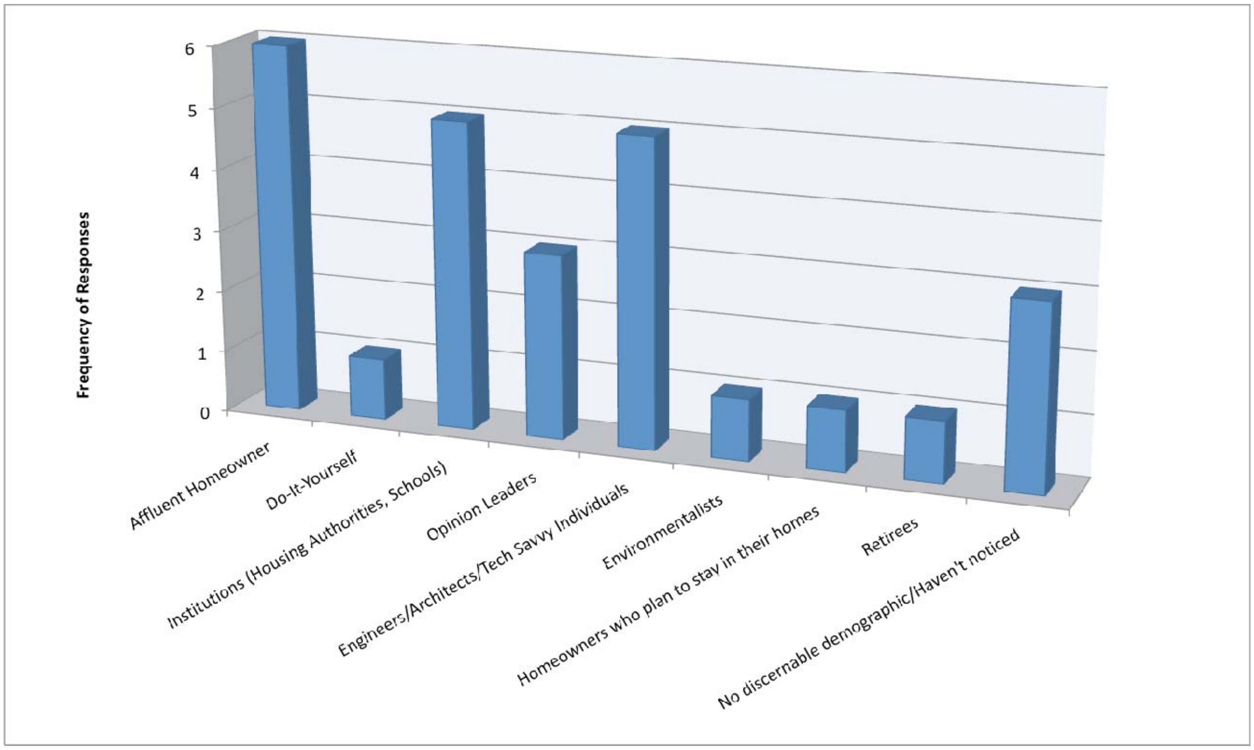
Customers focus primarily on cost savings and secondarily on environmental impact in the buying decisions.

Interestingly, while "Energy Savings/Efficiency" was one of the top messages stakeholders believed could generate positive public sentiment for GSHP technology; it was not directly noted as a common primary motivation for consumers who have actually purchased GSHP systems. It is, however, important to consider that Energy Savings/Efficiency does have some overlap with Value Proposition/Cost Savings, which was *the* most commonly noted primary motivation for consumers who purchased GSHPs.

Question: Have you observed any similarities in consumer demographics?

Response: The bar chart below illustrates the frequency of responses to this question. The categories listed below are not mutually exclusive, for example a consumer might be both an affluent homeowner and an environmentalist. However, these responses are intended to give some useful insight into some of the characteristics of the GSHP consumer. The top noted responses are "Affluent Homeowner," followed by "Institutions, Housing Authorities, Schools" and Engineers/Architects/Tech Savvy Individuals."

Figure 5: Perceived Consumer Demographics



Stakeholder demographic categories are not mutually exclusive in this case.

Question: If you were the head of an industry association, what would you do to increase public awareness of GSHP technology? What are some suggestions that you have to better inform consumers of this industry?

Response: Stakeholders had a variety of perspectives on these two questions. The following excerpts highlight some of the responses:

I would do everything I could to get geothermal heat pumps into the same place that solar is now. If GSHP became eligible for solar incentives – it would create artificial value because it would drop the initial capital cost immediately. It's all about value and economics. **California Driller**

The best way to get information out is via the contractors. These are the people who are getting the calls when there are problems with existing HVAC equipment and they are also the people/experts who are in people's homes. **GSHP Educational Institute**

Increase the organizational capacity of industry – manufactures have trouble tracking down dealers and it is difficult to track down people to talk to who know what they are talking about. Also, there hasn't been much of a push to advertise this technology to consumers in California. The industry needs to improve awareness and work with the manufactures and place ads in industry magazines. You could also get some of the big names like ClimateMaster and WaterFurnace to do collaborative advertising. **California Utility**

We need to push contractors to more specific advertising and trade shows and work with utilities to do more seminars that are green-related. People are looking to combine solar with ground coupled. We need to work harder with utilities and contractors to get them to do more promotion of the technology. **GSHP Manufacturer**

I would push the tax credit. Also, the more you can get into communities with seminars and workshops, and get involved with tradeshows, and home shows – the better. It's not an easy technology to understand so you need to get face to face with people. I was able to accomplish a lot through a community wide newspaper. **California Utility**

Adoption of Ground Source Heat Pump Technology

In the third section of the Stakeholder Survey, respondents were asked a series of questions about potential barriers that interfere with the market adoption of GSHP products and services.

Question: For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

Response: The most common barrier noted by stakeholders was the permitting process at the local level. There are a few notable exceptions: two representatives from rural electric cooperatives were interviewed for this survey and both reported GSHP friendly/workable local permitting processes.

I have encountered barriers in the following two areas: there is no consistency among the counties regarding permitting, they aren't sure how much to charge, or how to proceed. Secondly, influencing change at the state level –geothermal heat pumps are not treated fairly in Title 24 energy efficiency standards. **GSHP System Design/Engineering**

The cost of permits is the biggest barrier. Counties are used to dealing with small-scale projects and they are not geared for large numbers of wells. One geothermal project may have more wells than the entire county had the previous year. Counties have not quite figured out their fee schedules. **California Driller**

Utility incentives. When you look at what's going underground with GSHPs and the life of that, it looks like it ought to belong to a utility rather than a particular owner. It brings up the whole question of what role utilities should be playing in subsidizing or owning, or feed-in-rates with GSHP technology. **California Driller**

Uncertainty- people don't know what licenses/permits are necessary or if it is allowed where they live. A factor that amplifies this is the fact that there are hundreds of different rules that can apply. Each state has their own set of regulations and local jurisdictions may have different regulations as well. On the other hand, many jurisdictions do not have any regulations and/or do not understand the technology. There are a lot of jurisdictions that say they cannot do it. Regulators are trying to do their jobs and there is risk involved with new technologies. Significant uncertainty creates risk for both consumers and regulators. **GSHP Industry Association**

We don't have any barriers – we have a great county (Plumas) and 90% of our GSHP systems go in there. I've directed other counties in our service area to Plumas because they have been doing this for years. **California Utility**

Question: For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

Response: While there was no clear consensus from stakeholders on what key economic barriers may be for manufacturers, a few respondents did note that there is a general lack of contractors and market-share for GSHP technology. The following excerpt is from Mike Thomas, Regional Manager for ClimateMaster, the world's largest manufacturer of GSHPs:

Salesmen are paid on what they sell. It takes no effort to sell conventional HVAC, even in a downtime. Why waste 4-5 weeks to sell one unit (GSHP) where the salesperson has to handhold the contractor? It takes a lot of effort for a distributor salesman; he could sell 20 units a month of conventional HVAC equipment and only 20 GSHP units a year. To sell ground coupled units you have to know a lot of information. It takes a lot more effort to sell one unit. The Midwest might be different or easier, but in the West, this is one of the biggest barriers we have. **GSHP Manufacturer**

Question: For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Response: When it comes to economic barriers that consumers may face, stakeholders overwhelmingly (16/19 respondents) identified high upfront costs as the biggest economic barrier.

It's a high first cost technology and it is hard to get costs down, that is why we did volume sales in Truckee, to combat this. In 1997, we did a GSHP bulk purchase for 25 homeowners in Truckee Donner PUD service area and as a result we were able to get 50% of the normal pricing. During this time I also did a series of meetings with local homeowners to educate them about reducing costs. You have to get a lot of people interested. **California Utility**

High first cost and availability of financing from banks. Maybe there could be an Energy Commission bank that gave 2% loans for low carbon or "green" systems – and then listed the acceptable green systems. **California Contractor**

Question: **Do you believe that GSHP systems are priced too high, too low, or just right?**

Response: Six interviewees responded that they felt GSHP systems are priced just right, while (3) respondents replied that the market place determines the price.

Question: For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

- Response: This question elicited the following responses:
- Space/Siting (3 responses)

- Having sufficient heating and cooling loads (2 responses)
- Having the necessary installation infrastructure (2 responses)
- Lack of professionalism and/or standards
- The learning curve associated with GSHP technology
- People do not remain in their homes long enough to see a return on their investment
- Installing GSHPs can be a disruptive process
- Local regulations/permitting
- Availability of qualified contractors
- Confidence in the technology
- A lack of lenders who are educated about GSHP technology.

Question: How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

Response: When asked to characterize the size and growth of the GSHP industry, stakeholders across all industry sectors were in agreement that the size of the industry in California is small but growing and that the potential for future growth is good.

The industry's size in California is miniscule compared to what it could and should be. The economic situation has damaged growth; everyone has slowed down. In order to spur growth we need to get the value proposition right and get industry leadership. **California Driller**

There's a potential for a lot of growth. There are a lot of people wanting to do it but coming up with the upfront money/financing is very difficult in this economic environment. I don't see residential going up much even with 30% tax rebate. Commercial will be the big area of growth because they can get a grant instead of a tax credit. However, a lot of businesses are just as strapped as the consumer. **California Driller**

GSHP industry is still in its infancy. It's growing extremely fast, almost doubling every year in Canada. One of the biggest hindrances to growth is the stand-alone, "we're special" attitude the industry has had. The industry needs to form organizations so that they can share experiences, new trends and technologies. **Canadian Local Government**

In order to spur growth in the GSHP industry, stakeholders had the following suggestions:

The industry needs to form organizations so that they can share experiences, new trends and technologies. **Canadian Local Government**

We will need trained people to do good jobs and we need to avoid bad installations. Having the necessary infrastructure is the key. **GSHP Industry Association**

In order to spur growth we need to get the value proposition right and get industry leadership. **California Driller**

Utilities should take a major role in marketing. California Driller

Get the word out and start educating people. Solar and wind are natural to the public and ground source is not. They don't get it. We need advertising. **California Utility**

We need better awareness and more visible support from the utilities – people look to the utilities as litmus test. We also need think tanks like the Western Cooling Efficiency Center at UC Davis promoting this technology. **California State Government**

Drilling

Question: Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Response: 13 stakeholders agreed with this statement and 5 stakeholders disagreed. Stakeholders had the following suggestions to reduce the cost of drilling:

If you get enough work out there the drilling costs would come down to a reasonable level. You can get it down by economies of scale. **GSHP Industry Association**

There are different technologies that people are looking at to bring down the cost of drilling and new technology will be important. New pipes, new drills are possibilities. **GSHP Manufacturer**

Yes. It is very important to reduce drilling costs. In order to do so we need, education, improved comfort level with the technology on behalf of drillers, lower the cost of doing business, and improve regulatory issues. **GSHP Industry Consultant**

Question: Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers?" What changes need to be made in order to attract and retain more drillers to the GSHP industry?

Response: 9 stakeholders agreed with this statement and 5 stakeholders disagreed. Several interviewees pointed out that while there may be drillers available, there is still a lack of *qualified* drillers who have experience with GSHP systems.

Question: How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

The following excerpts are a sample of stakeholder responses:

I don't have a lot of experience getting permits. It can greatly impact the cost of the job and it can drive the design to some extent. **GSHP Educational Institute**

There are at least 40 different ways that the permitting process works and 40 different fee schedules. The only way to make this more uniform is to have the 40 counties get together and work something out. This is an issue that CGA is working with California Conference of Environmental Health. There is quite a difference on the fees charged by different counties. **California State Government**

The permitting process is very fragmented. It is different in every state, and local jurisdictions. If the industry (geothermal industry and drilling industry) could get together and agree on a campaign of what the model regulations for permitting and licensing should be and went to 50 states to educate regulators and got a consistent set of regulations established in all 50 states – that would be a big help. **GSHP Industry Association**

In northern California it is very restrictive. Every county has a different permit process – they throw up barriers, there's no consistency. They seem to want to restrict the application by having no consistency in permit process, no consistency on price (permit fee). **GSHP Manufacturer**

The permitting process is immature, local agencies do not know how to handle these projects. **California Driller**

I would describe it as Byzantine. Each county and/or municipality has a different process; it adds some time in getting projects started but I don't see getting that changed right now. **California Driller**

Counties are like little fiefdoms – no one has authority. In a place like Michigan, the state can override the counties but here that is not the case. **GSHP Designer/Engineering**

It's great in Truckee – permits are around $200. The process here is friendly and workable. **California Utility**

Question: Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

Response:

Drilling costs are a lot different here in California. We need to shift from PV and wind and realize that there's another thing out there that is more energy efficient. **GSHP Designer/Engineering**

You don't see geothermal so it's not sexy. **GSHP Manufacturer**

Growth is more than drilling the hole. We have to do a lot of training; we have a whole industry to educate. The key is to get organizations like Habitat for Humanity involved, associate the technology with things that really appeal to people and have high visibility. **GSHP Industry Association**

In California it is turf battle/turf war – each municipality wants to run its own serfdom. There has to be more consistency in permit process, as to what's required and what's not required. Drillers won't waste their time in places like this. There has to be consistency on drilling side permit process. There's interest but also so many barriers. **GSHP Manufacturer**

If the cost of drilling could be taken down to what it is in the Midwest then that could have big implications in California. **California Utility**

CHAPTER 6:
Advisory Group Comments

Summary

The purpose of the Advisory Board is to provide input and make recommendations that will help guide the overall approach and direction of Project Negatherm. The Advisory Board's main functions are:

To provide a forum for the collection and expression of opinions and recommendations on matters relating to the Ground Source Heat Pump (GSHP) industry.

To review and comment on Project Negatherm task work and project deliverables that have been completed to date.

To make recommendations on topics of interest or further inquiry for Project Negatherm.

In a manner pleasantly common throughout the industry, Advisory Board members were very generous with their time, attending sessions averaging two hours over a one-week period in March 2010 to provide their input on Project Negatherm project deliverables. Their comments and recommendations for Project Negatherm are listed in the following subsections of this report.

Members of the Advisory Board are listed below. They represent a cross-section of the national ground source heat pump industry and possess subject matter expertise across a variety of disciplines.

Project Negatherm Advisory Board Members

Name	Title	Organization	Industry Sector
Daniel Bernstein	President	Gaia Geothermal	GSHP Software Tools
Paul Bony	Director, Consumer Market Development	ClimateMaster	Manufacturer
Liz Battocletti	Senior Associate	Bob Lawrence & Associates	Consulting
John Geyer	Owner	John Geyer & Associates, Inc.	Contracting/Engineering
Augie Guardino	General Manager	Guardino Well Drilling, Inc.	Drilling
Patrina Mack	Principal	Vision & Execution	Consumer

In general, there was strong consensus on behalf of Advisory Board members on the need to build consumer awareness and industry confidence of GSHP systems and to further incentivize the efficiency benefits of the technology. There was also a firm acknowledgement and unanimous consent that GSHP permitting regulations need to be streamlined in California and across the nation in order to spur adoption. Key recommendations for streamlining regulations and incentivizing GSHP technology included:

- Creating a categorical exclusion via the California Environmental Quality Act (CEQA) to streamline regulations
- Enabling EE technologies, including GSHPs, to count towards California's Renewable Portfolio Standards (RPS)
- Instituting something akin to the California Solar Initiative for GSHPs
- Much greater utility involvement and support of GSHP technology

The Literature

The responses from the Advisory Board regarding the literature reviewed for Project Negatherm were uniformly positive. Several members mentioned being impressed with the depth and breadth of the materials covered. Recent USDA and Texas Foundation articles were added to the literature review at the suggestion of Paul Bony. John Geyer mentioned that the Geothermal Heat Pump Consortium compiled a comprehensive GSHP library between 1996 and 2001. Geyer also said that the consortium library is currently being stored in Pennsylvania and merging Project Negatherm library with the old consortium library would be advantageous.

Stakeholder Interviews

Due to their diverse backgrounds, Advisory Board members had various perspectives to contribute to the Stakeholder Interviews (Task 2.5). On the topic of adoption of ground source heat pump technology, developing consumer awareness, industry confidence and demand were recurring themes. John Geyer commented that building consumer confidence in GSHP technology was critical for greater market adoption and suggested this could be accomplished through stronger utility endorsement, which marketers would recognize as a "push." Liz Battocletti, on the other hand, noted that increased consumer demand is what is "pulling" many contractors she has talked to into the GSHP industry. Adding a driller's ground-level perspective, Augie Guardino stated that adopting GSHP technology for residential retrofits is challenging due to the near "perfect storm," required to complete a residential GSHP retrofit; a customer must have an AC/heater unit at or near replacement, be aware of GSHP technology and have sufficient space and budget for the GSHP system.

Licensing and Certification

All Advisory Board members concurred that the current regulatory and permitting structures in California for GSHPs are seriously flawed and need to be standardized. A few of the Advisory Board members (Augie Guardino and John Geyer) were actively involved in educating the California Department of Water Resources (DWR) during the early 1990s, when it was tasked with drafting the standards for geothermal wells. As such, members have first-hand knowledge of the haphazard way in which both statewide regulations and local permitting procedures have developed in California. Ultimately, the lack of state guidance has resulted in variations not only from county to county but in marked regional differences as well. For example, Augie Guardino has observed that because the Southern California region of DWR placed the draft standards, Bulletin 74-99, on their website, many local jurisdictions in Southern California have adopted these standards. This contrasts with Northern California, where Bulletin 74-99 was not widely publicized nor placed online. As a result, many counties in Northern California have been patching together their own procedures as GSHP projects arise in their jurisdiction.

At the ground level, counties are a big hurdle GSHP drilling businesses like Guardino Well Drilling. He explained that depending on the jurisdiction, it could take days to figure out which local dU.S. EPArtment is in charge of permitting GSHP projects. In addition, counties may often try to figure out the permitting rules for GSHPs as projects arise, requiring GSHP project managers to devote precious time to educating regulators and thus hindering project completion.

In order to streamline regulations, John Geyer suggested creating a "categorical exclusion" via the California Environmental Quality Act (CEQA). He also asserted "the regulations for GSHPs should be protective of existing sanitation and groundwater standards, not proscriptive of geothermal practices." John also mentioned that Idaho, Nevada and Washington are all examples of states that have been pro-active in streamlining regulations for ground source heat pump technology.

At the definitional level, Dan Bernstein, John Geyer and Liz Battocletti all underscored the importance of having regulators distinguish between boreholes and water wells. The distinction is an important aspect of educating regulators about (closed loop) GSHP boreholes, which are not open to the atmosphere and thus are not a threat to groundwater. In addition, re-classifying geothermal wells as boreholes could also have ramifications for permitting fee schedules.

Patrina Mack's consumer-side experience shopping for a GSHP system crystallizes the problematic nature of highly variable permitting fees and practices. She received a wide variety of information from contractors and building officials, but little of it was accurate or applicable. The one GSHP contractor she encountered who did not try to "bait and switch" her to another technology altogether quoted a "go fish"[28] price of $60,000 for a $1,300 square foot home.

As to the issue of licensing, Augie reported that there are not many drillers who have IGSHPA certification in California. One of the values of this certification is that you can be involved in the first line of conversation with the customer. He also stated that he doesn't foresee changes being made to the C-57 driller's license.

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[28] "Go fish" pricing has many names, but it is a speculative pricing gambit of setting an overly high price on what the contractor sees as a marginal project in the hope that the customer takes the bait.

Financing

Each Advisory Board member approached the issue of financing from their own unique perspective and offered suggestions on how to make GSHP technology more economically feasible. From the driller's angle, Augie Guardino explained that getting to the GSHP market is difficult because there are not enough people who are aware of GSHP technology. This could change, Augie suggested, by coordinating GSHP installs. Capturing this economy of scale would require a lot of work and coordination; however, if a GSHP install were coordinated in a new housing community, it would have a multiplicative effect on paybacks for drillers and make the technology more familiar to and affordable for consumers.

Many Advisory Board members pointed out that the tax provisions for GSHP systems included in the American Reinvestment and Recovery Act (ARRA) should have a positive impact on the industry. In addition, Dan Bernstein and Paul Bony both saw the advent of Property Assessed Clean Energy (PACE) financing as a potential boon for GSHP market dispersion. In particular, they pointed to CaliforniaFIRST financing and the $50 million Sonoma County allotted for its energy efficiency and renewable energy plan. Liz Battocletti also singled out Sonoma County as something of a thought leader when it comes to GSHP financing, as they have put together GSHP proposals using a PACE program.

Dan Bernstein and Paul Bony also pointed to a micro-loan financing program that the USDA Rural Electric Service runs as an example of an innovative financing solution. Under this program, the loop field expense is recouped through a tariff and a micro loan is utilized for the equipment inside of the home.

As a former utility economist, John Geyer asserted that the biggest problem for GSHP technology on the West Coast is the lack of utility endorsement and financing. He pointed out two notable exceptions within the realm of public utilities: Plumas-Sierra Rural Electric Cooperative and Truckee Donner Public Utility District. Plumas-Sierra has run a successful loop-lease program for over 15 years and Truckee Donner developed a bulk purchasing program to reduce up-front costs for customers. Yet, despite these examples, there's no utility leadership in California when it comes to GSHPs. John Geyer predicts that when utilities can rate base some portion of the geothermal system investment (most likely the ground loops), get credit for environmental benefits towards RPS targets, and aggregate greenhouse gas savings and trade them on the secondary market, GSHP technology will become much more commonplace in California and nation-wide.

Consumer Experience

Patrina Mack, who was contracted to assist Project Negatherm with developing Consumer and Driller Surveys, unexpectedly became a potential GSHP consumer after learning that her 55-year-old heater had four cracked chambers and was unsafe to use. In light of the 30% tax credits for the total cost of a geothermal project, and assuming estimates that the cost of installation would be around $7,500/ton with pay back in 8-9 years, she felt she must consider this as an option for her 1,300 sq ft. home in Menlo Park. Her experiences, contained below, are illustrative as to what a consumer may experience when investigating GSHP options.

She first contacted a national referral service, which was specifically chartered to offer GSHP HVAC installers. Instead, the service provided only traditional HVACs dealers. The first contractor knew nothing about GSHP and was 20 minutes late. The next rep communicated what he knew about GSHPs but stated that he outsourced GSHP work to an outfit in Santa Rosa.

The next appointment talked a lot about a Mitsubishi air-source heat pump as an alternative for A/C, declaring that there was no point in pursuing GSHP because of the costs, as there are many cheaper alternatives to choose from, especially given usage levels and improvements in natural gas furnaces.

The next contractor seemed to have some commercial experience with GSHP. He estimated that trenching for a system that would meet the home's heating and cooling needs would cost about $20-30,000; the system itself would cost an additional $10,000. He also emphasized replacing the ductwork and insulating the house to ensure we didn't oversize the GSHP system.

Finally, Patrina met an experienced contractor who walked her through the residential GSHP process. The contractors, a husband and wife team, learned about this technology ten years ago and proceeded to get certified at UC Davis in GSHP system design. They have been in business doing geothermal exclusively for the past nine years.

The breakdown of the estimate (which turned out to be uneconomic in the extreme at over $22,000 a ton) was as follows:

$20K for equipment and installation (heating unit, A/C and desuperheater) - $12K was equipment only for heating unit and A/C

$35K for drilling (design, permitting fees, vertical drilling, drilling spoils removal and cleanup).

Patrina told this contractor that she coincidently was working on a project to help overcome barriers to heat pump adoption in California, asked the contractor for their top issues they would like to see resolved by this project. They replied:

Establishment of a consistent permitting process

Creation of a special geothermal (not water well drilling) permit at a reasonable price

Increasing the design expertise of engineers designing the systems

Resolution of the drill cuttings and mud processing issue in a cost effective manner.

The contractor stated that their company faces two challenges: out of state drillers who underbid their projects because they don't understand and don't include the costs for CA regulations, and new-to-geothermal HVAC contractors who create poor designs that inspectors have to watch carefully, which keeps permitting costs high.

The contractor stated that it was really tough for them to make the case for geothermal over natural gas in urban and suburban areas. They have been most successful when being called to replace propane or fuels other than natural gas, custom homes (on large lots which can handle the drilling spoils) or schools, which have capital budgets, mandates to reduce energy consumption and lots of land.

Surveys

Advisory Board members were asked to provide input for the two surveys, consumer and driller that were completed as a part of this study. Their comments are noted in the following two subsections.

Consumer Survey

Several respondents commented on the importance of having a window into consumer behavior. Paul Boney noted that the GSHP industry has done very little research into consumer behavior and as such, the Project Negatherm consumer survey is a rare look into the customer mindset. Liz Battocletti also commented on the importance of gathering information from the consumer. John Geyer outlined the top motivations he's seen for purchasing GSHPs as: Comfort, Economy, Safety, Novelty, and the Environment. However, he also added that the decision always revolves around whether or not the customer can afford it.

Driller Survey

The Advisory Board's review of the Driller Survey brought up two main issues: risk and certification. With regard to risk, John Geyer pointed out, "drilling is risky and if the driller has to absorb all of it, he's going to charge more. If the risk is distributed amongst the customer and the driller, the cost will come down." Augie Guardino touched upon the significance of IGSHPA certification, noting, "There's not that many of us who have IGSHPA certifications (in California), but if you have the IGSHPA training you're more able to be involved in the first line (of communication) talking to the customer."

Web Portal

There was uniform enthusiasm for the Project Negatherm web portal amongst Advisory Board members. Members expressed the need for an easily accessible repository of information that would contain both reference and research materials, as well as provide a forum for industry news, education and developments. Liz Battocletti, in particular, was excited to hear that the Project Negatherm materials would be available online, as much of the research, surveys and interviews completed as part of this study will help inform her upcoming GSHP industry research for the United States Department of Energy.

Recommendations

While Advisory Board members come from different sectors of the GSHP industry, all were in general agreement with regards to the importance of building awareness, creating incentives, and streamlining regulations for GSHP technology.

In terms of building awareness, Advisory Board commentary highlighted the need for educational outreach at all ends of the spectrum, from consumer to contractor to regulators and utilities. Augie Guardino noted that, "There are ill-informed naysayers out there and the lack of awareness and education is our biggest deterrent. In California, it's about trying to get the word out." As Liz Battocletti pointed out, increased consumer demand is what is "pulling" many contractors she has talked to into the GSHP industry. An organized, industry-wide approach would multiply this "pull" factor and could have considerable impact on the industry.

Incentives are another critical component in increasing the appeal and affordability of GSHP technology. The newly re-vamped federal residential and commercial tax incentives for GSHP technology are an admirable start. However, Advisory Board members had some additional recommendations to further incentivize the technology. Liz Battocletti suggested allowing Energy Efficiency technologies to count towards California's Renewable Portfolio Standards (RPS) and instituting something akin to the California Solar Initiative for GSHPs. John Geyer, who once was a utility economist, spoke of the importance of incentivizing GSHP technology for utilities. He believes that Investor Owned Utilities (IOUs) will take GSHPs mainstream when the following conditions are met:

Utilities rate-base some portion of the geothermal system investment, most likely the ground loops.

Utilities can get credit for the environmental benefits GSHP can contribute towards Renewable Portfolio Standards (RPS) targets.

Utilities can aggregate greenhouse gas savings and be authorized to trade them on the secondary market.

Streamlining regulations are the third and final component. Advisory Board members were in complete agreement that there needs to be a renewed sense of leadership and uniformity at the state level in order for GSHP technology to take off in California. Furthermore, John Geyer suggested that utilities could play a key role in the streamlining process due to their typically large service areas that cross multiple jurisdictions.

Finally, while Advisory Board members identified several impediments to widespread GSHP market adoption in California, they also expressed a keen awareness of the potential of GSHP technology to meet California's stated clean energy goals and a hope that the twain shall eventually meet.

CHAPTER 7: Technical and Financial Hurdles

Summary

Technical and financial hurdles to the heat pump industry in California should be thought of on two planes: impediments to current business and future challenges for large-scale adoption. Once installed, the technical merits of ground source heat pumps are certainly impressive and compare very favorably with other HVAC alternatives. But for the heat pump industry to gain significant market share (and to significantly impact California energy consumption patterns), improvement needs to be made across the value chain: contractors need to streamline their service offerings as package solutions, drilling boreholes needs to be less invasive and less costly, and heat pump performance needs to continue to keep an efficiency advantage versus other alternatives.

The current financial equations involved in running a drilling company for water wells and for closed loop borehole work are fundamentally different. The price per linear foot for water wells is higher than for boreholes, but right now the costs for personnel, for regulation and for equipment are roughly the same. The challenge will be pivoting from a static market based on exploratory drilling to a dynamic, potentially very large market based on optimization and production. Market forces will determine much of what comes ahead, but California regulatory actions will also have a significant impact on the future.

The following points outline priorities for overcoming the technological and financial hurdles GSHP technology faces in California:

- Designate a statewide leader and champion for GSHP technology.
- Centralize and standardize permitting and fees for ground source heat pump boreholes at the state level.
- Create an educational GSHP web portal in order to inform and build consumer confidence and create a central repository of GSHP-related information.
- Overturn outdated utility regulations that contain punitive rate schedules for GSHP systems.
- Enable GSHP technology to count towards Renewable Electricity Standards (RES).
- Enable utilities to aggregate greenhouse gas savings from GSHP technology and be authorized to trade them on the secondary market.
- Streamline Title 24 accounting of the efficiency benefits of GSHP technology.
- Create split incentives (between owners and renters) in order to reach an as-of-yet inaccessible segment of the GSHP market.
- Propose no sales tax on GSHP equipment.
- Better support for drillers transitioning away from stationary diesel equipment.

- Add green collar jobs by growing California's GSHP jobs (drillers, contractors, manufacturers)
- Develop coordinating capacities (drilling, bulk purchasing) within the industry in order to combat the lack of aggregation and capture economies of scale.

The GSHP Value Chain

Despite the severe economic downturn, the HVAC equipment market in the US has been experiencing accelerated growth, projecting to $18 billion in 2010 from $13.3 billion in 2005.[29] "Increased energy efficiency in new units and retrofits along with increased interest in newer conditioning modalities such as whole-house ventilation systems [and] geothermal HVAC systems...are helping to stimulate interest in the market," notes Tatjana Meerman, managing editor of SBI Energy. Current residential HVAC retrofit expenditures are almost $12 billion nationwide, breaking down to approximately $7 billion in hardware and $5 billion in services.

Despite the recent economic downturn, the home improvement/remodeling market has grown tremendously in recent years; expenditures in this market sector have at least doubled every decade since 1980 to the point that they exceed those both in the commercial and public works construction categories.

While there has been some consolidation among residential HVAC contractors, the national residential HVAC industry remains highly fragmented and is defined by a large number of contractors. Over 40,000 privately held companies have annual sales under $5 million and operate from a single location.

Less than 10% of Northern California HVAC contractors actively offer GSHPs in their product lines. The two dominant distributors in the region, each have a small number of small companies that specialize in installation. These companies only handle the inside heat pump work in-house and subcontract everything else. Hiring drilling contractors is a very big problem, especially for residential work. The current sales approach would be described as "reactive" to incoming calls from motivated early adopters.

The GSHP Drilling Industry

The GSHP market is currently serviced by a mish mash of local "mom and pop" drillers focusing primarily on water well drilling and environmental monitoring, and a few more regionally-oriented specialty groups, who provide drilling services for large (100+ borehole) jobs. This large divergence of suppliers has lead to a disjointed and reactive marketplace that does not provide consistent services to residential or small commercial customers, and does not leverage economies of scale and scope.

Given the current state of the borehole drilling industry, there are several factors that drillers compete on: driller availability, price, job size, and applicable technology. Among these factors, job size and availability are the primary competitive drivers. Established drillers will compete

[29] HVAC Equipment in the U.S., SBI Reports, February 2007.

for larger jobs, which allow fixed costs to be spread over the life of a project and also seek jobs, which will commit resources for longer periods of time. Price is a significant consideration in these larger jobs. However, with smaller jobs (50 or less boreholes) drillers will only opportunistically commit resources when they cannot be applied to larger jobs. Drillers are also locked into specific technologies that are applicable to drilling in specific soil and rock types and can therefore only compete on jobs where there drilling is applicable and cost effective; drilling in hard rock environments is more costly and therefore sees less price competition than other environments.

Buyers within the commercial and industrial space that constitute large jobs can afford to select drillers based on price as drillers actively compete for large jobs and will commit to lower pricing to secure steady work. Direct buyers within the small commercial market segments do not have the same purchasing power and currently experience longer wait times to secure market pricing from existing drillers. Buyers within this segment are willing to pay a premium to secure drilling services in a timely manner. In addition to drilling availability, this segment is also concerned with environmental impact to the drilling site, as well as time on site, and is willing to pay above market rates to prevent disruption to the drilling site from large rigs and drilling mud contamination.

Within the California marketplace, there are relatively few in-state drillers available for borehole work. The California Groundwater Association, the leading drilling organization, has not historically tracked their member's line of businesses. The results of a 2008 phone survey of members of the California Groundwater Association indicate that 15% of water well drillers are either currently offering GSHP services or potentially interested in offering services in the future. An analysis of California Department of Labor information revealed 1,017 companies statewide listed within the "Water Well and Sewer" sub-classification of the "Earth Drilling – Non-Oil and Gas" classification. Both the number and size of companies providing any kind of drilling services is quite small. Over 58% fit the "Mom and Pop" profile with fewer than ten employees.

For the past five years, the most active and visible GSHP borehole-drilling entity within California is a Montana-based business, which transports drilling rigs for jobs in the California market. This company targets larger projects and will opportunistically take smaller jobs in between jobs, generally charging a relatively low price per linear foot on projects with hundreds of boreholes but adding additional charges for mobilization and difficult drilling conditions, which pushes their realized price upward. Some drilling companies have reputations for excessive site contamination and lack of regard for site clean upon job completion.

The water drilling industry is mature, offering only incremental improvements in the past decades. Large investments in drilling hardware make it difficult for traditional drilling companies to embrace revolutionary or disruptive technologies. However, to the extent that traditional drillers can leverage their legacy equipment for closed-loop boreholes, they possess a distinct cost advantage over new market entrants saddled with higher equipment costs.

Government Policy and the National Landscape

While the energy and emissions footprints associated with the transportation and industrial sectors have remained somewhat static, the footprints for buildings have increased—and are increasing—notably. In fact, according to the DOE's Energy Information Administration, virtually all growth in electricity consumption and peak demand since 1985 (as well as the investment and infrastructure necessary to support the demand) comes from buildings. Building operation and construction comprise nearly 48% of US greenhouse gas emissions, the largest single sector.

Faced with this data, the irrefutable climate science, and a balance sheet woefully out of whack from a deep addiction to foreign energy, the Obama administration has made improved energy efficiency in buildings a top national priority—a priority supported by billions of dollars of proposed new spending in the American Reinvestment and Recovery Act.

As with most emerging clean technologies, up-front installation costs often exceed those of comparable conventional technologies, making government or private programs essential to accelerate adoption, drive innovation and ultimately to reduce cost. The demand for residential HVAC service and retrofits is influenced by three factors: equipment breakdown, home improvements/remodels, and energy savings decisions. While demand for HVAC service and retrofits will grow with an increasing national housing stock and greater per-unit utilization of heating and cooling systems, the twin prospect of high energy prices today and higher energy prices in the future combined with the mainstreaming of green consciousness has homeowners actively investigating HVAC alternatives.

More than one million American homes undergo a major renovation each year. In 2001, 41 million homeowners undertook an improvement project. Approximately one-third of these projects, just over 13 million, involved replacing structural elements or major mechanical systems. The National Association of the Remodeling Industry (NARI) reported residential improvement and remodeling expenditures increased to $214 billion in 2003 from $163 billion in 2002, representing a 30%+ increase in spending in just one year. Expenditures in this market sector have more than doubled every decade since 1980 to the point that they now exceed those in both the commercial and public works construction categories.

Just as HVAC systems were noted to have an average lifespan of 20 years, home remodeling generally occurs at specific intervals. Average spending for remodeling peaks in homes that are 20- 30 years old and spikes again when homes are more than 50 years old. Home additions and remodels that include an HVAC element are almost exclusively retrofits. The primary reason for retrofitting part or all of the system is inadequate heating/cooling capacity. This can be due to reconfigured or added space. Inadequate insulation often plays a role, especially in renovations of older homes.

While many additional homeowners may be interested in replacing their conventional heating and cooling systems based either on the cost savings or environmental benefits of installing a GSHP system, the most conservative projections on the subsection of residential owners seeking to replace their systems due to the end of lifespan of the heating or cooling unit yields a fairly sizable market segment. On average, a typical furnace requires replacement every 20 years, and an average central AC unit requires replacement every 15 years. Using current replacement rates, it is estimated that the one potential annual market for GSHP retrofit and new homes installations is in excess of 10,000 units in the Bay Area and 30,000 statewide.

A study by America Lives/DOE examining Homeowners' "green sensibility" reports that:

- 56% believe that everyone should be personally responsible for saving energy
- 59% would spend money to save energy, if they could recover costs in lower energy bills

- 41% think the California energy crisis should have been a wakeup call for all to conserve
- 69% do not feel that new homebuilders are paying enough attention to their environmental impact
- Over 67% buyers feel they themselves are only somewhat aware of environmentally friendly building techniques & features.

Federal Policy

The energy efficiency importance of heat pumps has long been recognized at the federal level. An incentive was added for geothermal heat pump property as part of the *Emergency Economic Stabilization Act of 2008*. The incentive for businesses and for residential installations is available for units placed in service through 2016. Geothermal heat pump property is defined as any equipment, which uses the ground or ground water as a thermal energy source to heat the taxpayer's residence, or as a thermal energy sink to cool the residence. The unit must meet the requirements of the Energy Star program, which are currently in effect when the heat pump is purchased. The criteria for closed loop geothermal heat pumps are: for a closed-loop system, 14.1 EER and a coefficient of performance (COP) of at least 3.3. In addition, the geothermal heat pumps must include a desuperheater, which helps heat water, or an integrated water heating system.

The American Recovery and Reinvestment Tax Act of 2009 (ARRA) greatly expanded incentives covering a full 30% of the installed residential cost and doing away with the previous $2,000 cap. The incentive is available for taxpayers installing qualifying equipment at their primary residence or a second home, but not for a rental property.

Two options now exist for the commercial incentive. An investment tax credit of 10% of the installed cost is available through 2016. The ARRA legislation also provides the option of taking a grant in lieu of the credit, worth 10% of the installed costs for equipment placed in service during 2009 and 2010.

In addition to “back-end” tax incentives, property assessment–based PACE bond programs target first costs. This property tax lien oriented financing (originated in Berkeley) can dramatically improve the economics of energy retrofits, create jobs and accelerate movement toward energy independence and greenhouse gas reduction. The CaliforniaFIRST program, sponsored by the California Statewide Communities Development Authority, allows property owners within participating regions to finance the installation of energy and water improvements on their home or business and pay the amount back as a line item on their property tax bill. The CaliforniaFIRST Pilot Program is scheduled to launch in summer 2010. For residential properties, the minimum financing amount will be $5,000 and the maximum $75,000. The maximum financing amount for commercial property varies based on property value.

State Policy

While leading the nation in many environmental and renewable energy and energy efficiency categories, California has for the most part successfully resisted the charms of ground source heat pumps. In fact, drilling regulations in California are no farther along than they were over a decade ago, when Bulletin 74-99, the draft standards for geothermal heat wells, was developed. In contrast, several of California's neighbors have taken a pro-active approach to GSHP drilling requirements. Both Idaho and Washington have recently revised their standing water well regulations to include GSHPB-specific standards; Washington revised their water well construction standards in 2006, adopting language for "Ground Source Heat Pump Borings," and Idaho followed suite in 2009, adopting specific standards for "Closed Loop Heat Exchange Wells."

In order to consider California's regulations within a broader regulatory context, five states were identified and considered for comparison purposes: Missouri, New Jersey, Idaho, Oregon and Washington. While Missouri shares little in common with California in demographic and geographic terms, it was chosen as a comparison state because it has a growing GSHP industry and a construction code specific to GSHPs. New Jersey was chosen as the second comparison state due to the similarities it shares with California, among them: high median household income, a high cost of living, and a high volume of well permit applications per year. Idaho, Oregon and Washington were also surveyed to get a sense of how neighboring western states are regulating GSHPBs.

California, like its neighbors before it, can take certain action to surmount some of the technical and financial hurdles. By far the largest cost component and most daunting technical feat of a vertical loop ground source heat pump project is the drilling of the boreholes. It is a disruptive activity that relies on equipment purpose-built for water wells. While there are a number of drilling technologies available, the unpredictable nature of soil conditions can make projects technologically complicated and increase the cost of GSHP projects. One possible means of mitigating this uncertainty could be the creation of a publicly available repository of well logs (which drillers are already required to complete) in order to make the required technology and costs associated with drilling in difficult soil conditions more predictable. As discussed later in Task 2.7, many of California's neighbors have already made this information public and available on the internet.

Furthermore, while job size and availability are the primary competitive drivers within the GSHP drilling market segment, the state can use its regulatory power to streamline regulations and permit costs for GSHP boreholes. Again, by removing the uncertainty associated with regulations and permitting fees, drilling costs could be both reduced and standardized for GSHP consumers.

In addition, within the California marketplace, there are relatively few in-state drillers available for borehole work. In fact, much of the large-scale GSHP drilling work goes to out of state contractors. Compiling a list of local GSHP contractors could go a long way in growing the GSHP industry within California's boarders.

In order to achieve significant market share, ground source heat pumps must find a way to more effectively document and promote their inherent efficiency advantage. Ground source heat pumps need to demonstrate overwhelming performance in order to make installation worthwhile and this can be accomplished through state-sponsored pilot programs that record GSHP system performance and customer satisfaction.

Finally, as with most emerging clean technologies, up-front installation costs for GSHPs often exceed those of comparable conventional technologies, making government or private programs essential to accelerate adoption, drive innovation and ultimately to reduce cost. Utility sponsored "loop-lease" programs have proved effective in certain, mostly rural service territories and Property Assessed Clean Energy (PACE) financing holds much promise for GSHP technology. However, a statewide, GSHP-specific incentive program in the same vein as the California Solar Initiative could catapult the residential market, creating economies of scale and scope for drillers and manufacturers alike, while lowering upfront and operational costs for consumers.

Heat Pumps

Heat pumps, air source and ground source and water source, are the fastest growing segment of HVAC equipment. GE Appliances[30], Rheem[31] and AO Smith[32] have all recently introduced "hybrid" air source heat pump water heaters. Diakin[33], Sanyo[34] and Panasonic[35] have debuted air source heat pumps with efficiency claims beyond 4.0 COP and Maine-based Hallowell International has been pioneering a cold-weather air source heat pump model, the Acadia.[36]

In order to achieve significant market share, ground source heat pumps must press their inherent efficiency advantage. In this competitive environment, it is a simple case of good not being good enough. Ground source heat pumps need to demonstrate overwhelming performance in order to make installation worthwhile. Air source heat pumps are making long strides but will run into a operational ceiling: Carnot Theory thermodynamic principles show that the theoretical coefficient of performance limit for a room temperature of 70 degrees

[30]http://www.geappliances.com/heat-pump-hot-water-heater/high-efficiency-water-heater-savings.htm

[31] http://www.rheem.com/Products/tank_water_heaters/hybrid_electric

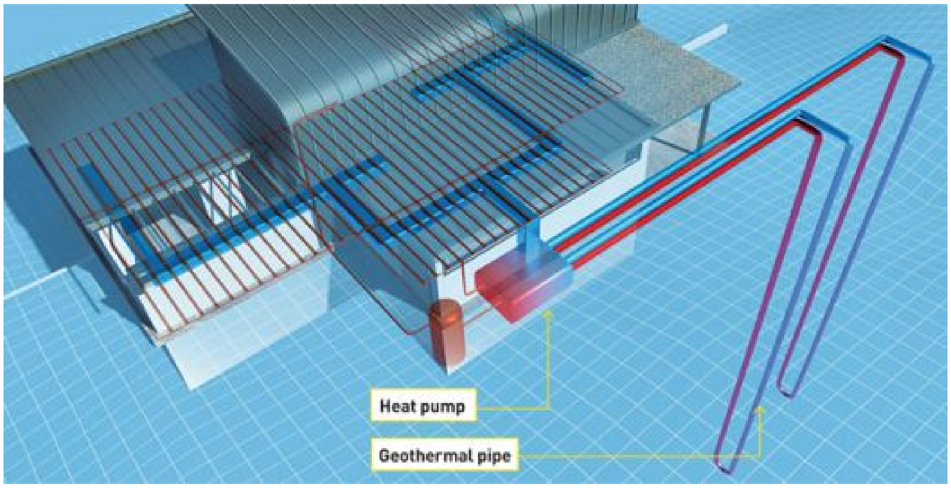
[32] http://www.hotwater.com/products/residential/voltex_hybrid.html

[33] http://www.daikinac.com/residential/altherma-energy-efficiency.asp?sec=products&page=53

[34] http://us.sanyo.com/HVAC/Core-Technologies

[35] http://www.panasonic.com/consumer_electronics/air_conditioners/default.asp

[36] http://www.gotohallowell.com/Acadia%E2%84%A2-Products/



Conceptual schematic of a ground source heat pump system.

Credit: Popular Science Magazine

Fahrenheit and an outside air temperature of 0 are equal to 7.566 units of thermal energy.[37] In other words, the projected maximum COP for air source is 7.566. Ground source heart pumps have much larger efficiency potential and should be able to achieve double-digit COP utilizing more efficient compressor technology (where 80% of heat pump energy is drawn), variable speed controls and more advanced electronics. Taken together with other improvements within the ground loops thermal transfer such as carbon fiber tubing or turbulent flow thermocouple[38], one might be able to say, “The ground’s the limit.”

Because heat pumps consume less primary energy than conventional heating systems, they are an important technology for reducing gas emissions that harm the environment, such as carbon dioxide (CO_2), sulphur dioxide (SO_2) and nitrogen oxides (NOx). However, the overall environmental impact of electric heat pumps depends very much on how the electricity is produced. The European Heat Pump Association estimates that a 30% market penetration of heat pumps in retrofit heating markets could yield global greenhouse gas emissions reductions of up to 8%.

Drilling

By far the largest cost component and most daunting technical feat of a vertical loop ground source heat pump project is the drilling of the boreholes. It is a disruptive activity that relies on equipment purpose-built for water wells. Some projects require a combination of methods as different strata are encountered. Several technologies are currently employed to develop the boreholes required for GSHP installations, breaking down into the following categories:

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[37] http://www.gotohallowell.com/Dealer-Resources/technical-information-35.html

[38] http://www.kelix.com/public/default.html

- Auger Drilling uses a rotating spiral drill system, which brings up soil by way of the spirals. This technology is relatively inexpensive and effective for rapid drilling in soft rocks, but is not effective in hard rocks or consolidated materials typically found in areas of GSHP adoption. A prevalent issue with this technology is the tendency for boreholes to collapse during removal of the drill string in soft materials, requiring drillers to re-drill the boreholes and incur additional cost.

- Rotary Drilling utilizes drilling bits with relatively high force and rotation to remove materials at moderately slow rates. Drilling mud or air foam mixtures are required to lubricate and cool the bit and remove material from the borehole. This technology is applicable to a wide variety of rock types but slows down in hard rocks and uses expensive bits. Use of lubricants can lead to significant contamination of the drill site.

- Impact (Hammer) Drilling is used for hard rocks such as limestone, granites, basalts or other crystalline structures. Impact drill bits are less expensive than rotary bits and drill rates for small holes can be substantial. Typically borehole collapse is not a problem when using these drills in hard rocks. Large diameter impact bits require larger drills and drill strings which are difficult to get into small areas. These systems are noisy and typically use foams to help lift particles and resolve dust issues.

- Sonic (Vibratory) drills are used for very soft sediments of soils, but are not effective in hard rock types. A high frequency pulse generator is used to create a sonic disruption of the soil, which helps creates a borehole. These systems are also quite noisy as well as being very large.

A number of manufacturers like Techno Drill[39] and the Tracto-Technik[40] of Germany have introduced smaller rigs targeted at residential and light commercial retrofit work, trading off the power and versatility of larger systems for the maneuverability of smaller platforms. Another advantage of the smaller rigs is the price point: a larger water well rig can cost a driller upwards of $700,000 while the newer units are more in the $150-200,000 range.

[39] http://www.technodrillusa.com/geothermalrig.html

[40] http://geothermic.tracto-technik.com/index.cfm?menuID=12

An air rotary boom rig setup.

Photo credit: Guardino Well Drilling

Trenching

Once boreholes are drilled, u-bend tubes emplaced and settled within grout, they need to be connected and terminated at the heat pump. Typically, the horizontal connection or header is laid four feet under ground using standard construction trenching equipment.

Ditch Witch has been the leading provider of trenching equipment and an indirect player in the heat pump industry. Lately, it has been adapting directional drilling technology, primarily used for cabling, to provide angled ground source boreholes. The heat exchange properties for this orientation may not be as high as a vertical loop, but the process is much less invasive if there is land available.

The Business

It is apparent that the ground source heat pump market operates at the intersection of a number of market categories comprising a dynamic environment of transformation and rapid growth.

Horizontal trench with “slinky” loop configuration.

Photo credit: Canadian Geoexchange Coalition

Energy efficiency investments in the building sector totaled $178 billion in 2006, according to the ACEEE.41 The overall heat pump industry has quietly grown to $2.5 billion in sales, but substantial barriers to residential GSHP adoption in the forms of installation cost and difficulty, the availability of drillers, and HVAC contractor knowledge. Up to 70% of the cost of a residential GSHP system is comprised of the “groundwork”: borehole drilling, loop installation, and trenching, making GSHP more than twice as expensive to install as alternative HVAC solutions. While tax incentives have been put in place and innovative financing programs are coming online, the industry is in the formative stages of trade group activity, especially compared to solar PV with regards to awareness building, branding and advocacy.

Existing HVAC contractors have largely ignored GSHP residential installations due to the easier sales cycles of gas furnaces, customer education and financing needs, training and promotion requirements. GSHP contractors have ignored existing residential buildings and opted to compete for larger residential development, commercial and institutional projects. For a company with the right tools and the capability of doing the work, the “blue ocean” in this market turns out to be where the overwhelming amount of existing buildings are located.

Individual companies entering the market suffer either from a lack of appropriate equipment, technical and marketing expertise and/or capital. Drilling companies transitioning from water wells have legacy “paid for” rigs that may not be as suitable for retrofit work. So far, no company has presented a full-service turnkey installation solution, and so each job requires an assortment of trades.

The best market penetration of ground source heat pumps have occurred with active management within a utility program framework. The logistical examples of “loop-lease” programs like Delta-Montrose and Plumas Sierra rural electric co-ops can be replicated elsewhere, even if the leasing plan is replaced with innovative financing. Repeated, organized activity yields scale benefits in terms of logistical support, streamlined permitting and lower costs.

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[41] The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture, Ehrhardt-Martinez and Laitner, ACEEE, May, 2008

CHAPTER 8: Field Research

Summary

It is easy to forget that the real work of ground source heat pumps takes place in the field and, quite literally, down in the trenches, so an effort was made in the course of this project to travel to a few work sites. If one word summed up overall impressions, crew conversations and future industry direction, it would be "integration," in the sense of making or forming a whole construct from disparate parts and point solutions.

Within all the worlds of green building, real estate, construction, architecture, mechanical engineering, insurance, property management, facilities management, energy management *among others*, ground source heat pumps are not well known and are not a go-to, front-of-mind tool to use in projects. GSHP is relatively exotic and unfamiliar. Although in each case relations were deemed cordial, both the Enlink and 88HVAC crews reported room for improvement in the intricate dance between different subcontractors within a construction project. A general contractor or construction site foreman generally has a good understanding of what a plumber or an electrician requires, but not so with a driller or a heat pump crew, and this unfamiliarity can cause problems. Perhaps one day GSHP will be just another tool in the toolbox and along with renewable energy and other energy efficiency components, part of an integrated net-zero whole building solution.

City College of San Francisco Site

Visits to the new joint use facility at City College of San Francisco's (CCSF) Ocean Campus started in late January 2009 and continued through the next few months. The land formerly contained the old Balboa Reservoir, which served as a parking lot across the street from the main campus the first of the four buildings planned will be the multi-purpose center that will be jointly used by City College (CCSF) and San Francisco State University students. The facility will include classrooms and administrative offices, and eventually a performing arts center, visual arts center, child-care facilities, and an advanced technology center.

The Balboa Reservoir development site work includes installation of a ground loop geothermal system using of geothermal bores and collection piping to provide cooling and heating for new facilities, rough grading and engineering fill to provide pads for the construction of the Joint Use facility and an area west of the Joint use facility, abatement and demolition of the old north and south gymnasium and dance studio located on the east end of Ocean Campus, and construction of two parking lots to replace parking at the reservoir site. The estimated construction budget was $7,300,000.

The Chicago Athenaeum Museum of Architecture and Design selected the Performing Arts Center, which was a joint venture design by LMN Architects[42] and Tom Eliot Fisch,[43] as one of

[42] http://lmnarchitects.com/profile

[43] http://www.tomeliotfisch.com/

66 distinguished new buildings in the coveted American Architecture Awards program. It is a contemporary structure with many green features. Besides the geothermal well field and heat pump system, there will be radiant floors and ceiling panel systems, natural ventilation, abundant natural light, water-saving fixtures and a 30,000 square foot living roof with native vegetation. When complete, the facility will have a 650-seat multi-purpose performance hall, a 150-seat recital hall, practice rooms and studio. The performing arts center will target LEED Gold certification

Artist rendering of completed City College Multi-Purpose Center

Credit: City College of San Francisco

Bovis Lend Lease, Inc. and Proven Management managed construction of the 112,000 square foot development. Enlink Geoenergy of Rancho Dominguez, California was the drilling contractor who produced 400 boreholes averaging 400 feet depth through three distinct soil zones.

The site work and landscaping project underway includes bringing in approximately 280,000 cubic yards of fill and the installation of a geothermal grid under the fill material, which will heat and cool the buildings. The multipurpose center and three future buildings will be heated and cooled by the heat pump grids system, so no natural gas lines were planned. With temperatures below ground at about 55 degrees, the cooled water brought up via the pipes will more efficiently cool the buildings on hot days than conventional air conditioning. "It uses much less energy and is more fuel efficient," said CCSF Vice Chancellor for Facilities Jim Blomquist.

La Vida Real Site and the Green Eichler Remodel

88HVAC is a hyperactive HVAC contractor reflecting the energy of founder Matt Jung. The company has made a specialty of ground source heat pump projects in large homes north and south of San Francisco. These projects are usually early-adopter, price “insensitive” custom installations utilizing the latest HVAC technology. Both a licensed electrician and plumbing

Multiple drills within view of an historic campus building at CCSF.

Photo Credit: Richard Butler, Enlink

contractor, Matt is a frequent visitor to Japan and an authority on new HVAC technologies such as high velocity systems, air purification systems and radiant heating and cooling. Visits were made to two 88HVAC projects: the “La Vida Real” residence in Los Altos Hills and an extensive remodel of a 1969 Eichler tract home in Monte Sereno.

The La Vida Real home is a very large reconstruction of two adjoining lots. The main home and guest cottage use 43 tons of heating and cooling for radiant heating and cooling, wine storage, an indoor pool and whole-house dehumidification.

The Green Eichler Remodel[44] was a challenging and considerable undertaking, transforming a classic if energy inefficient home into a much larger LEED for Homes, Platinum showcase. A full basement was added as the homeowners decided to build down instead of up to keep the

[44] The homeowners’ blog about their adventures at http://eichlervision.com.

character and spirit of the original design, creating a central atrium open down to a new lower level. “A second floor on an Eichler is not appropriate,” opined Bryan and Jo-Anne Mekechuk.

Left: Cutaway view of Green Eichler Remodel; Right: Entrance to La Vida Real project gives a sense of the property size.

Credits: Left: Eichlervision.com; right: Dennis Murphy, Project Negatherm.

The original home was disassembled and organized for reuse. Only 18 square feet was added to the footprint. The redwood panels will go over high R-value structurally insulated panels (SIPs) and a cistern was dug to harvest rainwater. The geo system was an unusual one involving fifteen energy pylons installed within the new cellar foundation.

Drilling

At City College of San Francisco, Enlink Geoenergy contracted directly with Proven Management, who in turn contracted to developer Bovis Lend Lease. The Proven/Enlink team was the only bidder on the drilling after a number of other companies dropped out of the process due to the extremely challenging drilling conditions detailed in the site report. The $2.8 million contract covered 400 boreholes. The SF Department of Public Health was the responsible agency for issuing permits. Unlike some previous projects, Enlink was happy to be issued one permit for all 400 wells in an expeditious manner. The installation lasted 10 months, with the actual drilling covering the last 4 months. Five drill rigs were on site at all times

According to Project Manager Richard Butler of Enlink, their large coil tubing units enable our operations team to install geothermal loops in wells that would have otherwise posed a significant challenge. “The loose formation constantly collapsed in the well before we could insert the loop, if we had attempted to insert the loops by hand I think this project would have been much more challenging, he said”

Scenes of big rigs and mobilization at the CCSF site. Note scale of equipment.

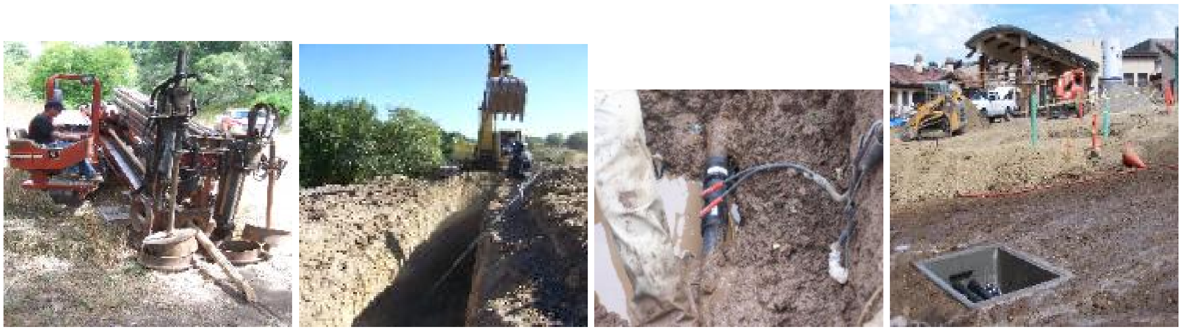
Photo credits: Richard Butler, Enlink

In addition, 180 bores out of the 400 drilled were installed under the building footprint, which was an unusual land usage. The extremely diverse geology ranged from clay and sand where mud rotary drills (utilizing chevron, polycrystalline diamond, drag, and wing bits) were used to green shale that required air hammers ranging in size from 3.75'' to 8''. In some bores, 300 feet of casing was set with sonic vibration rigs.

A typical bore consisted of roughly:

- 100 feet of clay/sand/large boulders
- 100-180 feet of very hard green shale
- 180-250 feet of coarse sand and small gravel (unconsolidated)
- 250 - 400 feet of fractures shale and limestone with strings of clay and coarse sand

Although fairly large for residential work, the La Vida Real house was a sizable drilling job of 16 boreholes at 280-foot depth supplying 30 individual heat pumps totaling 43 tons of capacity. 88HVAC was called after the initial drilling as a substitute subcontractor and supervised three "redrills" and traced leakage in the manifold. The role of a replacement subcontractor is extra difficult with an unfamiliar technology to the construction management and homeowner, but eventually things were "integrated."



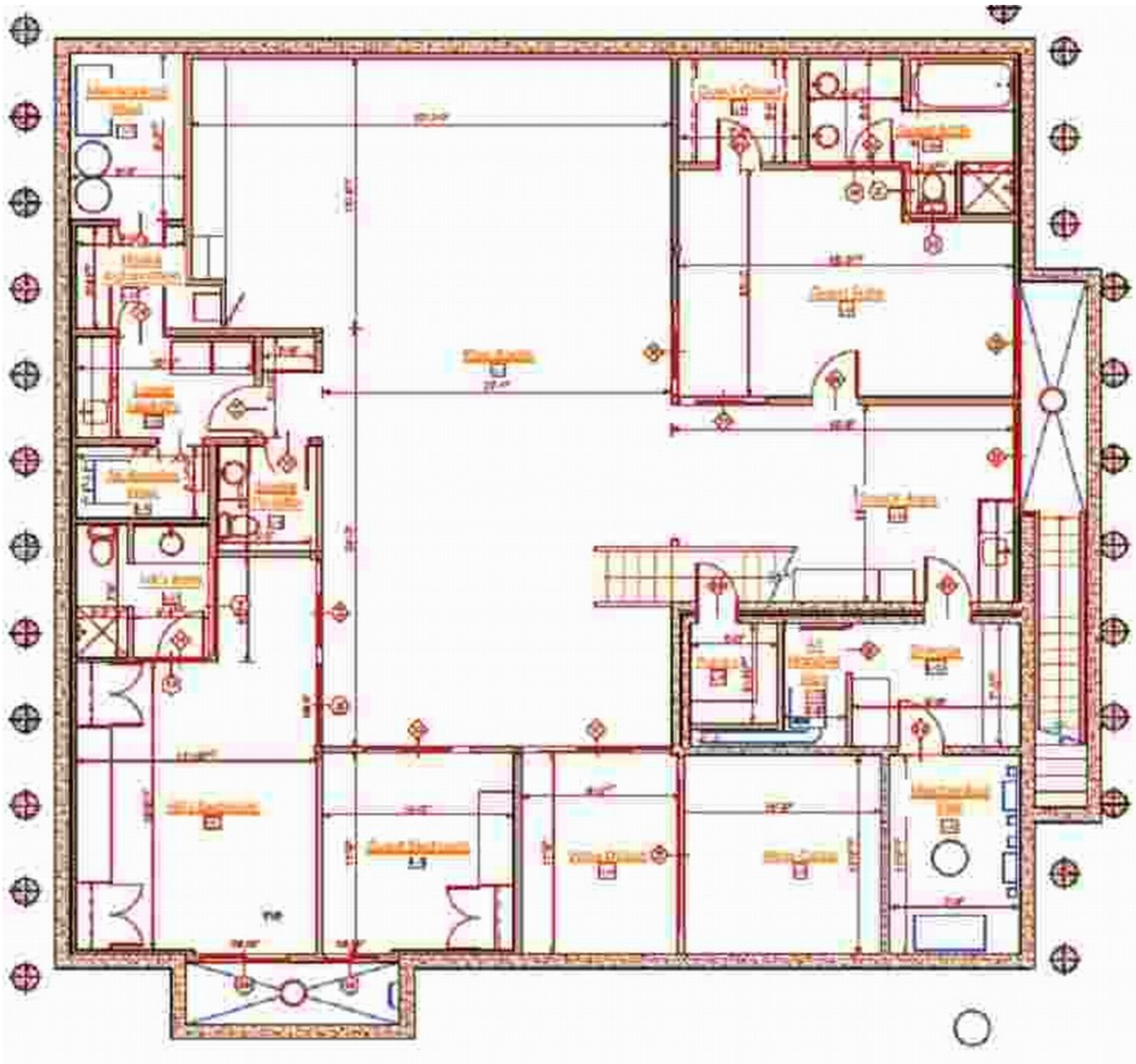
Drilling, trenching, testing and manifold view of front entrance of La Vida Real project.

Photo Credits: 88HVAC

The 15 energy pylons of the Green Eichler remodel was an unusual undertaking and is part of an integrated "whole house" system involving significantly superior insulation, daylighting, polished high slag concrete flo0ring, rainwater catchment and 43 solar PV panels.

From Left to right: lowering rebar cages into hole with tubing, guiding cage down hole, positioning in hole and beginning the grouting.

Photo Credits: Eichlervision.com



The Green Eichler Remodel lower level drawing shows the energy pylons that supply the ground source heat pumps.

Credit: Eichlervision.com

Trenching


Large-scale CCSF header manifold casement and smaller (but still sizable) La Vida Real casement.

Photo Credits: Richard Butler, Enlink; Dennis Murphy, Project Negatherm

Due to the subterranean nature of the City College project, Enlink was able to construct piping junctures and the header system on top of the ground, which saved substantial time. After the header system was built, Proven Management backfilled the circuits with almost 20 feet of imported fill.

88HVAC was originally called in to investigate mysterious leaking ear the manifold and ended up replacing some header tubing. The unique pier system at the Green Eichler Remodel lessened the need for extensive trenching.

Inside Installation

The CCSF Multi-Purpose building is still under construction, but the La Vida Real project and the Green Eichler Remodel both boasted impressive inside basement installations. La Vida, with over 30 individual point of use heat pumps tied together within an elaborate thermal control system, is more sophisticated a setup than many commercial buildings. Green Eichler's mechanical room is much more modest, but still very advanced and located next door to a 2,600 bottle wine cellar and dining area.

A view to some of the system water pumps, heat pumps (left), desuperheater water heater and insulated piping in the La Vida Real basement.

Photo Credit: Dennis Murphy, Project Negatherm

CHAPTER 9:
Financial Model Research

Summary

Energy Efficiency has long been a keystone of the state of California's energy strategy. In fact, thanks to large-scale energy efficiency programs that the state implemented in the 1970s, per capita electricity consumption in California has remained flat over the past 30 years[45]. Although these efficiency programs have generated considerable economic and environmental benefits, there remains a large amount of untapped energy savings.[2]

In its 2008 *Long Term Energy Efficiency Strategic Plan*, the California Public Utility Commission identified Heating, Ventilation and Air Conditioning (HVAC) as a leading opportunity to improve energy efficiency and reduce peak power demand[46]. As one of the most efficient heating and cooling technology currently available, Ground Source Heat Pump technology can play a key role in meeting these goals.

However, due to the high upfront cost associated with GSHP technology, lack of financing mechanisms has posed a considerable impediment for GSHP market adoption. This section of the report provides an overview of the various means of incentives and financing available for energy efficient technologies such as GSHP systems.

Conventional Energy Mortgages

There are two types of conventional energy mortgages available, Energy Improvement Mortgages (EIMs) and Energy Efficiency Mortgages (EEMs).

Energy Efficient Mortgages

An Energy Efficient Mortgage (EEM) is a mortgage that credits a home's energy efficiency in the mortgage itself. EEMs give borrowers the opportunity to finance cost-effective, energy-saving measures as part of a single mortgage and stretch debt-to-income qualifying ratios on loans thereby allowing borrowers to qualify for a larger loan amount and a better, more energy-efficient home.[47]

At the current time Fannie Mae's Energy Efficient Mortgage program is under review and not accepting applicants. Interested customers are advised to contact Fannie Mae periodically for updates[48].

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45 Itron, "California Energy Efficiency Potential Study," September 2008. http://www.itron.com/pages/news_articles_individual.asp?nID=itr_008890.xml

46 http://www.californiaenergyefficiency.com/docs/EEStrategicPlan.pdf

47 http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.energy_efficient_mortgage

48 http://ase.org/section/_audience/consumers/refinanceremodel/refinancing/

Conventional mortgages are not backed by a federal agency. Rather, private lenders sell EEM loans to Fannie Mae and Freddie Mac. Fannie Mae and Freddie Mac enable homebuyers to borrow up to 15% of an existing home's appraised value for improvements documented by a HER.

Fannie Mae also lends up to 5% for Energy Star new homes. Fannie Mae EEMs are available to single-family, owner-occupied units, and Fannie Mae provides EEMs to those whose income might otherwise disqualify them from receiving the loans by allowing approved lenders to adjust borrowers' debt-to-income ratio by 2%. The value of the improvements is immediately added to the total appraised value of the home.

Freddie Mac offers EEMs for one- to four-unit dwellings and also helps raise the effective income of the borrower to qualifying levels by allowing lenders to increase the borrower's income by a dollar amount equal to the estimated energy savings. Any energy efficiency improvements can qualify, and these mortgages can be combined with both fixed-rate and adjustable-rate mortgages. Borrowers should apply directly to the lender.
See www.natresnet.org/resources/lender/default.htm for more details.

Energy Improvement Mortgage (EIM)[49]

EIMs finance the energy improvements of an *existing home* through the mortgage loan by tapping into the monthly energy savings due to the updates.

EIMs are intended specifically for new homebuyers, enabling new homebuyers to get additional financing included in the mortgage to cover the cost of energy improvements. EIMs allow borrowers to include the cost of energy-efficiency improvements to an existing home in the mortgage without increasing the down payment.

Federal Incentives

There are a variety of means by which the Federal government is instituting incentives and financing programs for energy efficient technologies.

Residential Tax Incentives

Since 2008, federal tax incentives have been available for residential GSHP applications. The Residential Renewable Energy Tax Credit, which established a tax credit for residential property for solar and fuel cells, was initially established by the *Energy Policy Act of 2005*. However, it was *The Energy Improvement and Extension Act of 2008,* which extended this tax credit to small wind-energy systems and GSHPs. More recently, *The American Recovery and Reinvestment Act of 2009 (ARRA)* removed the maximum credit ($2,000) amount for all eligible technologies (except fuel cells).[50]

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[49] http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.energy_efficient_mortgage

[50]http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US37F&State=federal%A4tpageid =1&ee=1&re=1

Today, qualifying (Energy Star) ground source heat pumps installed after December 31, 2008 are eligible for a 30% credit of the installed cost, without a cap, as provided under the *American Recovery and Reinvestment Tax Act of 2009* (ARRA). A taxpayer may claim a credit of 30% of qualified expenditures for a GSHP system that serves a dwelling unit located in the United States and is used as a residence (not necessarily the *primary* residence) by the taxpayer. Expenditures include labor costs for onsite prU.S. EPAration, assembly or original system installation, and for piping or wiring to interconnect a system to the home. Furthermore, if the federal tax credit exceeds tax liability, the excess amount may be carried forward to the succeeding taxable year. The excess credit can be carried forward until 2016, but it is unclear whether the unused tax credit can be carried forward after then[51].

In order to be eligible for residential federal tax incentives, Ground Source Heat Pump systems must meet the following requirements[52]:

- Systems must be placed in service on or after January 1, 2008, and on or before December 31, 2016[53].
- The home served by the system must be located in the United States and used as a residence, although it does not have to be the taxpayer's principal residence. "The incentive is available for taxpayers installing qualifying equipment at their primary residence or a second home, but not for a rental property."
- IRS Form 5695 is required for the Residential Energy Efficient Property incentive.
- GSHPs must meet federal Energy Star program requirements in effect at the time the installation is completed[54].

Commercial Tax Incentives

The *Energy Improvement and Extension Act* of 2008 also established commercial tax credits for GSHP systems. The *American Recovery and Reinvestment Act of 2009*, expanded upon these credits by creating two options for commercial GSHP incentives. The first is an investment tax credit of 10% of the installed cost which is available through 2016. The tax credit can be used to offset both regular income taxes and alternative minimum taxes (AMT). If the tax credit exceeds the income tax liability, the loss can be carried back one taxable year and any remaining balance can be carried forward into future years[55]. The second option, a grant from the U.S. Treasury Department, is only available for equipment placed in service during 2009 and 2010 and is

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[51] http://energytaxincentives.org/business/renewables.php

[52]http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US37F&State=federal%A4tpageid=1&ee=1&re=1

[53] GSHP systems placed in service in 2008 fall under a $2,000 cap.

[54] Currently, the criteria for Energy Star geothermal heat pumps are: for a closed-loop system, 14.1 energy efficiency ratio (EER), and a coefficient of performance (COP) of at least 3.3. For an open-loop system, 16.2 EER and 3.6 COP. For a direct expansion system, 15 EER and 3.5 COP.

[55] http://www.climatemaster.com/downloads/LC028.pdf

worth 10% of the installed costs for equipment placed in service[56]. Grants are available upon request and will be paid within 60 days of the date of receipt of the application, or within 60 days of the date the energy property is placed in service, whichever comes later. The grant provides an option that can be taken in lieu of the energy credit to improve cash flow.

In order to be eligible for commercial federal tax incentives, Ground Source Heat Pump systems must meet the following requirements:

- Building located in the U.S.
- Original use begins with taxpayer
- The credit can only be claimed on spending for equipment that is placed in service[57] from October 4, 2008 to December 31, 2016.
- IRS Form 3468 is required for the Energy Credit.

Federal Housing Authority & Veterans Affairs Mortgages[58]

In addition to tax credits, homeowners can take advantage of energy efficient mortgages (EEM) to finance a variety of energy efficiency measures in a new or existing home. The U.S. federal government supports these loans by insuring them through Federal Housing Authority (FHA) or Veterans Affairs (VA) programs. This allows borrowers who might otherwise be denied loans to pursue energy efficiency improvements, and it secures lenders against loan default.[59]

Federal Housing Authority (FHA) Energy Efficient Mortgages (EEMs)

The FHA EEMs provides mortgage insurance for homeowners to purchase or refinance a principal residence and incorporate 100% of the energy efficiency improvements to an existing mortgage. EEMs can be used to make energy efficient improvements in one to four existing and new homes. The mortgage loan is funded by a lending institution, such as a mortgage company, bank, or savings and loan association; the mortgage is insured by HUD.

FHA mortgage limits vary by county, state and the number of units in a dwelling[60]. These mortgages were previously limited to $8,000; however, in June 2009, HUD removed the dollar cap. Loan amounts may not exceed the projected savings of the energy efficiency improvements and homebuyers must submit a Home Energy Rating (HER), contractor bids, and a FHA B Worksheet. The cost of an energy inspection report and related fees may be included in the mortgage.

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56 http://energytaxincentives.org/business/renewables.php

57 Equipment is considered "placed in service" when it has been fully installed and is capable of being used by the owner for its intended purpose.

58 http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US36F&re=1&ee=1

59 CITATION?

60 See www.fha.com/lending_limits.cfm for more details

All persons who meet the income requirements for FHA's standard Section 203(b) insurance and can make the monthly mortgage payments are eligible to apply[61]. New and existing owner-occupied homes of up to two units qualify for this loan; cooperative units are ineligible.

Department of Veterans Affairs (VA) Energy Efficient Mortgages (EEMs)

The VA EEM is available to qualified military personnel, reservists and veterans62. The VA insures EEMs to be used in conjunction with VA loans either for the purchase of existing homes or for refinancing loans secured by the dwelling. Homebuyers may borrow up to $6,000 if the projected energy savings are greater than the increase in mortgage payments. Loans may exceed this amount at the discretion of the VA. No additional home appraisal is needed, but applicants must submit a HER, contractor bids and certain other documentation.

Energy Star Mortgage Pilot Program[63]

The ENERGY STAR mortgage pilot program is a collaborative effort between the U.S. Environmental Protection Agency, the U.S. Department of Energy, the Energy Programs Consortium (EPC), state energy and housing agencies, as well as the Ford Foundation and the Surdna Foundation. The pilot program was launched in Maine and Colorado and plans are underway to extend the program to Massachusetts, New York, New Jersey, Pennsylvania, and the District of Columbia.

In order to qualify, a home being financed must either be ENERGY STAR qualified, undergo a Home Performance with ENERGY STAR assessment and improvement process that yields at least a 20% total energy savings, or achieve at least 20% total energy savings via participation in a Weatherization Assistance Program (WAP). The home must also be single-family (1-4 families) and owner-occupied.

Legacy State Initiatives

State Energy Programs (SEP)

The Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy administers the State Energy Program (SEP), which provides grants to states and directs funding to state energy offices. States use SEP grants to address their energy priorities and program funding to adopt emerging renewable and energy efficiency technologies[64]. Under *the American Recovery and Reinvestment Act of 2009* (ARRA), funding totaling $3.1 billion is available for State Energy Programs (SEP).

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[61] Eligibility requirements can be found at: http://www.hud.gov/offices/hsg/sfh/eem/energy-r.cfm

[62] See www.homeloans.va.gov/elig2.htm for more information.

[63] http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.pt_lender_mortgage

[64] http://apps1.eere.energy.gov/state_energy_program/

State Revolving Loan Funds[65] (RLF)

A RLF is a source of money from which loans are made. Loans are made to borrowers consistent with standard prudent lending practices. As loans are rU.S. EPAid by the borrowers, the money is returned to the RLF to make additional loans. In that manner, the RLF fund becomes an ongoing or "revolving" financial tool. The interest and fees paid by the RLF borrowers support program administration so that the fund’s capital base remains intact. Typically RLFs lend money with specific goals or borrowers in mind. The range of RLFs varies widely including such diverse area as affordable housing, historical preservation, energy efficiency, safe drinking water, and small business development. RLFs are typically administered by government agencies or non-profits with the goal of creating positive change within their community or target lending group

By creating a revolving loan fund, states are not subject to expiration of the funds after the current three year ARRA timeframe. The only restriction is that the entire amount allocated to the loan program must be loaned in the initial three-year time period. RU.S. EPAyment can be stretched over additional years. Money recaptured through loan payments must be used for the same purpose unless an amendment is approved by the DOE redirecting their use.

Many states have applied for ARRA funding in order to setup a revolving loan fund for energy efficiency and/or renewable energy. Revolving loan funds are an excellent way to provide access to capital to borrowers who might not have other resources, reduce borrowing costs, and create jobs. Example, Arizona[66]: proposing a $2,000,000 RLF to fund commercial energy efficiency improvements in commercial buildings.

California State Energy Program (SEP)

SEP is administered by the California Energy Commission and has allocated $195.4 million dollars of funds in these areas:

Energy Efficiency Program ($110 million) Funding opportunities concentrated in three areas: Residential Building Retrofit, Municipal & Commercial Building Retrofit, and Municipal Financing District Program.

Department of General Services ($25 million) An energy-efficient state property revolving loan program. The total amount was awarded to DGS through an interagency agreement. DGS has signed $3.7 million in loans to retrofit five state buildings and will sign five more loans for more than $12 million by the end of the first quarter of 2010.[67]

Energy Conservation Assistance Act (ECCAA) ($25 million) 1% low interest loans are targeted towards MUSH (municipalities, universities, schools, and hospitals) markets.

Green Jobs Workforce Training Program ($20 million) comprising 27 grants to regional partnerships totaling $14.5 million in ARRA funds.

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[65] http://apps1.eere.energy.gov/state_energy_program/pdfs/sep_rlf.pdf

[66] http://az.gov/recovery/assets/docs/SEPSubApp09.pdf

[67] http://gov.ca.gov/index.php?/press-release/13662/

Program Support and Contracts ($15.4 million)

California Legislation & Initiatives

AB 811

California's Clean Energy Municipal Financing Law enables property owners (residential and commercial) to finance energy efficiency and renewable energy projects that are permanently affixed to the property. Under AB811, cities and/or counties can form an assessment district that has the authority to levy property to finance EE or renewable energy related improvements. Cities and municipalities can finance EE projects by issuing a bond to pay for initial installation costs with rU.S. EPAyment made through tax rolls. *A key element of AB811 is that it can be utilized only for existing properties.*

CaliforniaFIRST[68]

Sponsored by the California Statewide Community Development Authority (an association of counties and cities). The CaliforniaFIRST Program is a property assessed clean energy (PACE) finance program. PACE programs allow property owners within participating regions to finance the installation of energy and water improvements on their home or business and pay the amount back as a line item on their property tax bill. The CaliforniaFIRST Program is sponsored by the California Statewide Communities Development Authority (California Communities), an association of counties and cities, in partnership with Renewable Funding and the Royal Bank of Canada Capital Markets.

Utility Initiatives

Residential On-Bill Financing (OBF)[69]

When a customer undertakes an efficiency measure, the utility pays for it and then recoups the cost gradually over time in the customer's monthly energy bill. Utilities offer on-bill payment in two different ways: through loans or tariffs. A loan is assigned directly to the customer who must pay it back even if he moves. In contrast, the tariff approach links the charge to the meter, meaning that whoever lives at the house or owns the business pays the fee. If the customer moves, the new occupant picks up the payment.

The majority of OBF programs do not include capital outlay to purchase and install equipment and implement EE measures. In the past, utilities have resisted assuming a "banker" role and limited their risk by offering relatively short rU.S. EPAyment periods. The California Public Utilities Commission emphasized the need for expansion of uniform OBF programs by the state's investor-owned utilities in a September 2009 ruling. During the upcoming 2010 to 2012 period, over $41.5M in new lending authorization (excluding funds that will replace the original

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[68] http://www.renewfund.com/node/220

[69] http://energyefficiencymarkets.wordpress.com/2009/04/09/making-efficiency-easy-with-on-bill-financing/

capital sources used for initial loans during 2006-09) will be allocated to OBF program loan funds in California.[70] San Diego Electric & Gas implemented an OBF program for commercial and institutional customers. In two years of the program's full operation, SDG&E has implemented more than 180 projects that are now operational.[71]

OBF programs offer much potential for progress in the residential sector, especially if programs could be adjusted to develop more ambitious and comprehensive efficiency projects. Presently, the terms and conditions of most utility on-bill financing programs indirectly encourage the implementation of single measure EE projects. A "big, bold" strategy with better funding and marketing could go a long way towards reducing energy usage in older buildings.

Tariffed Installation Program (TIP)[72]

TIPs are a variation of the OBF program. TIPs use a utility's billing system to collect a charge that has been attached to the meter as a special tariff to rU.S. EPAy the cost of energy improvements. Because the payment is tied to the meter, not the homeowner, TIPs allow for the current occupant to move, with the next occupant responsible for rU.S. EPAyment. Typically, the monthly charge must be less than the expected savings from the efficiency improvements and charged for a term less than the life of the efficiency measures being financed.

TIPs may offer a mechanism for rented premises where the split incentives between landlords and tenants chronically lead to under-investment in EE.

Loop Lease Programs:

The utility installs, maintains, and owns the ground source heat pump loop-piping network for the heat pump system, while the customer owns and maintains the heat pump itself. The utility charges customers either a monthly fee or a usage charge based on a BTU meter reading to supply geothermal energy, thereby rate-basing the financing costs. A geothermal rate class could be created if necessary.

Rural electric co-operatives have been the most agile and active utilities in setting up programs, taking advantage of low-interest USDA loan programs. The Delta-Montrose and Plumas-Sierra utility programs, both started by Project Negatherm Advisory Board member Paul Boney, have been the national models of loop leasing.

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[70] Public Utilities Commission, "Decision Approving 2010 to 2012 Energy Efficiency Portfolios and Budgets," Draft, August 25, 2009.

[71] CalCEF Innovations White Paper - February 2010

[72] http://www.sentech.org/energysummit/documents/3_Fuller_Summary.pdf

Plumas-Sierra Rural Electric Cooperative[73]

Plumas offers a 30-year, non-transferrable, interest free loan for ground source heat pump installations. The monthly payment is added to the customer's monthly electric bill and the amount of the loan is based upon the size of the GSHP loop installed.

- Installations total over 450 systems to date.
- Monthly loop payments for a 4-ton system would be $14.95 for a horizontal loop and $29.95 for a vertical bore field.
- As an incentive, a new 85-gallon water heater is offered free of charge. The addition of "desuperheater" waste heat capacity further reduces energy usage.
- Plumas-Sierra calculates annual heating savings of over $2,000 versus propane.[74]

Delta Montrose Rural Electric Cooperative[75]*:*

With its Co-Z Energy Plan program, DMEA pays for the installation of major components of a geothermal heat pump (GeoExchange) system for a homeowner. More than 300 ground source heating systems have been installed since 1997. The monthly financing plan between the customer and DMEA including the following elements:

- Custom design of a geothermal system
- Installation of all equipment
- On-going maintenance and rU.S. EPAir
- Monthly on-bill payments
- An energy credit rate lock, adjustable in 5-year intervals based on the system's estimated energy usage.

Efficiency Service Agreements (ESAs)[76]

In a manner similar to a Power Purchase Agreements (PPAs), customers who chose ESAs can receive 100% financing for engineering, design, construction, equipment, installation, maintenance and ongoing monitoring of EE projects. Project financing is structured as a services agreement whereby customer rU.S. EPAyment is based on an agreed-upon cost of avoided energy or share of energy savings. Under this model, the ESA provider serves as financier and owner of EE assets.

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[73] http://www.repartners.org/tools/geocase/GeoHeatPumps_Introduction.htm

[74] http://www.psrec.coop/energy_renewable_geo.php?sec=enersol&pag=enerrenew

[75] http://www.repartners.org/tools/geocase/GeoHeatPumps_Introduction.htm

[76] http://www.calcef.org/innovations/activities/NewBusModelforEE_CalCEF-March2009.pdf

Metrus Energy, Inc. is a Bay Area start-up company pioneering the ESA model, providing capital, project development, and asset management services for energy efficiency ("EE") projects at large commercial, industrial, and institutional facilities. According to Founder Bob Hinkle "Our ESA structure enables our customers to avoid all capital outlay associated with the implementation of a wide range of efficiency measures."

Among the more interesting aspects of these semi-custom financing arrangements are service charges set as a cost-per-unit of avoided energy (negawatts and negatherms) and a measurement and verification plan tied to performance guarantees.

CHAPTER 10: Driller Survey

Survey Methodology

The Project Negatherm Driller Survey was conducted by internet-based survey service over an eight-week period (December 2009 – February 2010). Email invitations were distributed to drillers who operate both within and outside of the state of California. There were a total of 142 fully completed responses with an additional 57 partial responses generated from 537 site visits. Six respondents were screened out. Calls to participate were circulated with assistance of the California Groundwater Association (CGA), the International Ground Source Heat Pump Association (IGSHPA), the Heat Spring Learning Institute and the Geothermal Heat Pump Consortium (GHPC). Twenty-nine percent of respondents were drillers who operate in California and 71% of respondents were drillers from out of state.

One objective of this survey was to gain insight into the evolution of GSHP drilling projects. Thus, drillers were asked several business operations questions in order to better understand how they are brought into GSHP projects, timelines associated with GSHP projects, and what roles and responsibilities drillers typically play in a GSHP project.

Survey Respondents

Survey populations:

- Drillers within and outside of California.

Sample Frame:

- Certified drillers working in or investigating the heat pump borehole market.

Sample:

- Volunteer respondents in all cases.

Sample Size:

- Approximately 142 respondents and 57 partial respondents form 537 site visits.

Possible Survey Error:

- Respondents to the stakeholder interviews will be volunteer respondents whose responses will be used to approximate the views of industry leaders.

Topics

The following topics will be incorporated into the stakeholder interviews:

- Education
- Business organization and operations
- Customer engagement
- Project attributes
- Training
- Industry leadership
- Regulation
- Industry growth prospects

Survey Reports

The Driller Survey questions can be found in Appendix E; the Survey Data report is in Appendix F.

Summary

The majority of respondents (61%) categorized revenues from GSHP products as either their "primary business" or as an "important segment" of their business; and, the majority of this sub-set of respondents (76%) have seen demand for their services increase since entering the GSHP market.

When drillers were asked who their main point of contact for a GSHP drilling project was, respondents were about evenly split between "HVAC dealers/reps" (30%), "property owner/manager" (27%) and the "general contractor" (23%). This suggests that there is no conventional path to securing GSHP drilling contracts. When asked about typical timelines for residential, commercial and institutional GSHP jobs, drillers reported that residential GSHP jobs were generally completed in the one-to three month range (85%), commercial GSHP jobs were generally completed in the one-to-six months-plus range (87%) and school/government /military work generally took longer than four-to-six months-plus (53%, with 34% not serving this market). The overall start-to-finish time of an average project was pegged at "longer than six weeks" by 61% of respondents.

In addition, drillers reported being very involved in with consumer education efforts. Survey respondents indicated having a high level of GSHP customer interaction, with 91% of respondents saying they have either "complete responsibility for customer education" or "give additional information to help the primary point of contact for the project".

When asked to gauge the relative importance of factors for consumers choosing *not* to do GSHP projects, "too expensive" (75%) and "too much trouble and mess" (53%) led the answers both in-state and out.

Project Negatherm researchers were also interested in exploring what kind of educational resources would be of value to GSHP drillers. When drillers were asked if an educational website would lower company sales and marketing expenses, 30% responded "not at all" or "somewhat unlikely," 36% "might/might not" and 33% "somewhat" or very likely." This is somewhat surprising given that 91% of respondents reported being involved with customer education efforts. However, when drillers were asked what could be done to increase consumer awareness and reduce sales cycle time, several of the open-ended responses focused on the significant role that online resources can play in both educating the consumer and connecting customers to certified GSHP drillers. This suggests that while drillers do not expect online resources to directly impact their bottom-line, they do see online resources as an important means of building consumer confidence and awareness.

Drillers were also asked their perspective on industry growth and responses to this line of questioning focused on incentivizing GSHP technology and standardizing the local permitting process. Government and utility incentives were cited by 84% of respondents as "somewhat important" or "very important" in increasing demand for GSHP drilling and a majority (62%) of drillers surveyed saw a direct connection between government incentives and an increase in demand for their drilling services. Furthermore, 75% of drillers surveyed ranked a uniform permitting process at the local level as "somewhat" or "very important" to their business. These responses suggest that federal, state and local government all play a significant role in creating a favorable or unfavorable environment for GSHP technology.

In gathering a national spectrum of responses, this survey provides a window into the regional differences present in the GSHP drilling industry. For example, while the majority of drillers surveyed have seen demand for their GSHP drilling services increase, a driller's ability to keep pace with that demand varies regionally. Twenty-one percent of drillers in California indicated they are not keeping pace with growing demand for GSHP drilling, compared to 8% of drillers outside of California. This disparity is likely due to a variety of regional factors including GSHP borehole permitting processes (which is non-standardized in California), availability of GSHP infrastructure and consumer awareness. In addition, geography and electricity costs were two factors identified through the course of this survey that vary regionally and will play a big part in determining the appropriateness of a GSHP system.

A more detailed analysis of the Project Negatherm Driller Survey can be found below. Where appropriate, both cross-tabulated graphics and tag clouds are used in this report to illustrate the content generated from survey respondents. Cross-tabulated graphics are used to isolate California drillers and identify regional differences in driller responses. Tag clouds are visual depictions of the word content of survey respondents' answers; the relative importance of the words included in the tag cloud is indicated by font size and color.

Analysis

Driller Respondents Overview

A clear majority (78%) of survey respondents work for companies that currently provide GSHP drilling; the remainder are from companies looking to enter the market. As the graph below illustrates, 66% of survey respondents who work in California provide GSHP drilling, whereas, 83% of survey respondents who do not work in California provide GSHP drilling. Furthermore, 34% of respondents who work in California do not provide GSHP drilling, compared with 17% of survey respondents who work outside of California. Thus, proportionally fewer California drillers have entered the GSHP market.

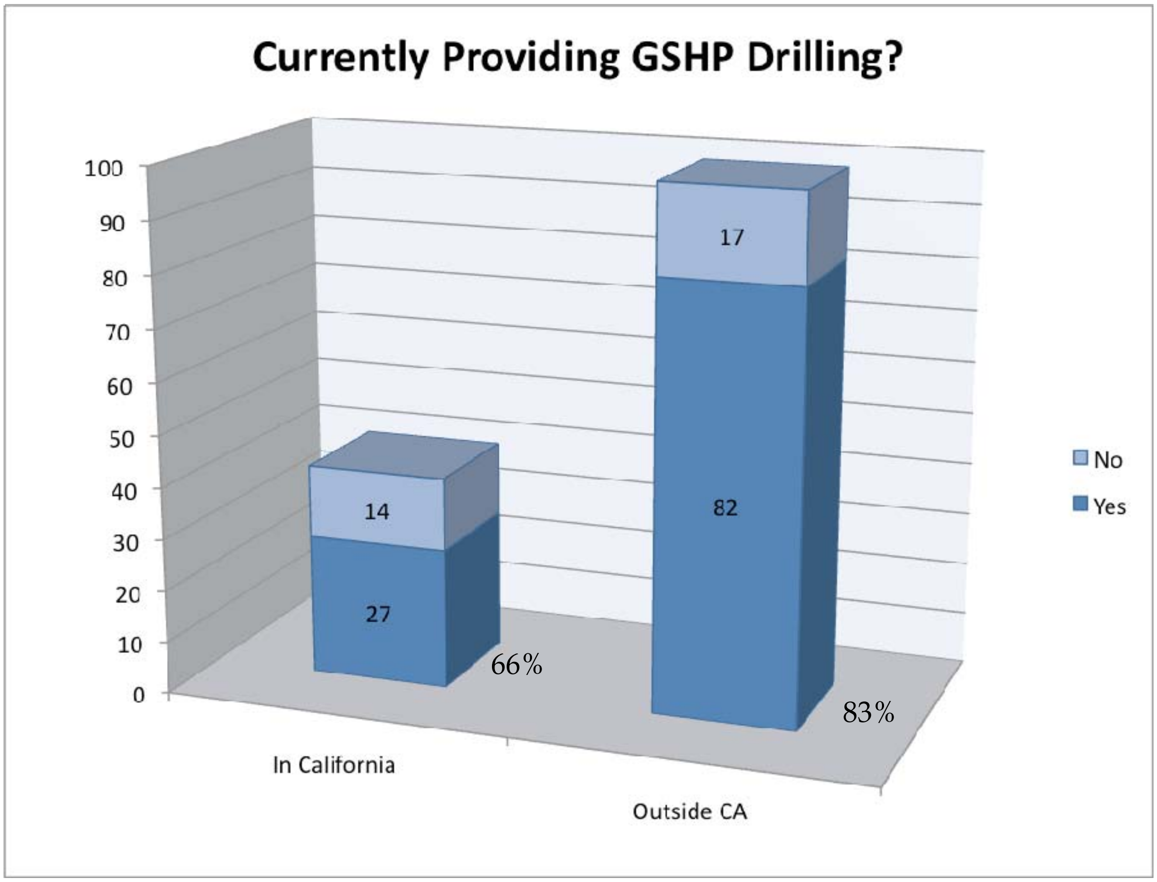


Figure 1: Proportionally fewer California water well drilling companies (66% Californian vs. 83% outside of California) have entered the heat pump market.

Overall, 61% of all respondents (and 58% of respondents who work in California) categorize revenues from GSHP products as either their "primary business" or as an "important segment" of their business. An additional 23% (15% in California) characterized their GSHP revenues as a "small but growing" part of their business. There are a relatively large number (24%) of California drillers who are not currently in the GSHP market but who expressed interest in entering the GSHP market.

Of those drillers (both within and outside California) who stated they are in the GSHP market, 108 out of 142, some 76%, have seen demand for GSHP borehole drilling increase since they started offering the service. Figure 3 below illustrates the increased demand for GSHP drilling services.

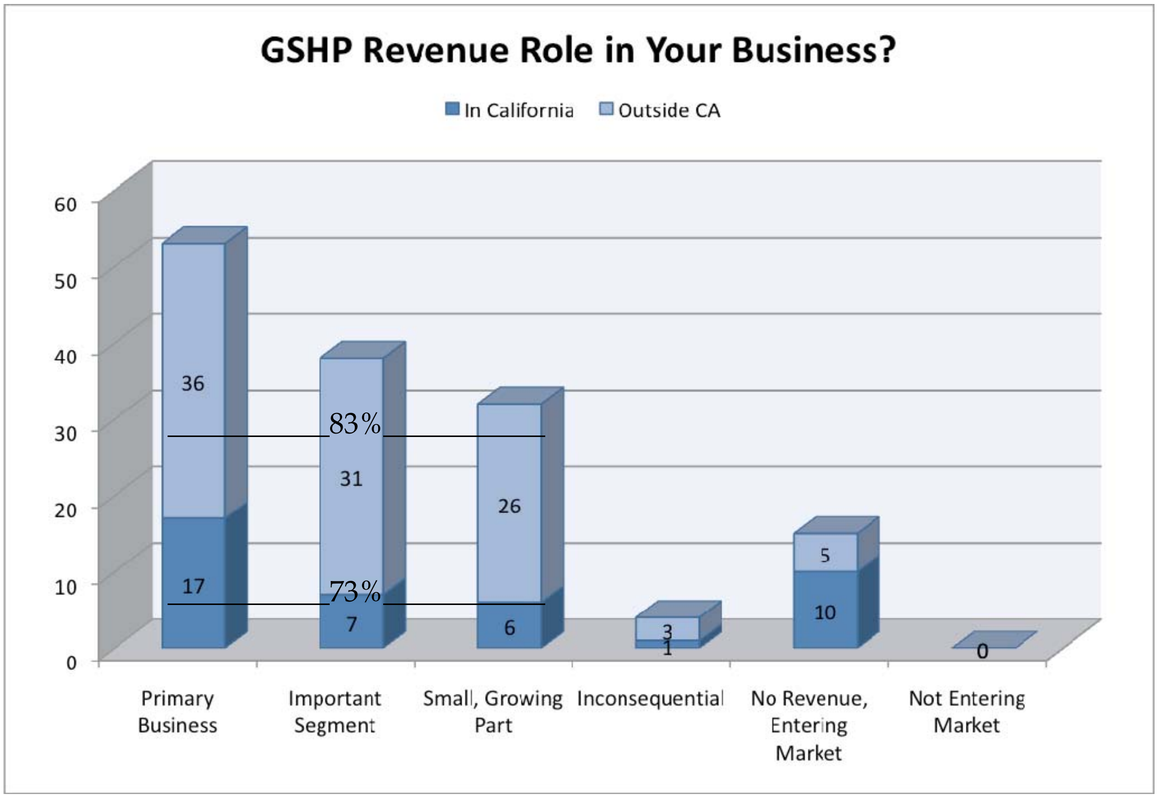


Figure 2: An overwhelming majority of survey respondents (73% Californian, 83% non-Californian) see GSHP work as strategic part of their overall business.

As to the cause for this increase in demand for drilling services, the rising cost of energy was cited by 95% of respondents as "somewhat important" or "very important" in increasing demand for GSHP drilling, following other factors such as "government/utility Incentives (85%), "green building trends (79%), "word of mouth (76%) and "increased demand from contractors/engineers/designers for GSHPs" (68%). In addition, over 63% felt the new federal residential and commercial tax incentives would increase demand for drilling services. While overall, 89% of respondents surveyed said they were keeping pace with increased demand, 21% of drillers in California indicated they are not keeping pace with increased demand, compared to 8% of drillers nationally. Thus, a higher proportion of companies doing GSHP drilling in California do not have the capacity to keep up with the increasing demand for their services.

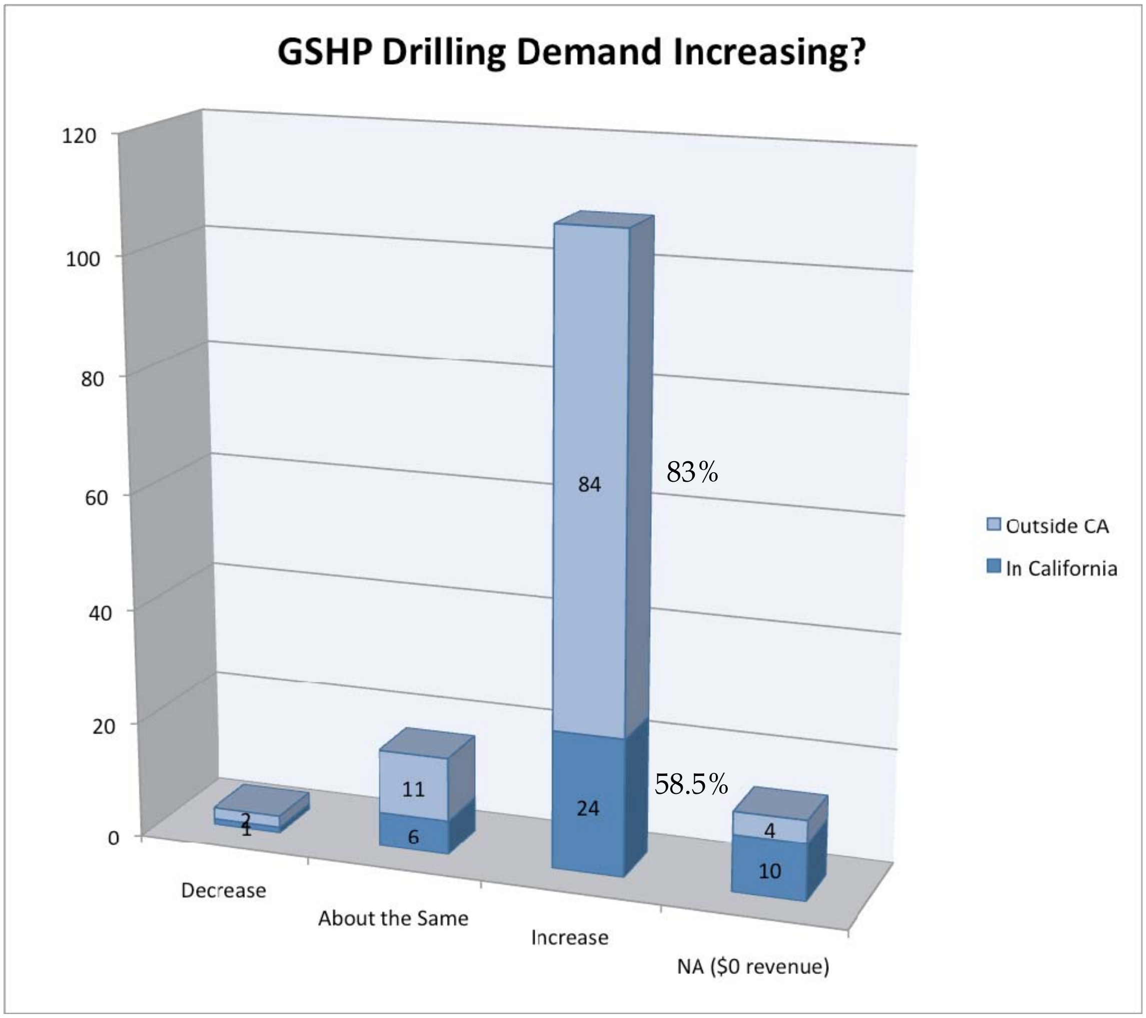


Figure 3: A large majority (58.5% Californian, 83% non-Californian) of the survey sample has seen demand for GSHP borehole drilling increase since they started their business.

GSHP Education

When respondents were asked how they first learned of ground source heat pumps and how they became involved in the drilling business, they replied in a variety of ways: a current driller is a former HVAC contractor who was asked about GSHPs by their customers, another is a former middle school teacher who learned about it from his students. Most respondents mentioned taking IGSHPA, Heatspring or NGWA training classes as their first contact.

The Figure 5 tag cloud highlights the content generated from the following question: "How did you first learn about GSHP technology?" Somewhat surprisingly, survey respondents indicated having a high level of GSHP customer interaction, with 91% of respondents saying they have either "complete responsibility for customer education" or "give additional information to help the primary point of contact for the project". Furthermore, a high number (54%) of companies reported marketing directly to consumers or meeting with installation designers during the pre-contract sales process (22%).

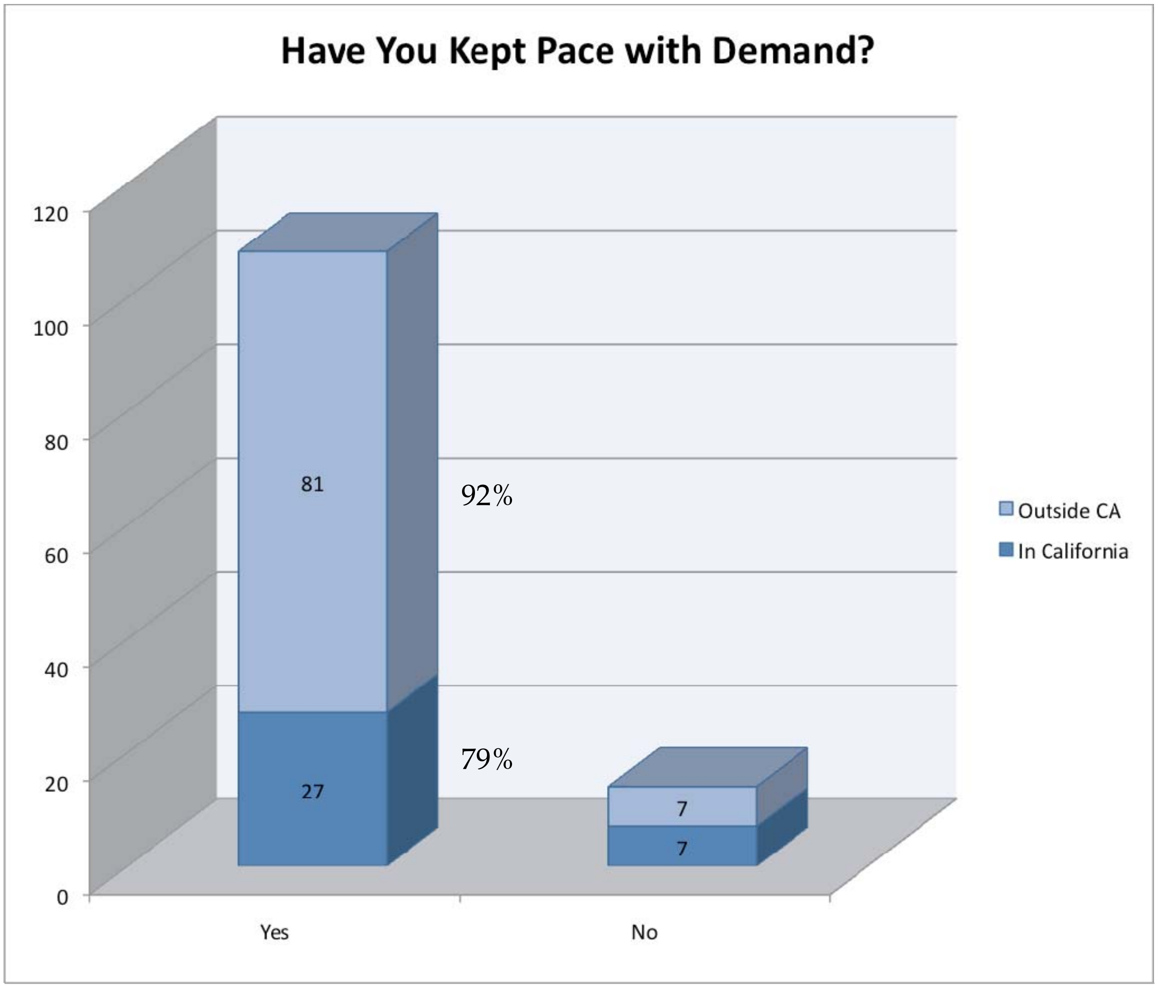


Figure 4: Companies have kept up with the increased demand spurred by tax credits and increasing awareness, but somewhat less so in California (92% Non-Californian versus 79% Californian).

When asked who their main point of contact was for GSHP drilling projects, drillers were nearly evenly divided in their responses, listing “HVAC dealers/reps” (30%), the “property owner/manager” (27%) and the “general contractor” (23%) by those polled. When asked to gauge the relative importance of factors for consumers choosing *not* to do GSHP projects, “too expensive” (75%) and “too much trouble and mess” (53%) led the answers both in-state and out.

There was an even split among those polled about whether an educational web site would lower company sales and marketing expenses as 30% thought “not at all” or “somewhat unlikely,” 36% “might/might not” and 33% “somewhat” or very likely.” However, the need for an educational web site was noted in the open-ended qualitative questions portion of this survey.

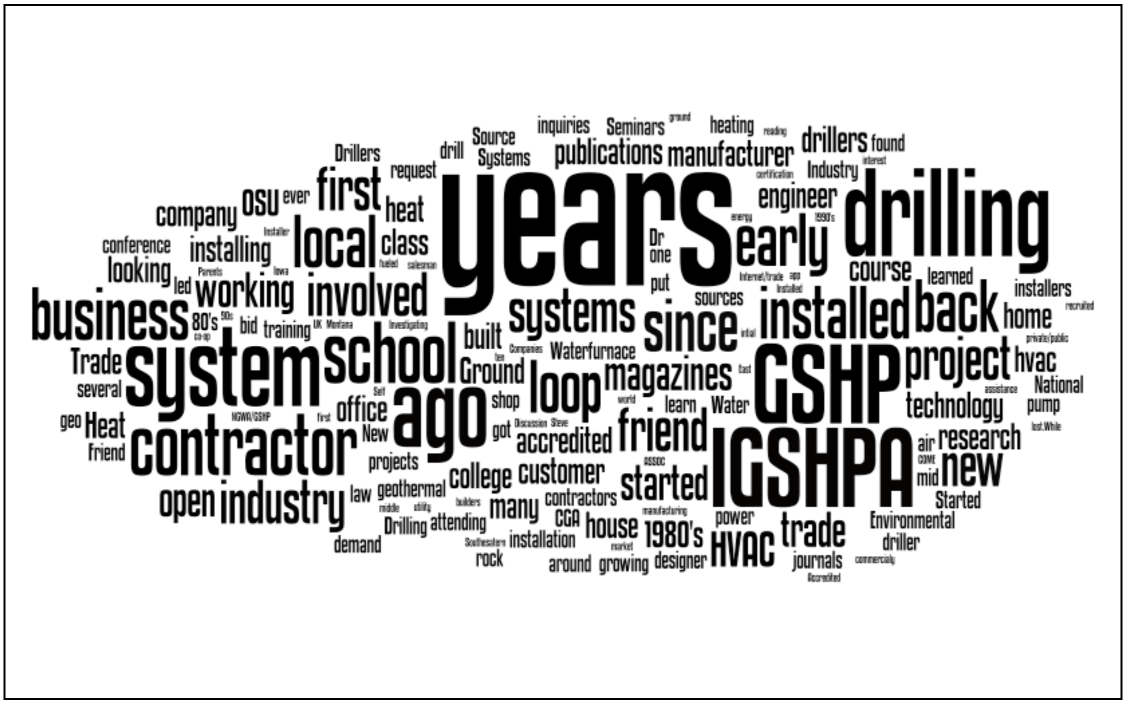


Figure 5: Tag cloud answers to survey question “How did you learn of GSHP?

Tag cloud images courtesy of ***http://www.wordle.net/*** under a Creative Commons Attribution license.

Respondents were asked an open-ended question about what could be done to increase consumer awareness and reducing sales cycle time. This question elicited a number of interesting responses. The following tag cloud (Figure 6) illustrates the content generated, many of the responses centered on the importance of increased media coverage of GSHP technology.

Business Operations

A number of survey questions were aimed at gaining insight into company business operations. The consensus on sales cycles was that residential GSHP jobs were generally completed in the one-to three month range (85%), commercial GSHP jobs were generally completed in the one-to-six months-plus range (87%) and school/government /military work generally took longer than four-to-six months-plus (53%, with 34% not serving this market). The overall start-to-finish time of an average project was pegged at “longer than six weeks” by 61% of respondents.

The following excerpts are responses to increase customer awareness and reduce sales cycle time. The first 4 responses focus on the importance of increased media attention and the following 4 responses speak directly to the GSHP industry’s online presence.

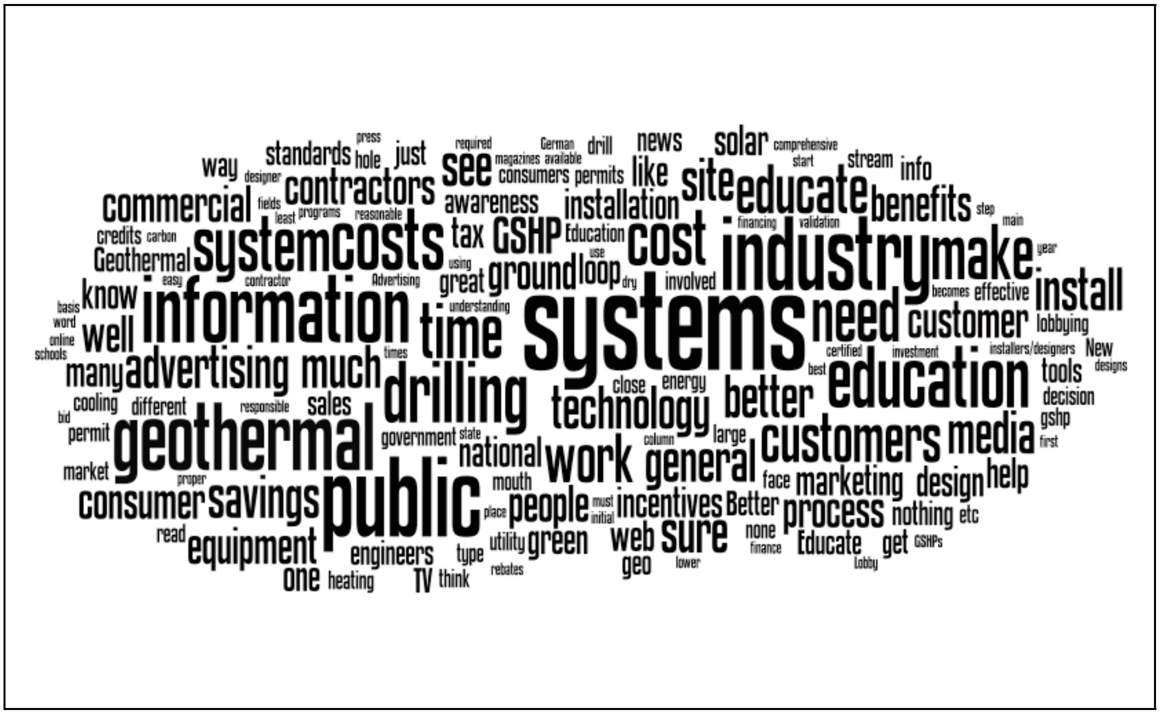


Figure 6: Tag cloud answers to survey question about reducing sales costs and sales cycle time.

Tag cloud images courtesy of ***http://www.wordle.net/*** under a Creative Commons Attribution license.

- GSHP systems need media attention badly. We all know they work well and are much more effective than solar. We need to be defining area where these systems are easy to install, i.e. easy digging and drilling conditions. We need to educate our general contractors, provide free seminars. We need better lobbying efforts, why do you think solar gets so much attention, even though they are polluting to create panels and are made overseas.

- More tools at my disposal to help educate myself so I can better educate and serve my customer. I will always meet with the customer face to face as many times as I can to close the sale. GSHP systems should be in the news, press releases, as much as you hear about solar. There is no "buzz" going about GSHP systems. When I tell customers about this technology they go "huh". If there is no buzz about it they think it can't be as great as I make it sound, as they have never heard about it. The customers need to have this technology in their face when they watch the news, read the paper, main-stream media.

- Improve public understanding of the benefits. A place where people can see the math (cost, coefficient of performance (COP), tax credits, operations, savings, compared to oil and gas' projected costs). Educate and encourage banks to make green energy project financing, green mortgages for homes built with renewables. These mortgages extend more credit to their customers since operating expenses are reduced by at least half.

- Focusing on concrete examples of cost savings for potential buyers to read. Case studies that show savings over other sources of heating and cooling. People will invest in geothermal and do it more quickly as it becomes a mainstay in the market. It's still seen as extremely expensive and risky. Word of mouth sells best as we see entire neighborhoods install geothermal one at a time. Those who have it like to brag about their savings to those who don't.

The responses directed at the GSHP industry’s online presence (below) capture an important perspective on the significant role online resources could play in increasing customer awareness about the GSHP industry. As these responses illustrate, part of building consumer awareness involves fostering knowledge of how regional differences affect GSHP projects.

- A website as suggested in question #14 could be counter-productive if it discusses costs. Costs vary by system type (horizontal/vertical), the formation thermal conductivity, the grout conductivity, labor rates, number heat pumps, tons/heat pump, etc. Pricing is best left to local experts who know their market.
- Our company is located in New England with bedrock really close to the surface. I get a lot of phone calls regarding horizontal systems, and people reading online that they are cheaper. This usually takes awhile to explain to customers that we do a different type of ground loop in New England, a type that needs drilling. Also, it would be helpful if the industry looked at the business of GSHPs on a geography basis, with different electricity costs for the different regions.
- This web site could offer a page that IDs certified drillers and certified installers that have systems that potential customers can see a system for themselves. Many are not sure how or if GSHP work they need to see it and hear it from someone who has one.
- I was looking for better animations that explain the geothermal heating/cooling process. I found one on YouTube (you can link to it on my company site, www.geosysteminstallers.com); however, it is in German. It's a great animation, but like I said, it's in German. Can't we come up with something better?

Drilling Information

The tag cloud below contains the content generated when drillers were asked the following question: “In most states drillers are required to submit drill logs to permitting agencies detailing number of bores and depths. Assuming this information could be made available in a public database, what other information would you find useful in these reports?”

Excerpts from driller responses are below; several suggestions focus on marrying available technologies such as GPS or Google Maps to geologic records relevant to the GSHP industry.

- Most drillers aren't geologists and their logs are poor at best. I would like to see better geologic information similar to how oil and gas drillers log the borehole.
- Google Map format
- Formations encountered
- Make the reports mandatory for every job
- Soil/rock type, depth of overburden

Figure 7: Tag cloud answers to survey question about what would be useful with more open and detailed drill log information.

Tag cloud images courtesy of ***http://www.wordle.net/*** under a Creative Commons Attribution license.

- Soil composition
- Static Water Level and Formation Encountered
- Static water levels, drill times, method, type of bits used and if mud rotary what amounts of drilling mud or lost circulation fluid used.
- Formation and thermal conductivity when available
- It would be helpful to know at what depth they hit water and had to case the hole.
- Interactive maps showing locations and info (like a Google Maps drilling formations and if casing was used
- Total time needed for the installation.
- Loop location triangulation measurements, satellite GPS coordinates of boreholes and loop field in a database/ customer available format specific to address
- Formations encountered, GPS boring location/ coordinates
- Subsurface and casing requirements
- GPS location of loop field for future neighboring installations could helpful.

- Soil conditions. Oklahoma already has a publicly accessible database, but the information provided by the drillers is incomplete.
- The drill logs should detail geology, amount of water encountered, casing required and drilling method.
- GPS coordinates, soil composition
- Geology of area, where was water encounter and how much
- What type of formations were drilled through and amount of water may determine what type of system and if the hole had to use a great deal of casing, which would increase the cost of the project
- Drilling conditions encountered at 10-20 ft depth intervals in order to accurately estimate nearby drilling conditions.

Government Incentives

Respondents were asked a number of questions intended to elicit views on the importance of government incentives for the GSHP industry. Significantly, government and utility incentives were cited by 84% of respondents as “somewhat important” or “very important” in increasing demand for GSHP drilling. In fact, a majority (62%) of drillers surveyed see a direct connection between government incentives and an increase in demand for their drilling services. Furthermore, when it comes to the issue of driller certification, 61% of respondents would support legislation for a special shorter “Green Collar Job” GSHP installation and borehole drilling certification.

In addition, 75% of drillers surveyed ranked a uniform permitting process at the local level as “somewhat” or “very important” to their business.

These responses suggest that federal government incentives have the potential to accelerate GSHP industry growth but that drillers perceive a need for standardizing the regulatory process at the local level.

Industry Growth

Drillers were asked an open-ended question regarding their perspective on GSHP industry growth: “In your opinion, what change would do the most for growing the borehole drilling industry?” Responses have been gathered into the tag cloud below.

The predominant responses to what would do the most to grow the GSHP industry revolve around incentivizing GSHP technology and standardizing the permitting process. As the responses below illustrate, these two suggestions often come hand-in-hand.

- Tax credits and public awareness. Streamline the permitting process.
- Reasonable driller licensing and regulation.

- Greater Government subsidies, and maybe stricter local "Green building codes." Higher fuel cost, Re-define the Geo-well permit requirements and remove the relevant ground water issues. Standardizing permitting.

Figure 8: Tag cloud answers to the question of what would do most to grow the GSHP industry.

Tag cloud images courtesy of ***http://www.wordle.net/*** under a Creative Commons Attribution license.

- Get the state of California to adopt the proposed Geothermal Well Standards part of Bulletin 74.

- Standardize the permits

- Adopt a permit process with one permit per project or one fee for the initial well and minimal fee for the next wells. No permit billing by the hour. There is no way to estimate this and if one gets a rogue inspector one can get punished with huge punitive permit fees. It will take the profit right out of a job.

- Really "drill" on the local ordinances -- and make them statewide. We've seen our projects delayed by 3 years because of local opposition -- often illegally.

- Standardization of the permitting process. Creation of a license for closed-loop holes i.e., less than the water well driller's license. Use of efficient purpose-built drilling equipment.

- Have a national GSHP driller’s license. Have multiple states accept others CEU we would gladly pay the cost as this is just a monetary issue for each state if you attended one and paid the fees in other states that would lower cost. As having to go to 8 states that I am licensed in takes away from my time on job sites and drives my cost as I am going back for the same classes 8 different times and not on the jobsite. Also if the government would fund the green energy projects and not give the stimulus money away to people that do not deserve it that would blow this industry wide open and make our country one of the true green leaders in the world.

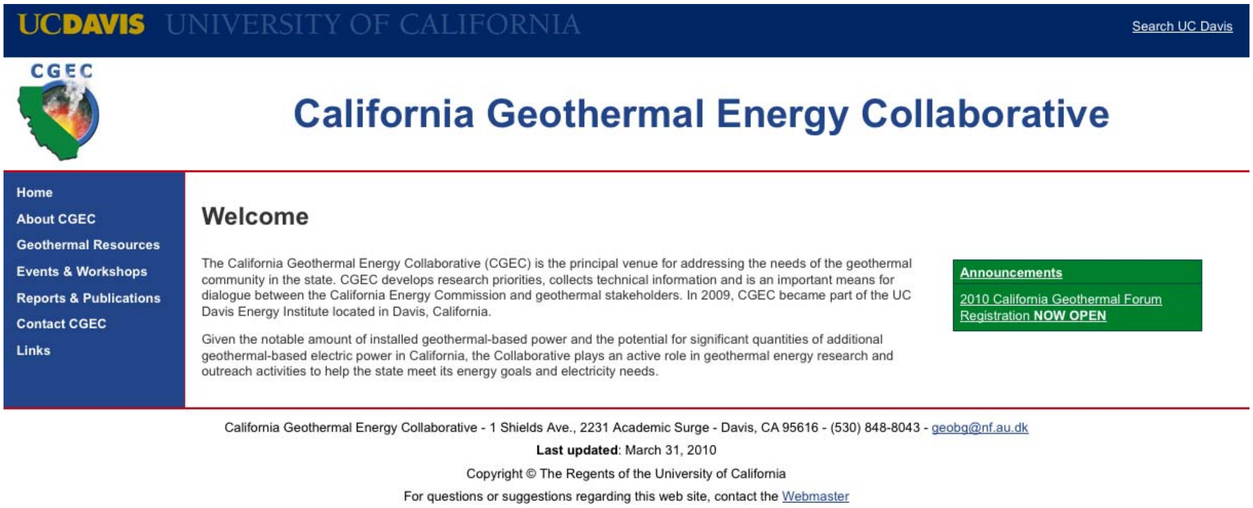
CHAPTER 11: Consumer/Drilling Web Portal

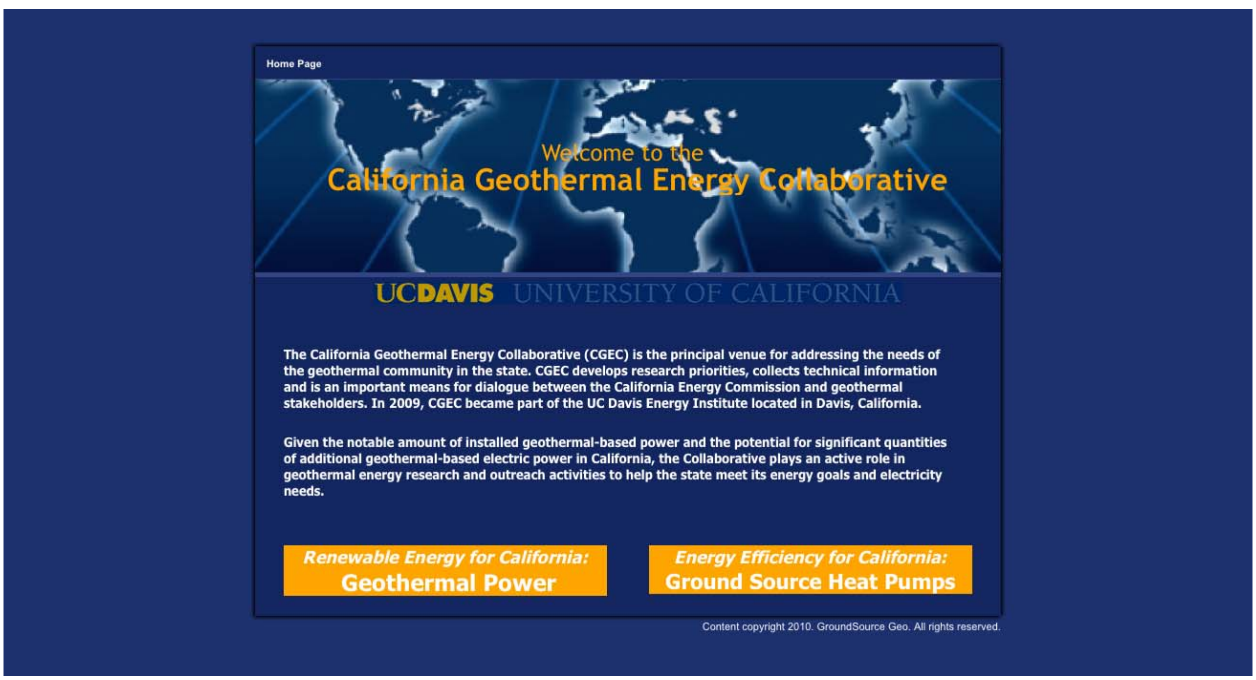
The development of the Project Negatherm website encompassed three goals:

- Developing web resources for the GSHP industry in California
- Developing a digest version of this information for California consumers
- Hosting a "living document" version of the report and other material gathered over the course of the project.

It soon became apparent that combining everything on one site would result in a confused product for the all of the user constituencies. The decision was made to create two sites: ProjectNegatherm.org and CaliforniaGeo.org. ProjectNegatherm.org would house the extensive collection of ground source heat pump, energy efficiency and green building policy documents as well as pertinent sections and appendices from this report. CaliforniaGeo.org would function as the consumer-facing front end featuring numerous examples of well-designed LEED Platinum "geo-powered" homes and buildings, descriptive and instructional videos, and guides to more information, including a variety of sizing and cost calculators. CaliforniaGeo.org would also serve the California GSHP industry by providing technical information, general marketing resources and links to the new California industry forum developed in conjunction with the Geothermal Heat Pump Consortium's Geoexchange.org website. Both ProjectNegatherm and CaliforniaGeo are set up with integrated WordPress blogs as well as Facebook pages and Twitter feeds.

The initial Project Negatherm website was originally to be hosted at the UC Davis California Geothermal Energy Collaborative (CGEC) site. While many logistical and financial considerations prevented this from happening directly within the project term, discussions are ongoing about shifting CGEC's primary and historical emphasis on geothermal power production to present a more balanced picture in future web design. A simple "main page split" concept was devised to U.S. EPA rate traffic between the two distinct subject areas.





Figures 1&2: Existing UC Davis Geothermal Energy Collaborative main page (previous page) and suggested CGEC Geothermal/GSHP "split" main page.

For the foreseeable future, both ProjectNegatherm.org and CaliforniaGeo.org will be hosted by Web Synergetics, the key project web developer and administrator of GHPC's Geoexchange.org site. The sites are constructed on the award-winning open-source Joomla portal engine and content management system which, unlike a more static HTML structure, keeps track of every piece of content (text, photos, music, video, documents) on the site and stores them in a logical, flexible fashion. Joomla is built upon the PHP scripting language and the MySQL database.

Sitemaps

Project Negatherm.org and CaliforniaGeo.org have very different looks and structures to underscore their different missions. ProjectNegatherm.org's content draws directly upon the primary research report tasks; CaliforniaGeo.org combines project research with material drawn from the energy efficiency, green building and clean tech communities to present an accessible information portal for consumers and industry. Both sites (and the blogs within them) will incorporate RSS news feeds on a variety of related topics.

ProjectNegatherm.org Sitemap

Home

- Project Negatherm Description
- CEC Disclaimer
- Latest Project Negatherm Blog Posting

Tabs

- GSHP Library (derived from Task 2.1)
  a) Regulation
  b) Case Studies
  c) Public Policy
  d) Financial Plans
  e) Technology
  f) Training
  g) Green Building
  h) Energy Efficiency
  i) General
- Permits & Regulation (derived from Task 2.3)
  a) Listing of all California Permitting Authorities
- Stakeholder Interviews
  a) Methodology (derived from Tasks 2.2 and 2.4)

    b) Interviews (derived from Tasks 2.6 and 2.7)

- Surveys
    a) Methodology (derived from Tasks 3.1 and 3.2)
    b) Driller Survey Data (derived from Task 3.3)
- Financial (derived from Tasks 2.7, 2.9 and 5.1)
- Advocacy
    a) Recommendations for Reform
- Project Negatherm Blog
    a) Home
        i) Latest News
        ii) Tag Cloud
        iii) Recent Post
        iv) Archives
        v) Top Headline
    b) About
- Community
    a) CaliforniaGeo.org home page
    b) California Geo Forum

CaliforniaGeo.org Sitemap

Home

- Revolving Stories
- How Heat Pumps Work
- Building Case Studies (Group of 4)
- Heat Pump News Feed
- Latest CaliforniaGeo Blog Post
- Latest Twitter Posts

Tabs

- Consumer Tools

a) Benefits

b) Technology Explained

c) Costs and Calculators

d) Financial Information

- Geothermal Installations (Two Pages)
- Videos
- CaliforniaGeo Blog
- GSHP Community Logon

a) Regulatory links

b) Permitting information

c) Soil maps

d) Technical info

e) California Geo Forum

- Project Negatherm

a) About

b) GSHP Library

c) Blog

Data Collection

The Project Negatherm team has assembled a wealth of primary and secondary data unique within the heat pump industry, combining information from a number of related disciplines. Using the DocMan document management extension for the Joomla development environment will allow secure, permission-based uploading, downloading and editing of documents across multiple categories and subcategories.

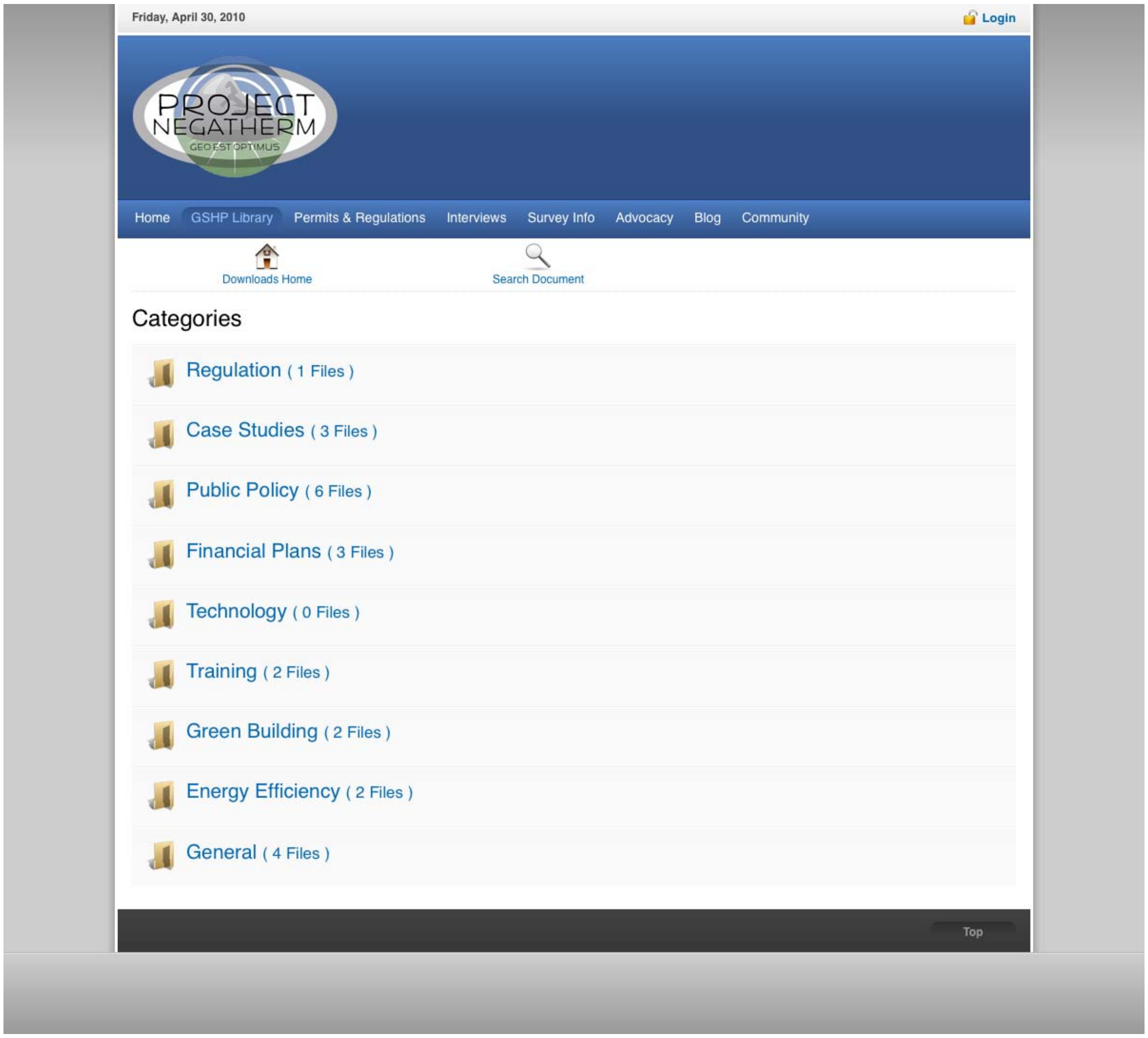


Figure 3: A view of the Project Negatherm library.

All documents will be fully searchable by author, organization, title, keyword and category. Files within each category folder will have supplementary synopses so that a user will be able to decide if a given file fits their informational needs.

Tuesday, May 04, 2010

Login

PROJECT NEGATHERM
GEO EST OPTIMUS

Home | GSHP Library | Permits & Regulations | Interviews | Survey Info | Advocacy | Blog | Community

Downloads Home

Search Document

Public Policy

Documents

Order by : **Name** | Date | Hits [Ascendant]

World Business Councill EE in Buildings Report

To achieve an energy-efficient world, governments, businesses and individuals must transform the building sector through a multitude of actions, which include increasing energy awareness globally. Buildings today account for 40% of the world's energy use. The resulting carbon emissions are substantially more than those in the transportation sector. New buildings that will use more energy than necessary are being built every day, and millions of today's inefficient buildings will remain standing in 2050. We must start now to aggressively reduce energy use in new and existing buildings to reduce the planet's energy-related carbon footprint by 77%, or 48 gigatonnes (against the 2050 baseline), to stabilize atmospheric CO2concentrations at the level called for by the Intergovernmental Panel on Climate Change (IPCC).
Based on extensive research conducted over the past four years, the Energy Efficiency in Buildings (EEB) project has developed recommendations and an actionable roadmap to transform the building sector. (See the roadmap on the CD Rom at the end of this document or access it at www.wbcsd.org/web/eeb-roadmap.htm). The project began with a comprehensive inventory of current and future building stock and modeled the impacts of consumer preferences and behaviors, designs and technologies, and policies on energy consumption. The project is focused on six markets — Brazil, China, Europe, India, Japan and the US — that represent nearly two-thirds of the world's energy use. This degree of data and sophistication has never been achieved before.

Date added:	04/23/2010
Date modified:	05/03/2010
Filesize:	5.62 MB
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The Green Bank and Green Jobs

Create a Green Bank to Create Green Jobs

Reed Hundt and Todd Filsinger
Co-Chairmen, Coalition for the Green Bank
December 3, 2009

We propose that Congress should pass a Jobs Bill, and include in it the Green Bank as proposed in the Van Hollen Green Bank Act of 2009, HR 1698. Under the name Clean Energy Deployment Administration (CEDA), this proposal drew overwhelming bipartisan support in the House Energy and Commerce Committee (51 yes, 6 no) and was incorporated in the American Clean Energy and Security Act of 2009 (ACES), the Waxman-Markey Bill, HR 2454. It was also passed on a bipartisan basis in the Senate Energy and Natural Resources Committee.
We propose that Congress move the Green Bank into the Jobs Bill, and capitalize it on a one-time basis with $25 billion, all of which would be returned, over time, to the Treasury. In order to meet the challenge of creating more than four million direct job years – all in the private sector – by the end of 2012, the Green Bank should have, as proposed by Congressman Van Hollen, the flexibility and dispatch of a small private firm. Instead of being an agency or instrumentality of the government, it would be governed by a board of public officials and private persons, and would operate in partnership with, but outside of, existing departments, much like the Export-Import Bank and other similar entities in our nation's history.
This memorandum explains the purpose and function of the Green Bank, addresses possible objections, and outlines the content of the legislation that would create it.

Date added:	04/09/2010
Date modified:	04/09/2010
Filesize:	274.94 kB
Downloads:	4

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Figure: 4: Document listing within "Categories" folder provides file summary information.

Web Portal Page Design and Production

ProjectNegatherm.org uses a relatively utilitarian SolarSentinal design theme befitting its mission as a research project web site. In addition to the incorporation of final report sections, the plan is to provide a single source for research involving ground source heat pumps in California and across North America. The SolarSentinal theme also has a number of beneficial search engine optimization features.

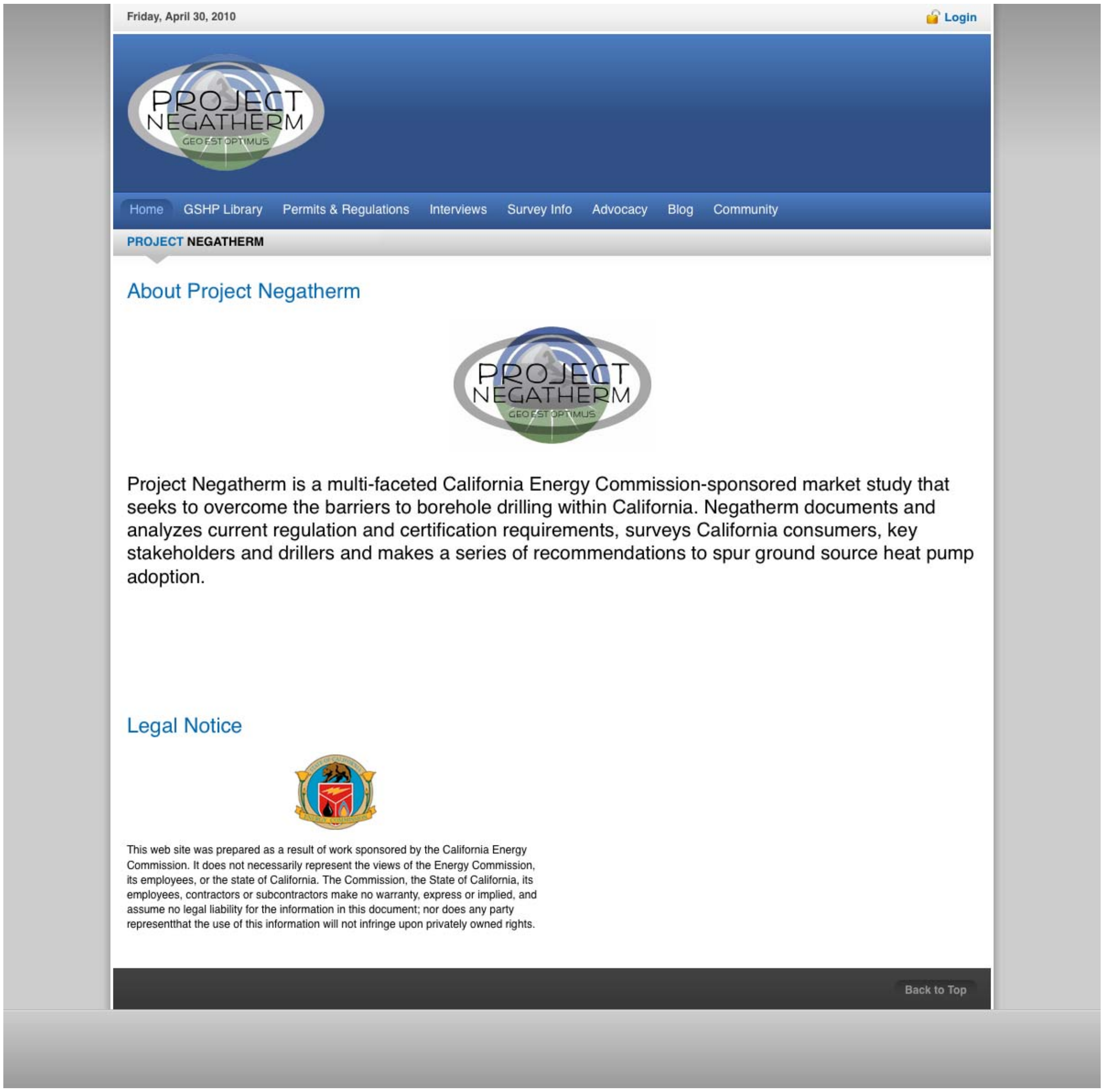

Figure 5: ProjectNegatherm.org main page.

The blog utilizes a WordPress engine employing a SolarSentinal common visual theme. The blog editorial outlook will feature research-oriented topics that touch on building energy efficiency, thermal transfer, and thermal storage. Guest bloggers will be drawn from Project Negatherm Advisory Board members and thought leaders throughout industry, national labs and academia.

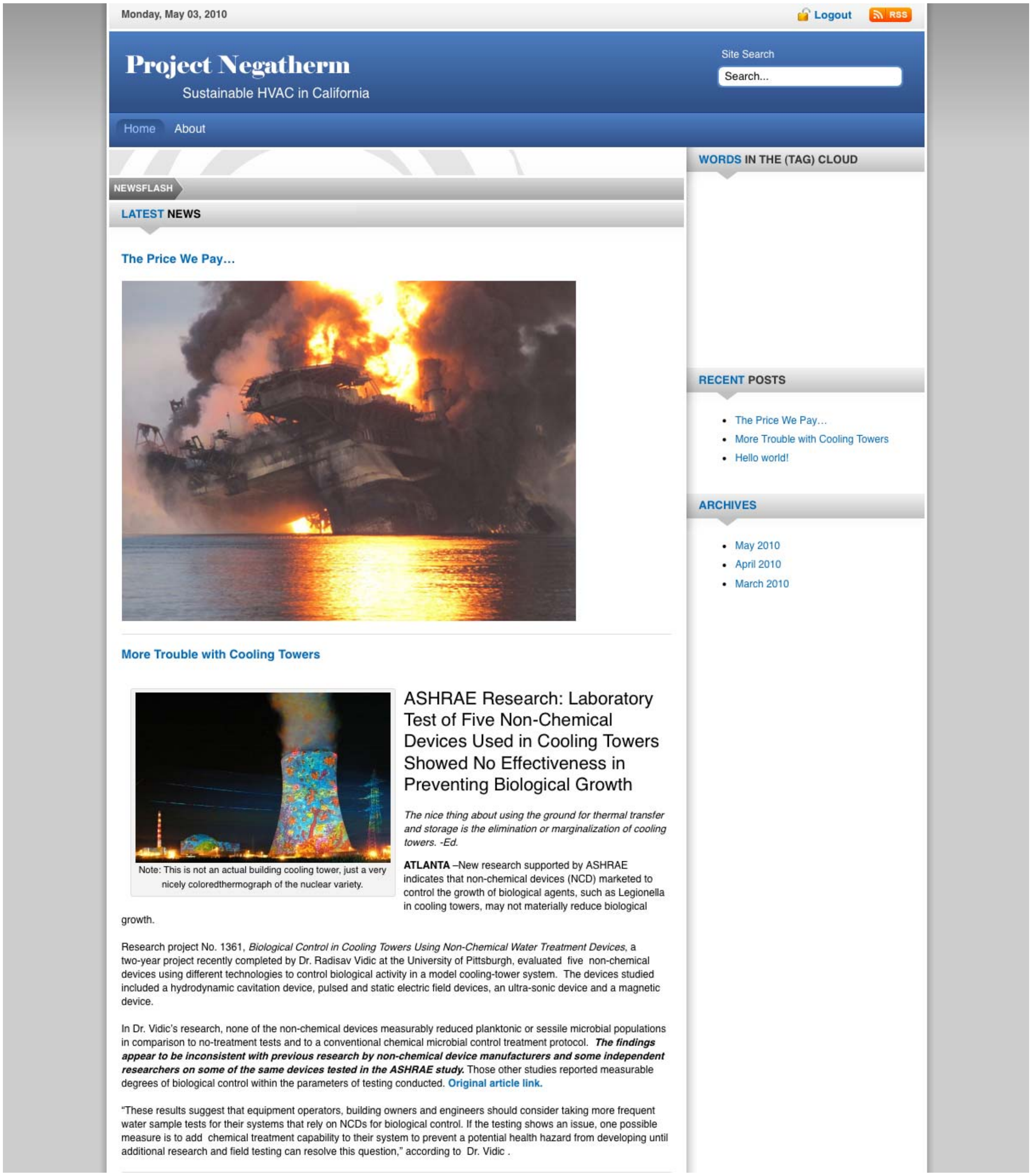

Figure 6: ProjectNegtherm.org blog

The CaliforniaGeo.org site will have a completely different look and feel than its counterpart. The rich green "Moxy" theme features circular shapes that subtly suggest boreholes. The rotating front page "RokStories" module serve up examples of attractive LEED Platinum and Net Zero buildings that utilize ground source heat pumps. The front page will also display educational video, multi-topic newsfeeds, recent blog and Twitter posts, and additional architectural case studies, which contrast markedly with traditionally amateurish heat pump industry material. With some search optimization and industry referral support, CaliforniaGeo.org can quickly become an engaging, honest broker of heat pump information.

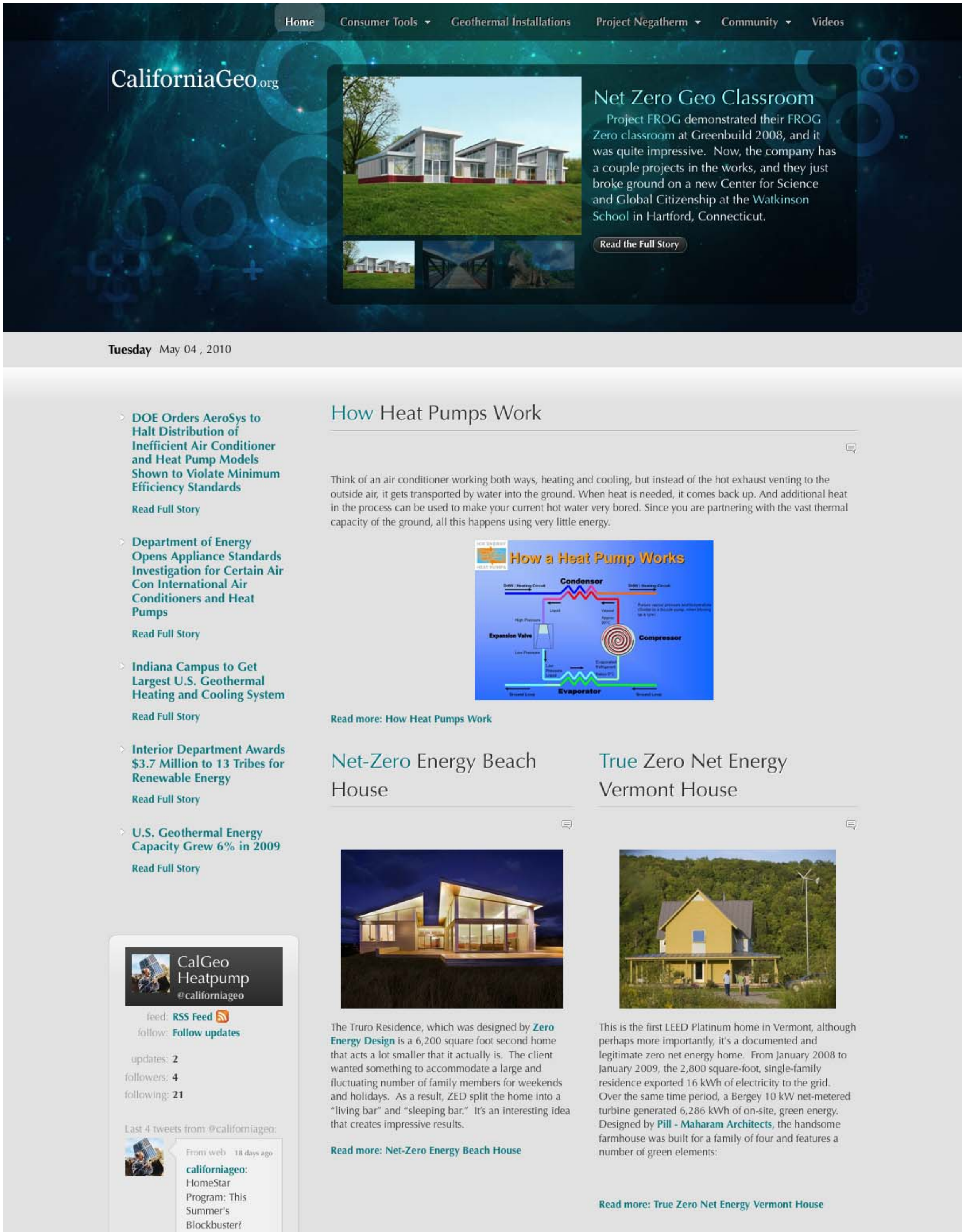

Figure 7: CaliforniaGeo.org main page

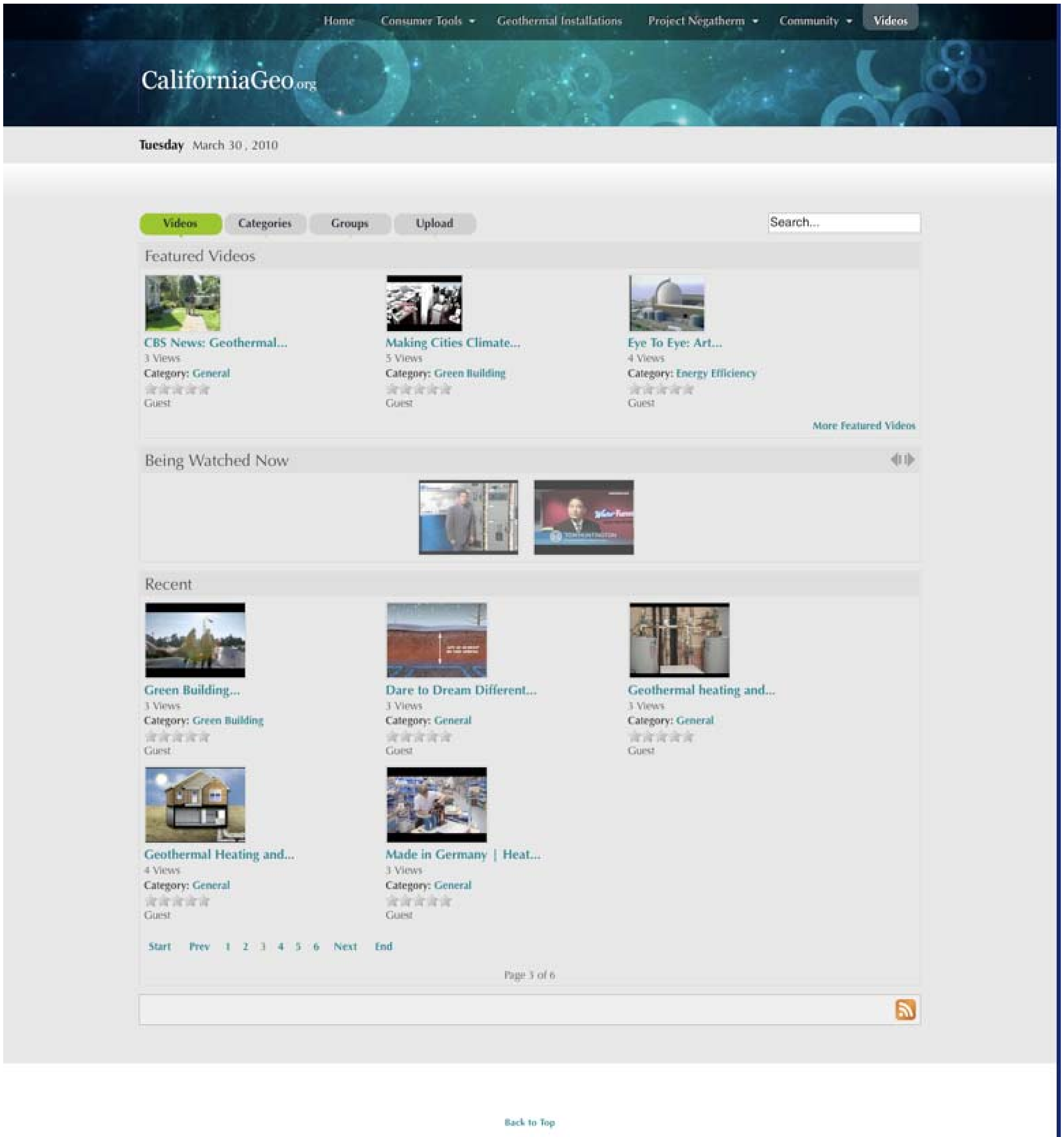

Figure 8: CaliforniaGeo.org video page.

Besides functioning as a consumer information destination, CaliforniaGeo.org also will serve as a resource to California industry. A registered section of the site will give providers access to information on best practices, specific climate and soil conditions, general marketing examples, and information on regulatory and legislative activity. In addition, CaliforniaGeo.org's industry section integrates with the Geothermal Heat Pump Consortium Geoexchange.org's newly configured California Discussion Forum. Future cross-promotion with the California Groundwater Association, IGSHPA, and National Groundwater Association is planned.

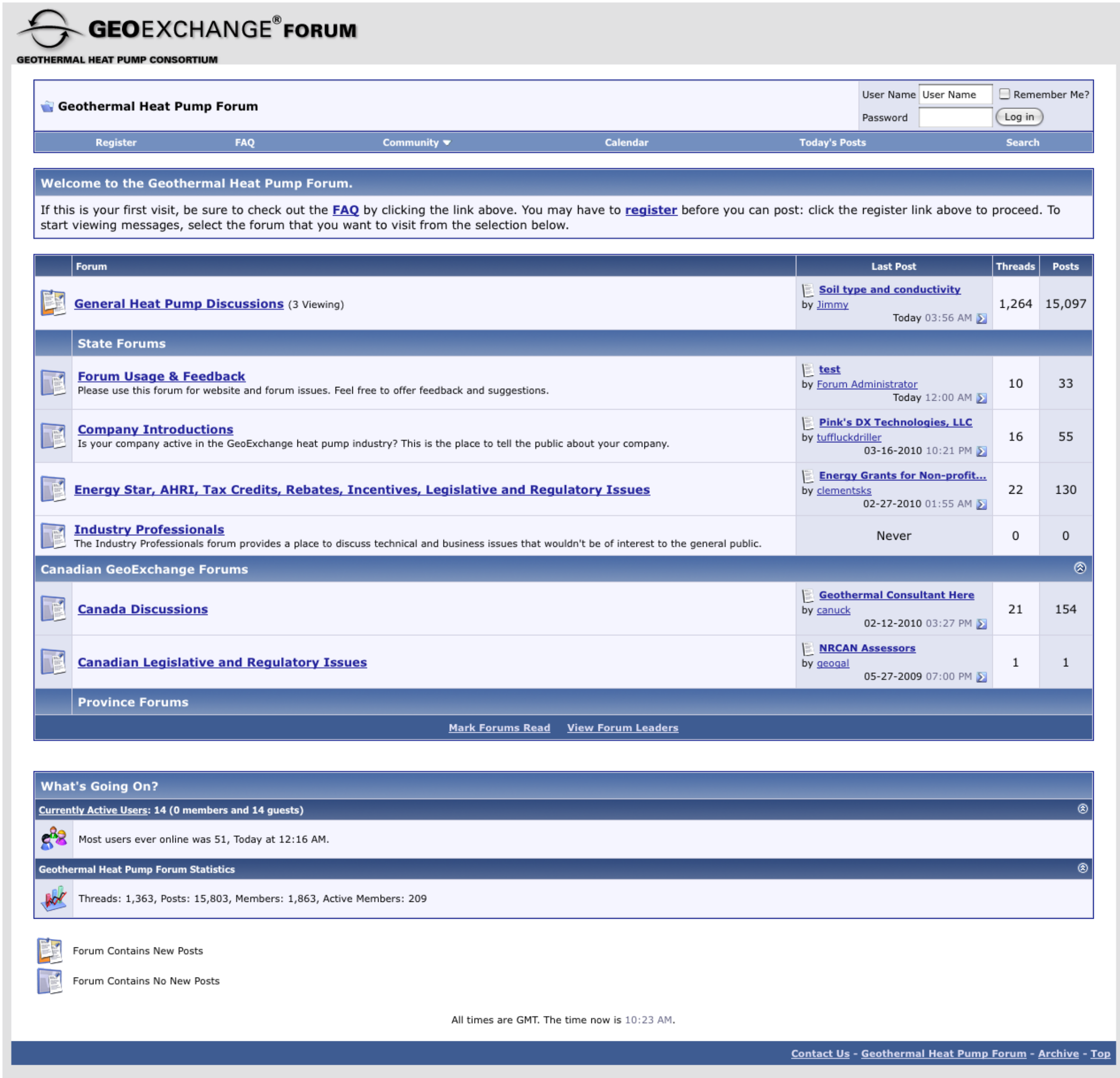

Figure 9: CaliforniaGeo.org's industry section integrates with GHPC's Geoexchange.org's California Discussion Forum.

Web Portal Review and Quality Assurance

The web portal component differentiates Project Negatherm from a typical research project in that the intent is to create a living, changing resource rather than a static paper. Of course, the initial emphasis and concentration is on a paper, but thereafter, appropriate paper sections will provide the basis for the web product.

Project Negatherm.org and CaliforniaGeo.org are currently up and running but under password protection until official launch.

Delivery of Finished Portal

The conversion/translation of the final Project Negatherm report into hosted web products for industry and consumers is being delivered as existing sites and on CD to the Energy Commission under sU.S. EPArate cover. The web sites are, by nature, constantly changing, but much work has been done on back-end structure to facilitate front-end content.

CHAPTER 12:
Financial Overview

Summary

Energy efficiency and renewable energy technologies share a common financial impediment to broader market dispersion: high first costs. Ground Source Heat Pumps are no exception to this rule. However, since GSHPs are one of the most efficient heating and cooling systems available, the technology has relatively short payback periods when compared to other renewable energy options. The Energy Pyramid (image below) illustrates the order of operations for energy saving measures. Measures located at the bottom of the pyramid are much more cost effective than those at the top. As such, GSHPs should be an attractive financial option in the energy pyramid after basic "energy conservation" measures such as weatherization and insulation.

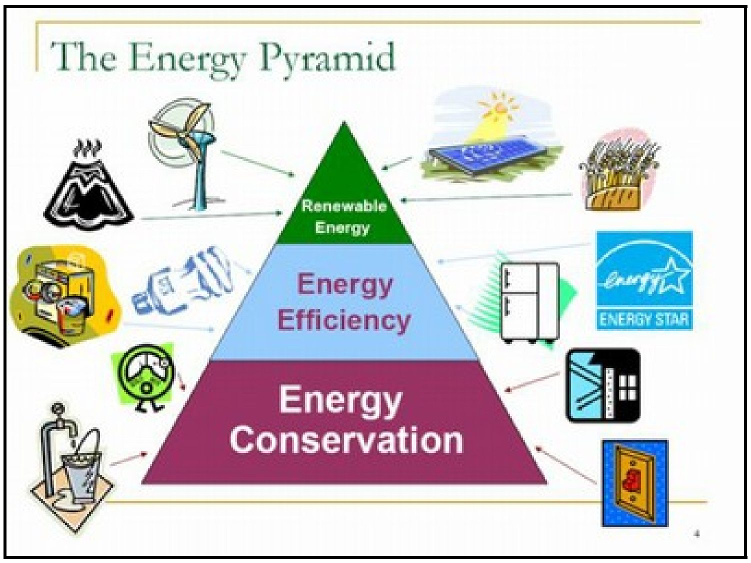

Figure 1: The classic energy industry version of "reduce, reuse, recycle."

Credit: U.S. Department of Energy

While the first cost barrier has proven challenging for GHSP technology, it is a hurdle that can be overcome with proper financing mechanisms. According to the Geothermal Heat Pump Consortium, "an additional state $2,000 rebate on the purchase of a geothermal heat pump – or the availability of low interest loans – could generate an additional 200 heat pump sales every month in a typical state, or 2,400 geothermal heat pump unit sales at the end of the first year.[77]" Having the financial infrastructure that will enable consumers to adopt technologies like GSHPs

[77]http://www.geoexchange.org/index.php?option=com_content&view=category&layout=blog&id=371&Itemid=368

will be a key step in both meeting aggressive carbon reduction targets and scaling energy efficiency installations far beyond historical growth.

Currently, there are a number of innovative financing options that have the potential to play an important role in spurring demand for GSHP systems. Property Assessed Clean Energy (PACE) Financing and utility-sponsored loop lease programs, both originally developed in California, are two means by which the industry could achieve much greater market adoption. In addition, the idea of Energy Efficiency/Renewable Energy Banking (aka "The Green Bank") has been gaining ground with the US and British governments, attaining strong (and rare) bipartisan status in the current Waxman-Markey energy bill and was recently announced as a 2010 budget item in the United Kingdom[78]. In order for GSHPs to become mainstream elements of these financing mechanisms, however, the GSHP industry needs to become a much more visible member of the energy efficiency and green building community.

Property Assessed Clean Energy (PACE) Financing

Property Assessed Clean Energy (PACE) financing was designed to help homeowners overcome the high first-cost barriers associated with renewable and energy-efficiency home improvements like GSHPs. PACE financing is similar to a loan, whereby a homeowner can borrow funds from local government and rU.S. EPAy the amount borrowed via a special assessment on property taxes or other locally-collected tax or bill (for example, utility, water, or sewer bills).

PACE financing originated in Berkeley in 2008 with the Berkeley Financing Initiative for Renewable and Solar Technology or "FIRST" program. The BerkeleyFIRST pilot program, which commenced in 2009, enabled Berkeley property owners to borrow money from the City's Sustainable Energy Financing District. In return, the city levied a special tax on the homeowner's property tax to be rU.S. EPAid, with interest, over 20 years. In order to participate, property owners had to opt into the PACE program. The program requires no upfront cost to the homeowner and importantly, the rU.S. EPAyment obligation transfers with ownership. The initial phase sold out in nine minutes.

As a charter city, under California law, the City of Berkeley was able to implement PACE financing without statewide enabling legislation. However, California law had to be amended in order to enable other cities and local jurisdictions that do not fall under charter status to do the same. AB 811, California's Clean Energy Municipal Financing Law, was the legislature's answer. Passed in September 2008, AB 811 enables cities and/or counties to form assessment districts with the authority to levy property taxes to finance energy efficiency or renewable energy related improvements. Several other local jurisdictions, including the City of Palm Desert and Sonoma County have since launched PACE-style programs.

Most states require legislative authorization for cities and/or counties to issue special assessments on residents' property taxes. Since 2008, 16 states have passed legislation to

[78] http://www.washingtonpost.com/wp-dyn/content/article/2010/03/21/AR2010032102571.html

authorize PACE-style financing and 2 states permit it based on existing law[79]. A map outlining which states have passed legislation to enable PACE financing is below.

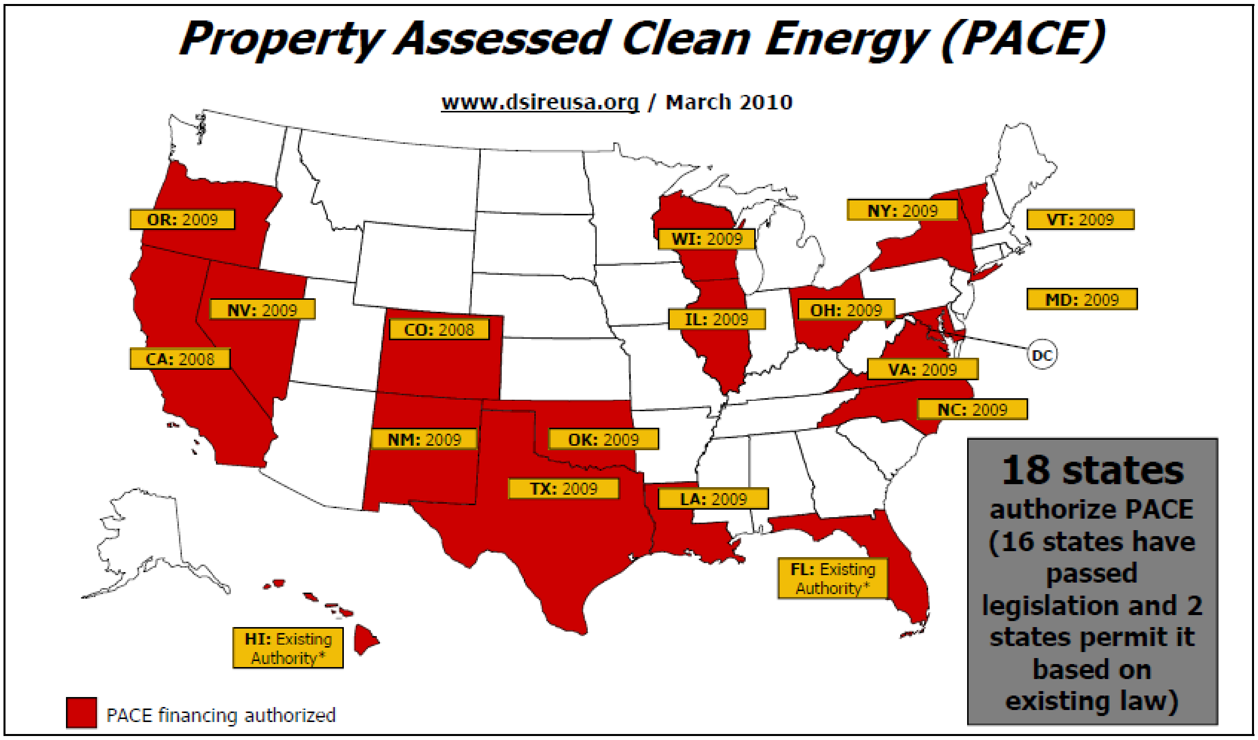

Figure 2: The PACE funding concept has spread quickly over the last year.

Credit: DSIRE.org

PACE financing is a cornerstone of the Obama Administration's "Recovery Through Retrofit" initiative and Federal funding for PACE programs are available through Department of Energy (DOE) funded State Energy Programs and Energy Efficiency Conservation Block Grants. The DOE received approximately $80 million in applications under the State Energy Program, to provide the upfront capital for PACE-type programs in 2009.

As a new financing model, PACE programs are encountering some legal questions as they spread across the country. Lenders in some states are opposing the program because the PACE loan rU.S. EPAyment is a senior lien on the property. As the senior lien, the PACE financing is ahead of the mortgage itself, and if the homeowner defaults, the lender could end up responsible for the payments if the mortgage is greater than the home's value[80]. However, In order to streamline the process, the White House developed a PACE Policy Framework[81] in 2009 and the Department of Energy (DOE) is working with existing programs and those designing pilot programs to collect information and provide additional guidance when

[79] http://www.dsireusa.org/solar/solarpolicyguide/?id=26

[80] http://greeninc.blogs.nytimes.com/2010/03/11/home-efficiency-program-poised-for-ramp-up/

[81] http://www.whitehouse.gov/assets/documents/PACE_Principles.pdf

appropriate[82]. Ultimately, it seems unlikely that the resistance posed by mortgage lenders will adversely impact PACE financing programs.

GSHP applications have not yet been undertaken as part of a PACE program. However, local jurisdictions can make GSHPs eligible for PACE financing – Sonoma County has done just that under its Energy Independence Program. The GSHP industry will need to advocate for inclusion in PACE-style financing programs.

CaliforniaFIRST[83]

CaliforniaFIRST is a statewide pilot program for property assessed clean energy (PACE) financing. CaliforniaFIRST is sponsored by the California Statewide Community Development Authority (an association of counties and cities), administered by Renewable Funding, LLC and underwritten by the Royal Bank of Canada Capital Markets. CaliforniaFIRST will pilot in a limited number of counties and cities beginning in summer 2010[84].

A pilot stage of the CaliforniaFIRST Program will roll out in a limited number of counties and cities beginning in summer 2010. Participating counties currently include: Alameda County, Fresno County, Kern County, Monterey County, San Benito County, San Diego County, San Luis Obispo County, San Mateo County, Santa Clara County, Santa Cruz County, Solano County, Ventura County, and Yolo County. The program received funding totaling $16.5 million from a California State Energy Program (SEP) grant[85].

Once the Program is launched, a property owner will be able to access an on-line web portal to[86]:

- Investigate energy and water improvements that are right for their property
- Calculate the annual assessment payment and associated energy and water cost savings
- Find eligible contractors
- Research additional local programs that provide incentives and education on energy and water efficiency
- Apply for financing

[82]http://www1.eere.energy.gov/wip/solutioncenter/pdfs/EECBG_PACE_Legal_Issues_121509.pdf

[83] http://www.renewfund.com/node/220

[84] http://www.renewfund.com/node/223

[85] Participating counties are: Alameda, Fresno, Kern, Monterey, Sacramento, San Benito, San Diego, San Luis Obispo, San Mateo, Santa Clara, Santa Cruz, Solano, Ventura, Yolo. (http://www.renewfund.com/sites/default/files/2-17-10 CalFIRST FACT SHEET.pdf)

[86] http://www.renewfund.com/node/223

Utility Loop-Lease Programs

Other financing mechanisms, such as utility-sponsored loop-lease programs, have proven successful at reducing upfront cost barriers for GSHP consumers. Since 2007, rural electric cooperatives (RECs) have been able to obtain long-term loans with terms of up to 35 years at the cost of government funds from the U.S. Department of Agriculture Rural Utilities Services (RUS) to provide the outside-the-building portion of GSHP systems to customers in exchange for a tariff on the utility bill[87].

In addition to reducing the upfront cost barrier for consumers, loop lease programs achieve cost savings through economies of scale by coordinating GSHP applications for entire communities or subdivisions. The first GSHP loop lease program was developed in California in 1993 by Plumas-Sierra Rural Electric Cooperative (PSREC). The Delta Montrose Electric Association (DMEA), located in Colorado, also implemented an innovative GSHP financing program in 1997.

These programs illustrate the success GSHP technology can attain when efforts are made to educate consumers, coordinate and streamline the installation process to capture economies of scale, and provide financing to reduce upfront cost burdens for customers.

Plumas-Sierra Rural Electric Cooperative

Plumas-Sierra Rural Electric Cooperative (PSREC) developed the first GSHP lease-loop programs in California. In 1993, PSREC launched a pilot program to test the long-term effectiveness of offering a long-term (30 year) loop-lease program to offset the high initial costs of GSHPs for their customers. The pilot concluded successfully in 1996 and the full program was launched in 1997. Today, PSREC offers 30-year, non-transferable, interest-free loans with a maximum loan amount of $14,994. The monthly payment is added to the customer's monthly electric bill and the amount of the loan is based upon the size of the loop installed[88].

GeoExchange Monthly Loop Lease Payments, with Normal Site Conditions[89]

Heat Exchanger Size	Horizontal Loop	Vertical Loop
3 ton	$12.45	$24.95
4 ton	$14.95	$29.95
5 ton	$17.95	$36.95
6 ton	$20.45	$41.65

Figure 3: The Plumas-Sierra lease rates are extremely attractive.

[87]http://www.goodcompanyassociates.com/files/manager/TFIC_GCA_Geothermal_Report_FEB2010_COMPLETE.pdf

[88] Market Development Group Case Study, 2007.

[89] http://www.psrec.coop/energy_renewable_geo.php?sec=enersol&pag=enerrenew

PSREC maintains a website for their GSHP loop-lease program which contains a list of certified HVAC contractors for members to choose from, and provides comprehensive marketing materials to prospective customers, including a CD and PDF documents.

PSREC's loop-lease program has been successful for several reasons. PSREC was able to negotiate a competitive per-foot drilling price by coordinating drilling schedules so drillers can do bulk drilling[90]. PSREC has also forged strong relationships with manufactures, suppliers, HVAC contractors/installers, drillers, builders and local county officials who permit the jobs. According to program administrators, to date the PSREC program is responsible for over 450 GSHP installations comprising over 2500 tons of capacity[91].

Delta-Montrose Electric Association

The Co-Z Energy Program, piloted in 1997 and formally launched in 1998, was developed by Delta-Montrose Electric Association (DMEA) for their southwestern Colorado service territory. Under the Co-Z program, the DMEA performs an energy analysis of the home, customizes GSHP system design, and locks in electricity rates for a determined interval of years. DMEA pays for the installation of major components of a homeowner's GSHP system, excluding the ductwork or other in-home elements, and the system is financed for 50 years on a monthly lease payment that includes equipment maintenance. The lease is rU.S. EPAid on the customer's electric bill.

Similar to PSREC, the success of DMEA's Co-Z Energy Program hinged on the electric cooperative's ability to create the infrastructure necessary to support the program. Not only did DMEA develop relationships with trade partners, it created a HVAC subsidiary called Intermountain Energy Services One to control pricing, quality and customer care. DMEA also worked with drillers and the state's water quality dU.S. EPArtment to expedite the drilling rules for GSHP technology. As a result, GSHP loops can be permitted and installed by drilling contractors without the need for water well licenses and regulations when used in geothermal installations. This is an area where Cal's procedures can be improved.

Green Bank Proposal

Another financing concept that has been gaining momentum is that of a "Green Bank." Both H.R. 2454, the Waxman-Markey Bill, and the Kerry-Boxer Climate Bill include provisions establishing a Green Bank or Clean Energy Development Authority (CEDA). Under these proposals, the Green Bank would be either an independent non-profit bank wholly owned by the federal government with a Board appointed by the President or the Secretary of Treasury (House version), or a semi-autonomous entity within the Department of Energy (Senate version). The Green Bank would make very low interest loans to clean energy projects or energy efficiency projects designed to make those projects competitive with fossil fuel projects. Proponents are seeking at least $10 -$20 billion in funding which could then be leveraged to

[90] Conversation with Sharon Schwilling, PSREC Energy Services Assistant, Geoexchange Program, October 14, 2009.

[91] Email correspondence with Sharon Schwilling, PSREC Energy Services Assistant, GeoExchange Program, August 20, 2009.

finance between $100-$400 in clean energy and energy efficiency projects. Funding would be provided either by the sale of Treasury bonds, the income from which would be used to buy 100% of the shares of the Bank, or through income from the sale of allowances in a cap and trade system[92].

Green Bank advocates are proposing a program to fund up to 100% of the cost of residential, small business and commercial retrofits and to limit rU.S. EPAyments to the amount of the energy savings. Furthermore, proponents envision the Green Bank providing financing support to utilities, energy service companies (ESCOs), PACE programs, state programs and other businesses, enabling those entities to implement energy retrofits. The two diagrams below, developed by The Coalition for Green Bank (CGB), a consortium of energy industry leaders including renewable resource developers, original equipment manufacturers, investors, financial advisors and consultants, further illustrate these concepts.

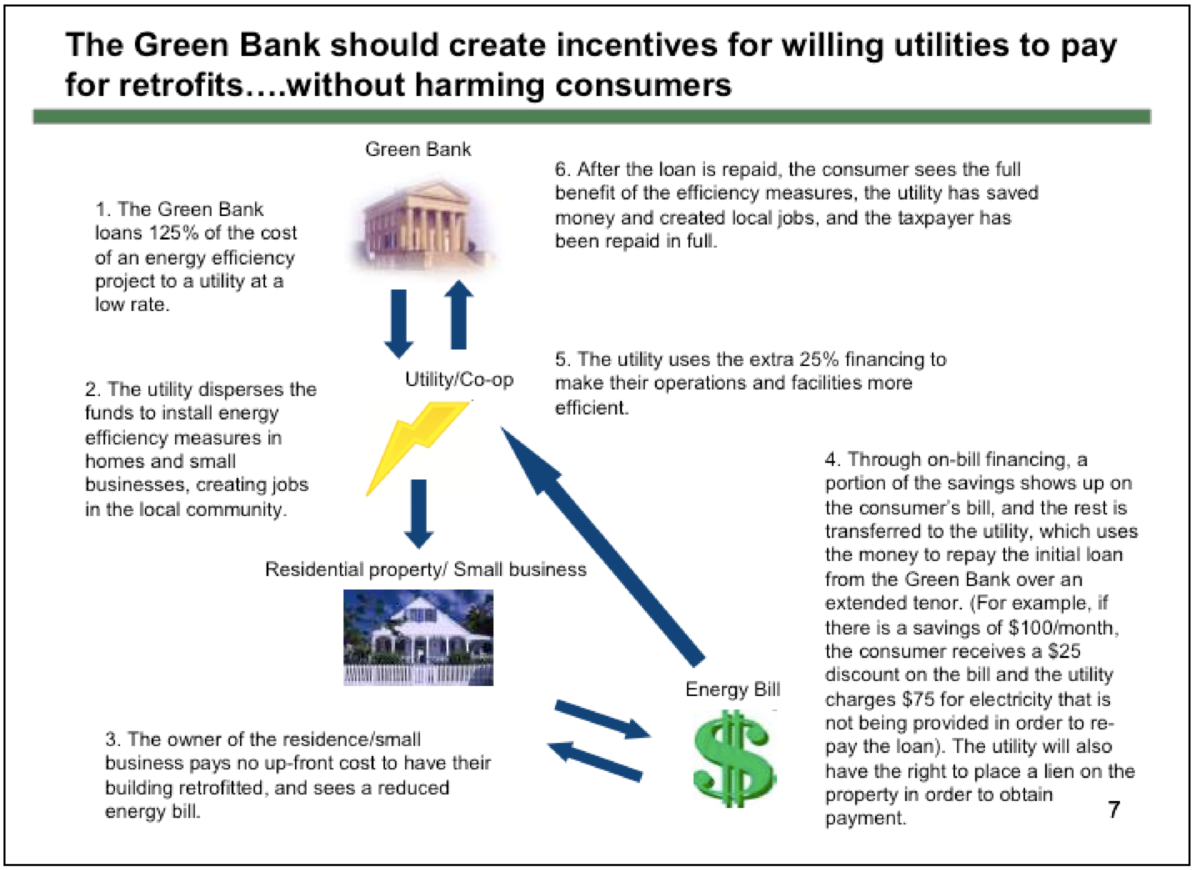

Figure 4: Green Bank utility incentive concept.[93]

Credit: Washington Post

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92 http://www.coalitionforgreencapital.com/uploads/2/5/3/6/2536821/ken_berlin_skadden_presentation.pdf

93 Create a Green Bank to Create Green Jobs, Hundt and Filsinger, Coalition for a Green Bank, December 2009.

The Green Bank concept is also gaining ground in the United Kingdom, where British Finance minister Alistair Darling recently announced budgeting for a 2 billion pound ($3 billion) "green" investment bank to help Britain's transformation to a low carbon economy. This green investment bank will be half-funded from government asset sales with the remaining capital coming from the private sector.[94]

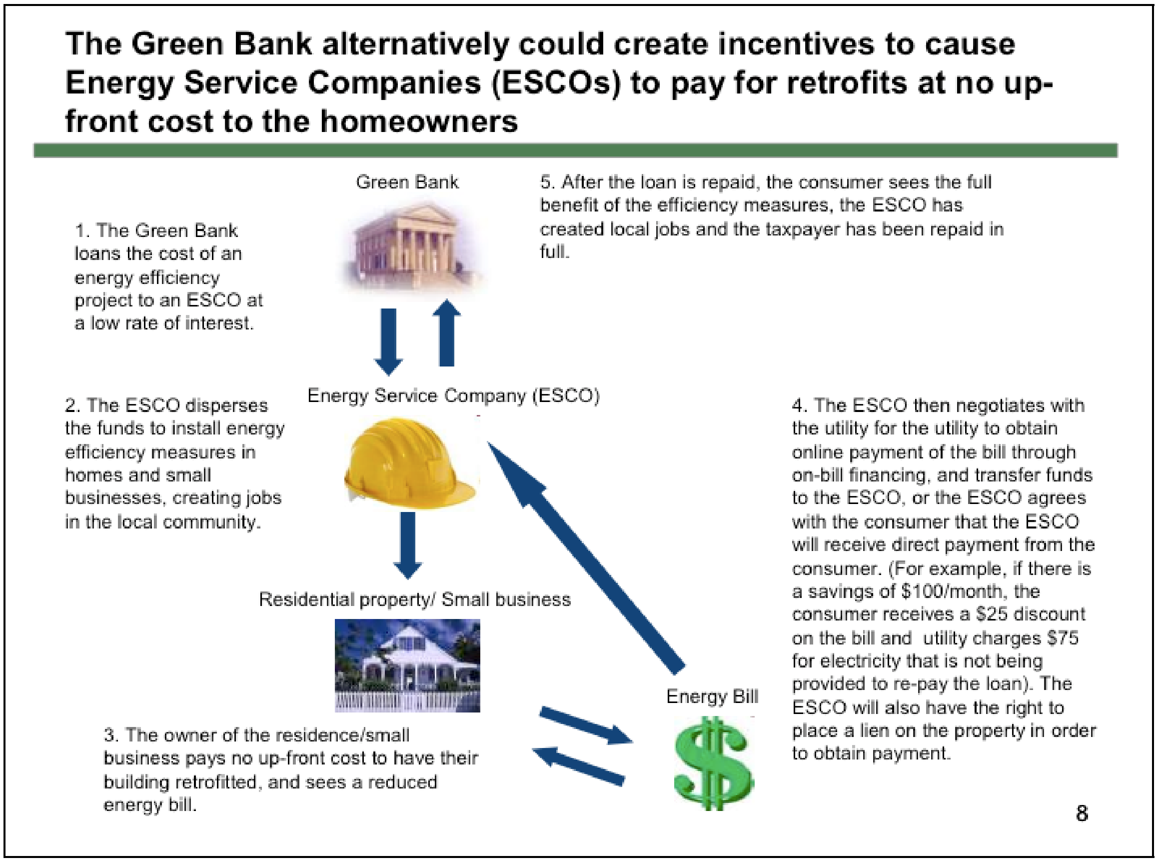

Figure 5: Green Bank ESCO incentive model.[95]

Credit: Washington Post

[94] http://www.washingtonpost.com/wp-dyn/content/article/2010/03/21/AR2010032102571.html

[95] http://www.washingtonpost.com/wp-dyn/content/article/2010/03/21/AR2010032102571.html

CHAPTER 13: Technology Transfer Plan

Summary

The idea of spending a significant amount of time on a report that gathers dust is not an attractive one. Project Negatherm's original intent was to break down the stumbling blocks to drilling closed-loop ground source boreholes by investigating the specific regulatory, technical and financial hurdles faced by industry. Much ground has been covered and material compiled; the intent from the beginning is to make the content of this report living, since stumbling blocks can be resistant to change and may need persistent persuasion to go away.

Web Portal

Over the course of the project, a "California drilling industry resource portal" has grown into two web sites: one that can serve as a unique library covering energy efficiency, heat pump industry, green building, public policy and green financial topics as well as functioning as the "living report document;" the other site serves both consumers and industry by applying research, presenting information and resources and initiating discussion forums.

ProjectNegatherm.org

The ProjectNegatherm.org site houses the extensive collection of ground source heat pump, energy efficiency and green building policy documents and videos as well as pertinent sections and appendices from this report.

ProjectNegatherm.org will also run a movie version of the Project Negatherm Report PowerPoint presentation.

Project Negatherm publishes an integrated WordPress blog, a Facebook group and has a branded Twitter feed.

CaliforniaGeo.org

The CaliforniaGeo.org site caters to consumers and industry, offering a consumer-facing front end featuring numerous examples of well-designed LEED Platinum "geo-powered" homes and buildings, descriptive and instructional videos, and guides to more information, including a variety of sizing and cost calculators.

CaliforniaGeo.org also serves the California GSHP industry by providing technical information, general marketing resources and links to the new California industry forum developed in conjunction with the Geothermal Heat Pump Consortium's Geoexchange.org website.

CaliforniaGeo publishes an integrated WordPress blog, a Facebook group and has a branded Twitter feed.

Schedule of Presentations

- IGSHPA, October 2009, 2010
- Geothermal Resource Council, October 2009, 2010

- Harvard Club of San Francisco (moderator), August 2009
- California Geothermal Energy Collaborative, May, 2010

Publicity

- Press release through PR Web and other open source services (issued in coordination with CEC Media Office).
- Email to legislators, legislative staff, regulatory staff, industry stakeholders, media (issued in coordination with CEC Office of Governmental Affairs).
- YouTube movie version of PowerPoint presentation

APPENDIX A: The Literature Reviewed

L'Ecuyer, Michael, Cathy Zoi, John Hoffman. ***Space Conditioning: The Next Frontier***. Office of Air and Radiation, U.S. Environmental Protection Agency, Washington D.C. 1993.

In this report, the U.S. EPA compares the cost and performance of emerging high-efficiency space conditioning equipment with equipment already on the market. Space conditioning systems compared in this report include: Standard Air Conditioning, Standard Air Source Heat Pump, High Efficiency Air Source Heat Pump, Advanced Air Source Heat Pump, Standard Ground Source Heat Pump, Advanced Ground Source Heat Pump, and Emerging Ground Source Heat Pump. This report was intended to start a dialogue between various stakeholders in order to facilitate increased sales of higher value added, energy-efficient space conditioning products.

Key findings included:

- In most climates, ground source heat pumps save consumers hundreds of dollars annually over standard electric technologies even when their higher first costs are factored in.
- Under most electricity generating scenarios, ground source heat pumps had the lowest CO2 emissions of all technologies analyzed, ranging 55%-60% less than standard air source heat pumps.
- Strategic partnerships are the best way to promote advanced residential space conditioning equipment.
- The industry should determine how utility incentives would be most effective, options include paying rebates to the consumer, dealer or directly to the manufacturer. Manufacturer incentives might be best because they have the greatest effect on reducing equipment costs.

Geothermal Heat Pumps Make Sense for Home Owners. Department of Energy, Office of Geothermal Technologies. DOE/GO-10098-651 April 1999.

This four-page document provides an overview of Ground Source Heat Pump technology for potential residential users. Key selling points include: Over 95% of all GHP users would recommend a similar system to their friends and family; an April 1993 U.S. EPA report said that ground source heat pump systems are the most energy efficient, environmentally clean and cost effective space conditioning systems available. Furthermore, while a ground source heat pump system costs more upfront (roughly $2,500 per ton of capacity or roughly $7,500 for a 3-ton residential unit), when the system is included in the mortgage the homeowner has a positive cash flow – the energy cost savings will easily exceed the added mortgage amount over the course of each year. No particular mention of drilling is included in this document.

Evaluation of California GeoExchange Market Potential, Davis Energy Group, Inc., Pacific Gas & Electric, May 1999.

This report was prU.S. EPAred as a research and development component of PG&E's two-year Geothermal Heat Pump Model Utility Program Demonstration. The demonstration spanned 1997 – 1999 and was co-funded by PG&E, the California Energy Commission and the Geothermal Heat Pump Consortium. This study reports on the potential of GSHP technology within 8 different climate zones in PG&E territory that were previously determined by the Davis Energy Group as potentially viable GSHP markets. The resulting research centers on parametric thermal performance modeling and economic analyses to assess GSHP market viability.

The study's findings included:

- There are many opportunities for GSHP technology within California. Key specialized markets include: New custom homes, Multifamily housing, especially low-income housing, Schools, Federally owned buildings.
    - For residential markets, PG&E's Yosemite division earned top ranking according to this report's market analysis.
    - Climate Zone 16 (including portions of the North Valley, Sierra, Stockton and Yosemite Divisions) was top ranked for non-residential markets.
- Cost reduction is the major obstacle to improving the economic viability of GSHP technology.
    - Improved GSHP technologies are the major hope for achieving project mature market cost targets.
- GSHP systems using horizontal, vertical helix or vertical loops can be economically viable statewide if projected cost reduction scenarios can be achieved.
    - Achieving cost reduction targets will require both market enhancement and additional R&D. Additional R&D can reduce costs by developing better GSHP technologies and improving performance predictions.

Drilling is not a topic that is thoroughly evaluated in this report.

Ground Source Heat Pump Market Assessment. Regional Economic Research, Inc. Report #00-061. September 2000.

The Northwest Energy Efficiency Alliance sponsored this report, which focuses on the Ground Source Heat Pump (GSHP) market in the Pacific Northwest (PNW). The main objective of the research was to determine the potential for wide-scale adoption of residential GSHP systems throughout the Pacific Northwest.

The authors of this report interviewed multiple stakeholders including utilities, manufacturers, local dealers and installers and users. The report had the following findings:

- The soil conditions in much of the PNW make trenching and vertical drilling costly.

- There are few drillers in the PNW with the type of experience required to drill for GSHP systems.
- Current GSHP installers are mostly HVAC contractors, the majority of who became involved with GSHP as a result of utility programs in their area. Many but not all of the HVAC contractors have been certified by International Ground Source Heat Pump Association (IGSHPA).
- There are very few drilling companies involved in GSHP in the PNW and to date the market in the PNW has not been sufficient for many drilling companies to learn these techniques
- The combination of equipment costs and high drilling and trenching costs are the main drivers of high first costs for residential closed-loop GSHPs. Other barriers to GSHP result from the small number of installers in the region. As such, there is a need to train additional system installers and drillers. This support would lead to lower cost and higher quality installations as a result of improved capability and increased competition.
- Furthermore, the lack of awareness and knowledge of GSHP systems on the part of installers and well drilling companies, combined with doubts about system performance, and low consumer demand result in few installers and well drilling companies being interested in GSHP systems. Lack of consumer demand for these systems occurs both because awareness on the part of consumers is fairly low and because consumers doubt system performance.
- There is one well drilling company in the PNW with experience in GSHP.

Understanding and Evaluating Geothermal Heat Pump Systems. PrU.S. EPAred for the New York State Energy Research and Development Authority by the Geothermal Heat Pump Consortium. February 2004 (revised July 2007).

This document provides an overview of the steps involved in evaluating and selecting a ground source heat pump (GSHP) system. It describes GSHP system types and operations and presents seven GSHP case studies throughout the state of New York. This report goes into some detail regarding drilling, particularly how drilling conditions impact costs, as well as regulations that pertain to borehole drilling.

Drilling Costs: The thermal conductivity of the soil is the determining factor in the total length (number of bores and optimal depth) of the bore field needed to meet the heating and cooling requirements of the building. Soil conductivity tests are performed for systems that exceed 20 tons in size and cost between $6,000 and $11,000. A soil conductivity test and a test bore may be unnecessary where data on drilling conditions from local drillers, or well logs from nearby water wells, could yield soil composition, water table, and bedrock information or where the soil conditions are already known. Furthermore, local well drillers often have limited experience installing large commercial projects and depending upon the size of a project, experienced drillers often travel from other areas. Open loop and pond systems are generally less expensive to install than vertical bore fields. Costs range from $500 to $750 /per ton. Vertical bore field loop costs depend on the driller experience, capability, site conditions and design. Complete costs typically range from $1,200 to $2,000 per ton ($8+/ foot of bore).

Regulations: New York State does not explicitly regulate GSHP bore fields, however, the New York State Department of Environmental Conservation, through the Division of Mineral Resources, regulates wells which includes GSHP bores with depths greater than 500ft. Registered water well drillers are required to notify the state of proposed water wells and provide a completion report. Closed loop GSHP boreholes do not meet the legal definition of a water well, which is defined as, "an excavation for the purpose of obtaining water". Within the state of New York there are over 400 registered water well drillers.

This report had the following findings:

- Office buildings and schools are particularly good applications of GSHP
- The simple payback for the marginal cost of a GSHP system usually falls between 2 and 8 years (depending on building type, system design, operating parameters and energy costs).
- The best time to consider installing GSHP technology is when a new building is being planned or when considering the replacement of an existing system that has reached the end of its useful life.
- The main hurdles remain the willingness of designers to consider the system, the decision process for system selection, and availability of local expertise in designing and installing ground heat exchangers.

The authors have also compiled a "GeoExchange installation inventory" that describes GSHP installed in New York in recent years.

Final Evaluation Report In support of: GHPC's Program To Promote GeoExchange To Southern California Edison's Customers, Geothermal Heat Pump Consortium, Inc. GHPC-SCE-004. May 2004.

In the fall of 2002 through mid-2004, the Geothermal Heat Pump Consortium (GHPC) managed a program within the Southern California Edison (SCE) service territory designed to enhance public awareness and educate potential customers and trade allies on the advantages of the GeoExchange technology for HVAC application. The program was targeted toward new and existing schools, small to mid-sized owner occupied businesses, multi-site commercial chains, and municipal buildings.

There were three prime components to the program. The first was public education, which consisted of a series of educational seminars and workshops. The second was public outreach, which included face-to-face meetings with building system decision makers, outreach material, press kits, and prU.S. EPAration of case study information for the media. The third primary component is the still to be completed installations of two GeoExchange systems in schools within economically distressed areas of the SCE service territory.

Key findings from the evaluation efforts include:

- An increasing awareness and acceptance over time among the architects, mechanical engineers, and school officials within the SCE service territory of the GeoExchange technology.

- Very limited number of geothermal heat pump installations in the Southern California area.
- A high level of acceptance of the technology after attending the workshops/seminars/meetings.
- Although an increased awareness of the technology over the program life, still a limited understanding of the technology among architects, school officials, and government oversight agencies as a whole.
- A relatively good understanding of the technology among mechanical engineers.
- Remaining high levels of uncertainty regarding the reliability and cost effectiveness of the technology among decision makers as a whole. However, attendance at the workshops and seminars helped reduce these levels of uncertainty considerably.
- A desire for local case studies and local information.
- A desire to clear the uncertainty regarding required permits and regulatory issues.
- Workshops and seminars appeared to be the most effective means of increasing awareness and appreciation of the technology. Distribution of media kits was of limited value. The most effective media kits and news releases had a specific local angle to them and in the case of specialized publications, a local angle that was specific to that target audience.

Throughout the surveys, the topics of drilling and regulations surfaced as an issue on which workshop attendees would like more information/clarification.

Curtis, R. et al. ***Ground Source Heat Pumps - Geothermal Energy for Anyone, Anywhere: Current Worldwide Activity Proceedings***. World Geothermal Congress 2005 Antalya, Turkey, 24-29 April 2005.

This report provides an overview of where ground source heat pumps have seen success. Ground source heat pumps (GSHP) have seen annual increases of 10% in approximately 30 countries over the past 10 years. The present worldwide installed capacity is estimated at approximately 10,100 MWt (thermal) and the annual energy use is about 59,000 TJ (16,470 GWh). The countries with the highest use of GSHP are as follows: U.S.A. (600,000 installed), Sweden (200,000), Germany (40,000), Canada (36,000), Switzerland (25,000), and Austria (23,000). According to the IEA, it is estimated that heat pumps could cut global CO2 emissions by more than 6% - one of the largest that a single technology can offer and the technology is available in the marketplace. Furthermore, there are suggestions that it in order to maximize the delivery of renewable energy, it makes economic sense to couple expensive renewable electricity to ground coupled heat pumps as quickly as possible.

Overview of GSHP in the United States:

- In the Unites States, most units are sized for the peak cooling load and are oversized for heating (expect in the northern states), and thus, are estimated to average only 1,000 full-load heating hours per year

- Over 600 schools have installed these units for heating and cooling, especially in Texas.
- In the U.S., heat pumps are rated on tonnage (i.e. one ton of cooling power - produced by a ton of ice) and is equal to 12,000 Btu/hr or 3.51 kW (Kavanaugh and Rafferty, 1997). A unit for a typical residential requirement would be around three tons or 10.5 kW installed capacity.

Overview of GSHP in Europe:

- Most units are sized for the heating load and are often designed to provide just the base load with peaking by fossil fuel. In contrast to the U.S., European units may operated from 2,000 to 6,000 full-load hours per year, with an average of around 2,300 annual full load hours.
- It is difficult to find reliable numbers of installed heat pumps in Europe.
- Sweden has the highest number of GSHP in Europe.
- GHP systems have spread rapidly in Switzerland with annual increases up to 15%.
    - GHP systems have spread rapidly in Switzerland for a variety of reasons, these include: local utility rebates for heat pumps, "energy contracting" by public utilities whereby the utility plans, installs, operates and maintains the GHP system and sells the heat/cold to the property owner at a contracted price, lower operating costs, emissions-reduction.

Moonis Ally. ***Ground Source Heat Pumps in the U.S.A. DOE Space Conditioning, Refrigeration & Water Heating Program.*** U.S. Department of Energy. International Energy Agency (IEA) Heat Pump Meeting: Global Advances in Heat Pump Technology, Applications, and Markets. 2006

This presentation, presented in 2006 at the IEA Heat Pump Meeting, provides an overview of the U.S. market for Ground Source Heat Pumps (GSHP). There are approximately 30 geothermal equipment manufacturers in the U.S. (in 19 states) and GHPS sees annual sales of approximately 80,000 units (46% vertical closed loops, 30% horizontal closed loops, 15% open loops).

The main barriers to the adoption of GSHP technology are the following:

- Installation cost - The cost of the loop varies from $3.50/ft to $17/ft (average cost is around $11/ft) depending on site properties, lowering the cost per foot is a major barrier.
- Local Regulations
- Contractor Performance
- Large real estate needed for horizontal loops
- Initial investment compared to air-to-air heat pumps is high.
- Technical breakthroughs needed to reduce system cost

At the time of this presentation, twenty-two states had incentive programs to help offset costs. The presentation also provided a brief overview of a new concept in ground-coupled heat pump technology.

Electric Programs, Summary of Items of Engineering Interest. United States Department of Agriculture Rural Development Utility Programs. September 2006.

This report contains an introduction to Ground Source Heat Pump technology and covers the following topics: environmental benefits of GSHP technology, utility benefits from GSHP technology and utility ownership of GSHP systems. GSHP technology is described as a renewable energy resource because it is a net producer of renewable thermal energy. It is estimated that over 1,000,000 GSHP units are currently operating in the United States.

This report lists the environmental benefits that can be attributed to GSHPs currently in use as:

- Elimination of more than 5.8 million metric tons of CO2 annually
- Annual savings of nearly 40 trillion BTUs of fossil fuels
- Taking close to 1,295,000 cars off the road
- Planting more than 385 million trees

Furthermore, the report states that the U.S. General Accounting Office estimates that if ground source heat pumps were installed nationwide, they could save several billion dollars annually in energy costs and substantially reduce pollution.

This report also highlights the benefit GSHP technology can have for utilities by pointing out how ground source heat pumps provide electric utilities improved load factors due to their low operating demand, minimal impact on both summer and winter peaks, and long run times. Furthermore, a strong argument is presented for utility ownership of the ground source heat pump ground loops because use of GSHPs generates consumer energy savings, environmental benefits, and high margin utility load for utilities. This paper argues that by taking responsibility for the ownership of the ground loop, the electric utility can capture new electric margins by competing favorably with fossil fuels.

Green, Bruce and Gerry Nix. ***Geothermal – The Energy Under Our Feet, Geothermal Resource Estimates for the United States.*** National Renewable Energy Laboratory. Technical Report, NREL/TP-840-40665. November 2006.

On May 16, 2006, the National Renewable Energy Laboratory (NREL) in Golden, Colorado hosted a geothermal resources workshop with experts from the geothermal community in order to re-examine domestic geothermal resource estimates. The workshop found that the domestic geothermal resource is large. The Geothermal Heat Pump (GHP) working group found that GSHPs are used in all 50 states and that there is great potential for near-term market growth. They also estimated made the following estimations about GHP resource potential:

- Ground Source Heat Pumps

- Estimated Developable Resource: >1,000,000 MWt
- 2006 actual MWt: 7,385
- 2015 Estimated Developable Resource (MWt): 18,400
- 2025 Estimated Developable Resource (MWt): 66,400
- 2050 Estimated Developable Resource (MWt): >1,000,000

Ground-Source Heat Pumps at Department of Defense Facilities. Office of the Secretary of Defense Report to Congress. January 2007.

This report provides an overview of GSHP technology as deployed at Department of Defense (DoD) facilities. DoD has been installing GSHP systems on installations since the late 1980s; as of 2007, more than 52,000 tons of GSHP systems were operating. This report describes the type of DoD facilities where GSHPs have been used, examines GSHP performance by geographic region, assesses the applicability of GSHP for both new-construction and retrofitting projects and finally, offers recommendations for facilitating and encouraging the increased use of GSHP systems at DoD facilities. This report contains a table that outlines state regulations that pertain to vertical borehole drilling.

Findings:

- The most common application of GSHP technology in the Department has been in family housing units in the eastern half of the U.S. where GSHP technology has proven the most cost effective.
- Analysis of DoD data shows that GSHP projects have been the most cost effective in the South, Southeast, Midwest, and Mid-Atlantic regions. To date, neither DoD installations nor the GSHP industry has widely used GSHP systems in other regions of continental United States.
- Computer modeling using three representative DoD buildings indicates that vertical-bore GSHP systems when hybridized with conventional heating, ventilating and air conditioning (HVAC) equipment are cost effective in the Northeast, Southwest, Western Mountain, Northwest, and West Coast regions of CONUS. However, within these regions, modeling shows that vertical-bore GSHP systems alone require many more favorable site conditions to be cost effective. Further analysis, such as detailed modeling, is needed to identify specific opportunities in these regions.
- GSHP can be a cost effective alternative in new construction and retrofitting of facilities.

Drilling is discussed as an uncertainty when it comes to cost projections.

Recommendations for increasing the use of GSHP systems at DoD facilities include:

- Training select personnel who will act as the advocate for GSHP technology within each service
- Update the GSHP design manual

- Create a soil thermal properties database
- Conduct long-term performance studies of existing DOD GSHP installations.

Hanova, J. et al. ***Strategic GHG reduction through the use of ground source heat pump technology.*** Environmental Research Letters. IOP Publishing, (2007) 044001 (8pp).

The primary focus of this study is on quantifying greenhouse gas reductions associated with residential use of GSHP. The results of the study are intended to serve as a tool to estimate emissions and operating cost savings and to facilitate better decision-making with respect to GSHP and conventional systems. The authors of this report quantify the achievable greenhouse gas (GHG) reductions based on parameters including heating load, fuel choice, heat pump efficiency, and electricity carbon intensity.

The report outlines the following barriers to worldwide market diffusion of GSHP systems:

- System designs have not been standardized and the actual performance of systems has sometimes fallen short of its promise
- The initial capital costs are significant
- Substantial educational infrastructure investments are required to address the current shortage of skilled tradespersons
- Effective policy direction has yet to facilitate increased adoption of this technology
- Economies of scale and scope are rarely exploited.

The report findings include:

- In regions where electricity prices are significantly higher than natural gas costs the financial returns of GSHP are questionable.
- GSHP systems are preferable to electric and heating oil systems in all countries for which data are available.
- GSHP provides the largest emissions savings relative to natural gas and heating oil-fired systems where the electricity used by heat pumps is derived from environmentally sound primary fuels.
- GSHP can provide significantly larger environmental and financial benefits for large residences/commercial/institutional sites due to their high heating loads.
- Tapping into the environmental and fiscal benefits that GSHPs offer is only possible if government policies and business strategies affecting homeowners' fuel choices reflect preference toward technologies with long-term environmental and economic benefits

Hanova, Jana et al. ***Ground Source Heat Pump Systems in Canada Economics and GHG Reduction Potential***. Resources for the Future. May 2007.

This paper presents an assessment of the Greenhouse Gas reduction potential of ground source heat pumps (GSHP) across Canada. The authors define the key criteria for evaluating the desirability of a GSHP as lifetime costs and GHG reduction. These criteria vary by location according to the costs of electricity, gas, and oil, the electricity generation mix, the norms in fuel choice used to provide heat, and local geology.

The authors used province-level data on household fuel choices and energy use, and found that GSHP systems offer significant GHG reductions, as well as savings in operation and maintenance costs.

The economic viability of their widespread adoption, however, depends on the costs of energy, and their impact on GHG reduction depends on fuel choices both in electricity generation and on customers' premises. At present, high capital costs also limit market diffusion, however, costs will likely go down as demand for GSHP systems increase, making the technology more accessible for the average-sized home.

The report had the following findings:

- GSHP systems have a large and currently unrealized GHG-reduction and financial savings potential across Canada. Maritime Provinces and Quebec could achieve emissions reductions to up to 7Mt if GSHP systems were to replace heating oil. If Ontario and the western provinces transitioned from natural gas to GSHP, emissions reductions could reach 21.4 Mt.
- GSHP can not only meet the rising demand for increased comfort, but can achieve emissions reductions necessary to help stabilize climate change. The cumulative effect of a Canada-wide transition to GHSP heating and cooling would result in emissions reductions of 38 Mt of CO_2eq per year. This technology would result in emissions reductions of 62 percent with respect to current emissions associated with residential space conditioning and water heating

The report had the following recommendations:

- Commitment to emissions-reduction strategies can be demonstrated through the provision of provincial-level incentives for increased GSHP adoption as well as accountability for emissions embodied in inter-regional electricity trade.
- Provincial governments should support infrastructure supporting the GSHP industry by addressing the current shortage of GSHP trades persons and installers. This could in part be achieved through sufficient funding for various accreditation processes and support for standardized system design requirements.

Halozan, Hermann. Annex 29***. Ground Source Heat Pumps, Overcoming Market and Technical Barriers.*** IEA Heat Pump Program. May 19, 2008.

Annex 29 outlined its work plan at a workshop in Zurich in May 2008. Their first task is to conduct a Ground Source Heat Pump (GSHP) market analysis that examines: the number of installed systems in different sectors such as single-family and multi-family homes, commercial buildings, and data on the operation modes such as heating-only vs. cooling only systems. From this data, Annex 29 is developing a matrix of ground source heat pumps to help identify systems designs for particular climatic conditions, soil temperatures, soil properties, heat source/heat sink systems as well as different types of buildings with different distribution systems. Task 4 for Annex 29 is overcoming legal barriers, which include using fluids without any toxic components. Economic barriers that must be overcome include enacting subsidies to support the industry and reducing first costs for the customer. Finally, Annex 29 intends on increasing the acceptance of GSHP technology by information, training and advertisement to policy makers, planners, installers, drilling companies and users.

Long, Bryan. ***Ground Source Heat Pumps in the Department of Defense***. Naval Facilities Engineering Service Center, Port Hueneme, CA. August 7th, 2008.

This presentation presented an overview of the use of ground source heat pump (GSHP) technology within the Department of Defense (DoD) and made the following recommendations which were based on a DoD report on GSHP:

- Design Assistance
    - Train designers and energy managers
    - Establish a center of expertise either within DoD or in collaboration with one of the Department of Energy laboratories.
- Specifications
    - Conduct periodic reviews of Department of Defense UFGS covering GSHP systems for consistency.
- Design Manual
    - The ASHRAE HVAC design manual published in 1997 needs to be updated.
- Soil Thermal Properties Database
    - Collect soil thermal properties data and maintain a database of the information.
- Continue DoD screening feasibility analyses

Hughes, Patrick J. ***Geothermal (Ground-Source) Heat Pumps: Market Status, Barriers to Adoption, and Actions to Overcome Barriers.*** Oak Ridge National Lab. December 2008.

This report was undertaken at the request of the Department of Energy to identify and generate recommendations to remediate the key barriers to the widespread adoption of ground source heat pumps (GSHPs) in the United States. Hughes points out that GSHPs are both a proven technology capable of producing large reductions in energy use and peak demand in buildings, and have a history of federal support. However, this report identifies several factors that hinder GSHP applications:

- High First Cost of GSHP systems to consumers

- Lack of consumer knowledge and/or trust or confidence in GSHP system benefits
- Lack of policymaker and regulator knowledge and/or trust or confidence in GHP system benefits.
- Limitations of GSHP design and business planning infrastructure
- Limitations of GSHP installation infrastructure
- Lack of new technologies and techniques to improve GSHP system cost and performance.

One of the key limitations of GSHP installation infrastructure is the limited supply of experienced GSHP drillers. Rapid growth of the GSHP industry would require an influx of drillers trained in the specifics of GSHP drilling (GSHP drilling requirements are significantly different from those of water well drilling). Several training programs already exist for voluntary certification of vertical borehole heat exchanger drilling and installation contractors. However, the drilling side of the industry is not recognized in any meaningful way.

Hughes asserts that the domestic GHP industry is better positioned for rapid growth than ever before and suggests the following actions to accelerate market adoption of GSHPs:

- Conduct a Cost/Benefit analysis of GSHP
- Federal emphasis and leadership
- Universal access to GHP design and installation infrastructure
- Develop the data, analysis, and tools to enable lowest life-cycle-cost GSHP infrastructure

Hughes recommendations particular to drilling include seeking significant price reductions through improved driller asset utilization and competition; market aggregation can drive prices down even in difficult drilling conditions. He also asserts that future policies should ensure that GSHP systems are not excluded from renewable portfolio standards.

National Best Practices Manual for Building High Performance Schools. U.S. Department of Energy. 2008

This report was produced as part of the U.S. Department of Energy's Rebuild America EnergySmart Schools program in order to help promote energy efficiency and renewable energy in schools. It is designed for architects and engineers who are responsible for designing or retrofitting schools and for project managers who work with the design teams. The report provides an overview of ground source heat pump technology and recommends that schools consider ground source heat pump systems in locations with considerable heating and/or cooling loads or when heating fuel is expensive. The report also points out that the payback period for GSHP systems generally falls between 5 to 10 years and that some utilities offer incentives to make systems more affordable. There is no specific mention of drilling but the report also outlines design tools and resources for GSHP systems.

Retrofitting the Workforce: Report #2, Geothermal Heat Pumps (Geothermal Heat Exchangers). Good Company Associates, Texas Foundation for Innovative Communities, February 2010.

This report provides a current market overview for GSHP technology and identifies GSHP market and workforce opportunities for the state of Texas. This 55-page report presents some interesting new data points, including:

- Total shipments of geothermal heat pumps increased more than 40% in 2008 to 121,243 units compared to 86,396 shipments in 2007.
- A June 2009 report by the Priority Metrics Group (PMG) estimates that the 2009 market for GHP in the U.S. was around $3.7 billion, including equipment and installation costs.
- PMG expects a high growth rate to continue for a few years and by 2013 they project the U.S. geothermal heat pump market to almost triple in value
- California receives 2.3% of the reported 2008 GHP shipments in the U.S. by capacity in tons (9,522 of 416,105). This figure represents a 73% increase from 2007.

The report argues for the establishment of educational programs for various sectors of the GSHP industry and draws the following conclusions:

- The GHP market has been growing, and will likely continue to grow, even in spite of (or partially because of) the economic conditions in the country. Recently enacted long-term tax incentives and other efforts to encourage their usage nationally will facilitate industry growth. Additional state and local efforts could further accelerate industry growth and increase workforce demands.
- A shortage of trained workers will be a limiting factor for GHP industry growth; however classroom training alone will be insufficient to overcome this obstacle. Experience is also crucial, so there needs to be a mechanism for experienced local professionals to oversee/mentor/transfer knowledge to trainees. Therefore apprenticeships or other on-the-job trainings opportunities should also be explored, along with classroom learning.
- IGSHPA is, and will continue to be, the industry standard for certification and accreditation; however, there are important differences in regional topography/geology/hydrology/climate that should be taught at the local level. Information about GHP designs that have been proven to be successful in each region should also be a component of any developed training in Texas. Since appropriate designs could differ by community, community colleges are naturally excellent delivery vehicles for these trainings.

APPENDIX B: Regulation in Other States

Missouri

Regulations: The Water Well Drillers Act (1987); amended in 1991 to include the Heat Pump Construction Code.

Language: *Vertical closed-loop heat pump well* is defined as, "the borehole perpendicular to the horizon deeper than ten feet (10') into which a closed-loop pipe is placed for the purpose of heat transfer."

Department: Missouri Department of Natural Resources, permits are administered by the state.

Advisory Board: Water Well Drillers Board; 9 person board that must contain one water well driller.

Driller Licensing Requirements: Missouri requires that drillers complete two-year apprenticeships.

Fee Schedule: Standardized.

Notes: Regulators report that by standardizing what is required of GSHP projects they have created a level playing field for drillers and consumers alike[96]. Missouri has seen marked growth in the commercial side of the GSHP industry[97].

Table 3 provides an outline of many, though not all, guidelines contained in Missouri's Heat Pump Construction Code.

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[96] Conversation with Beth Marsala of Missouri Department of Natural Resources

[97] Conversation with Beth Marsala of Missouri Department of Natural Resources

Table 3

Missouri Department of Natural Resources – Heat Pump Construction Code[98]	
Driller Qualifications	Water well driller permit, which requires a 2-year apprenticeship with a fully permitted contractor[99].
Reporting	Certification report form must be submitted within 60 days after completion of the system.
Certification Process	Review of the certification report form, after which a certification number will be issued to the landowner.
Location	Vertical heat pump systems: at least 300 ft from a storage area for commercial fertilizers or chemicals, landfill, lagoon, or above-ground storage tank for petroleum; 100 ft from a below-grade manure storage area, cesspool, unplugged abandoned well, grave, building or yard used for livestock or poultry; 50ft from an existing operating well, septic tank, buried sewer. Horizontal heat pump wells: least 2ft above or below any other intersecting underground piping (to prevent freezing of water lines) or wiring on the property. *A variance may be granted if set back distances cannot be met.
Exclusions/Exemptions	Closed loop heat pump systems installed in trenches or pits 10ft or less in depth are exempt from these rules.
Sealing the borehole	Full-length grout is recommended and may be required.
Sealing materials	Bentonite slurry, nonslurry bentonite, thermal grout slurry, other grout as approved.
Heat Pump Loop Materials	High density polyethylene or polybutylene pipes
Loop Fluids	Pure glycerine solution, food grade propylene glycol, dipotassium phosphate, sodium chloride, potassium acetate, methanol, water, ethanol or other fluids as approved. All fluids must be 90% biodegradable.
Hole Depth	Closed-loop heat pump wells must not be deeper than 200ft. *A variance must be obtained to drill deeper than

[98]http://www.dnr.mo.gov/env/wpp/lawsregs.htm

[99]http://www.sos.mo.gov/adrules/csr/current/10csr/10c23-1.pdf

	200ft.
Fee Schedule[100]	Well certification fees are capped at $125 per well. Well registration fees are capped at $100 per well. Open-loop and closed-loop heat pump Well certification fees: • One to fifty (1–50) ton heat pump unit $150 • Over fifty (50) ton heat pump unit $250

New Jersey

Regulations: The New Jersey Department of Environmental Protection (NJDEP) distributed the first regulations pertaining to GSHPs on September 2001. Currently, these rules sunset every five years and they were most recently republished in March 2007. A few minor amendments were made to the most recent regulations, including: a fee hike, requiring that wells be located using GPS, and the removal of an onerous apprenticeship requirement for drillers. In addition, New Jersey also regulates pump installers.

Language: *Closed loop geothermal wells* are defined as, "a well or a borehole drilled to a specific depth either singly or in a series wherein a continuous closed loop of pipe is inserted from one well to another for the purpose of noncontact thermal energy transfer from a fluid in the loop to or from the earth."

Department: New Jersey Department of Environmental Protection; Permits are administered by the state and local authorities have the opportunity to pass local ordinances for their jurisdiction.

Advisory Board: State Well Drillers and Pump Installers Examining and Advisory Board[101]. This nine-member board[102] was established by the "Subsurface and Percolating Water Act," and provides advice to the dU.S. EPArtment on exam questions, license status, and recommendations to the Department of Environmental Protection on new rules and regulations. All meetings of the board are open to the public.

100http://www.sos.mo.gov/adrules/csr/current/10csr/10c23-2.pdf

101. http://www.state.nj.us/dep/watersupply/advisoryboard.htm

102. Three master well drillers, 1 licensed well driller, 1 pump installer, 1 public member, 3 NJDEP Representatives

Driller Licensing Requirements: New Jersey requires that drillers complete a three-year apprenticeship but regulators report that the state currently faces a lack of qualified drillers because the test for drillers is only offered two times a year.

Fee Schedule: Standardized.

Notes: In re-writing their regulations, the Department of Environmental Protection reports that they have learned that they need to give themselves the flexibility to provide for new technologies (refrigerants etc)[103].

Table 4 provides an outline of many, though not all, guidelines contained in New Jersey's Well Construction Code.

Table 4

New Jersey NJ Department of Environmental Protection at N.J.A.C. 7:9D (Well construction)	
Driller Qualifications	Licensed Driller, which requires 3 years of well drilling experience[104].
Reporting	Well Record Document must be submitted by the driller.
Certification Process	Site Wide permit is required
Location	Minimum distance not specified for GSHPBs
Exclusions/Exemptions	None specified
Sealing the borehole	The entire annular space between the closed loop and the uncased borehole shall only be sealed under pressure.
Sealing materials	High-grade bentonite, cementitious thermally enhanced grout or Thermal Grout 85.
Heat Pump Loop Materials	Pipe material for the underground buried portion of the heat exchanger shall be 160 psi polyethylene pipe
Loop Fluids	The circulating fluids utilized in the closed loop system shall be potable water or an Appropriate mixture of potable water with one of the following antifreeze solutions: i. Calcium Chloride;

103 Conversation with Pat Bono of the New Jersey Department of Environmental Protection

104. http://www.state.nj.us/dep/watersupply/app_journeyman.pdf

	ii. Ethanol; iii. Potassium Acetate; iv. Potassium Carbonate; v. Propylene Glycol; or vi. Sodium Chloride;
Hole Depth	Not specified
Fee Schedule	Each sitewide permit application for borings, cathodic protection wells, closed loop geothermal well systems or dewatering well systems shall be accompanied by a fee of $1,300.00. A sitewide permit shall allow for the construction of 10 or more borings, cathodic protection wells, closed loop geothermal wells, or dewatering wells or dewatering wellpoints for each project area. Where less than 10 borings, cathodic protection wells, closed loop geothermal wells, or dewatering wells or dewatering wellpoints are proposed to be drilled at a site, individual well permits are required, and the fee at (b)1 above applies.

Idaho

Regulations: As of May 2009, Idaho's Department of Water Resources (IDWR) revised their decades-old well construction standards to include regulations pertaining to closed loop heat exchange wells. Regulations are contained in IDAPA 37.03.09 Well Construction Standards.

Language: *closed loop heat exchange well* is defined as, "a ground source thermal exchange well constructed for the purpose of installing any underground system through which fluids are circulated but remain isolated from direct contact with the subsurface or ground water."

Department: Idaho Department of Water Resources (IDWR); permits are administered by the state.

Advisory Board: Drillers Advisory Committee; typically convenes to address special issues, typically related to driller licensing.

Driller Licensing Requirements: 30 months of drilling experience in Idaho, bonded with at least $5,000, and passed licensing exam. Employees of drilling firms, co-partnerships, corporations or associations are authorized to operate drilling equipment for the driller after obtaining an operator's permit. An operator's permit shall be obtained by filing with the director an application in writing on a form provided by the director accompanied by a twenty-five dollar ($25.00) application fee[105].

Fee Schedule: Standardized.

Notes: In drafting the new language for closed loop heat exchange wells, the IDWR worked with the Idaho Groundwater Association and met with drillers who were involved in the GSHP industry to see how the regulations could both accommodate the industry's needs while meeting well construction standards. In addition, Idaho purposely left their regulations for closed loop heat exchange wells broad enough to allow for regulatory flexibility as new technologies arise.

Table 5 provides an outline of many, though not all, standards contained in Idaho's Well Construction Standards.

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[105] http://www.legislature.idaho.gov/idstat/Title42/T42CH2SECT42-238.htm

Table 5

Idaho Department of Water Resources – IDAPA 37.03.09 Well Construction Standards Rules	
Driller Qualifications	All persons constructing wells must comply with the requirements of Section 42-238, Idaho Code, and IDAPA 37.03.10, "Well Driller Licensing Rules." (30 months of drilling experience in Idaho, bonded with at least $5,000, and passed licensing exam.) Application fee is $200.
Reporting	Every newly constructed, modified or decommissioned (abandoned) well location must be identified by latitude and longitude with a global positioning system (GPS) and recorded on the driller's report in degrees and decimal minutes and within the nearest 40 acre parcel using the Public Land Survey System.
Location	Minimum SU.S. EPAration Distance (Feet) Septic Drain Field – 100; Septic Tank – 50; Property Line – 5;
Exclusions/Exemptions	Artificial openings less than 18 feet deep are exempt from these rules.
Sealing the borehole	All casing must be sealed its entire length with cement or a cement grout mixture unless waived by the Director. The seal material must be placed from the bottom of the casing to land surface either through the casing or tubing or by use of a tremie pipe. The cement or cement grout must be undisturbed for a minimum of twenty-four (24) hours or as needed to allow adequate curing.
Sealing materials	Seal material must consist of bentonite chips, pellets, or granules, bentonite grout, neat cement, or neat cement grout as defined by these rules
Heat Pump Loop Materials	Fluid-tight circulating pipe, composed of high-density polyethylene, grade PE3408, minimum cell classifications PE355434C or PE345434C conforming to ASTM Standard D3350, or other Director-approved pipe.
Loop Fluids	Propylene glycol, or other circulating fluid approved by the Director.
Fee Schedule[106]	One permit ($200) covers 1 – 10 borings[107].

106 Conversation with Chad Hersley, Idaho Department of Water Resources

107 Conversation with Chad Hersley, Idaho Department of Water Resources

Testing Requirements	Pressure test the system with potable water prior to installation of the circulating fluid at one hundred percent (100%) of the designed system operating pressure for a minimum duration of twenty-four (24) hours.

Oregon

Regulations: Oregon Administrative Rules (OAR) Water Resources Department Chapter 690, Division 240.

Language: GSHPBs fall under the Geotechnical hole category, which is defined as, "a hole constructed to collect or evaluate subsurface data or information, monitor movement of landslide features, or to stabilize or dewater landslide features. Geotechnical holes are not monitoring wells or water supply wells as defined below. Various classes and examples of geotechnical holes are listed in OAR 690-240-0035(6)-(9)."

Department: Oregon Water Resources Department; no permitting involved, however drillers must submit reports.

Advisory Board: Ground Water Advisory Committee; 7 person committee that contains members who are drillers who have experience with ground source heat pump boreholes, but it is not their primary source of business.[108]

Driller Licensing Requirements: License required, 1 year of experience.

Fee Schedule: Standardized.

Notes:

Table 6 provides an outline of many, though not all, standards contained in Oregon's Well Construction Standards.

[108] Conversation with Mike Zwart, Oregon Water Resources, October 6, 2009.

Table 6

Oregon Administrative Rules (OAR) Water Resources Department Chapter 690, Division 240[109]	
Driller Qualifications	
Reporting	A 'Geotechnical Hole Report' shall be filed with the Department within 30 days of the completion of the geotechnical hole
Location	Not specified
Exclusions/Exemptions	Not specified
Sealing the borehole	If permanent casing is installed in a geotechnical hole, it shall meet the casing requirements in OAR 690-240-0430, 690-210-0210, or 690-210-0190 and the sealing requirements in OAR 690-240-0475.
Sealing materials	Well seals shall consist of a physically and chemically stable hydrated grout slurry composed of: Neat cement; or Sodium bentonite; or a cement-bentonite grout mixture containing no more than five percent bentonite by dry weight; or Sodium bentonite granules, pellets or chips placed in an unhydrated state, and subsequently hydrated downhole.
Heat Pump Loop Materials	Not specified.
Loop Fluids	Not specified.
Fee Schedule	Fees are required for Geotechnical Hole Reports only; a $25 fee was established for the first report and $10 for each additional report at a project site within a seven-day period.
Testing Requirements	Not specified.

Washington

Regulations: The state of Washington revised its water well construction standards in 2006, adopting language for “Ground Source Heat Pump Borings” in Chapters 173-160 and 173-162 of the Washington Administrative Code (WAC).

[109] http://arcweb.sos.state.or.us/rules/OARS_600/OAR_690/690_230.html
and http://www.wrd.state.or.us/OWRD/LAW/oar.shtml

Language: *Ground Source Heat Pump Borings* are defined as, "a vertical boring constructed for the purpose of installing a closed loop heat exchange system for a ground source heat pump."

Department: Washington Department of Ecology

Advisory Board: Technical Advisory Group; 50% of the members are drillers. These drillers may have experience with ground source heat pump boreholes; however there is no specific GSHP industry presence.[110]

Driller Licensing Requirements: Washington requires that drillers have at least 600 hours of drilling experience working under the direct supervision of a licensed operator who has held a Washington state water and/or resource protection well drilling license for at least three years; have obtained six continuing education units as approved by the Department; and pass a written examination.[111]

Fee Schedule: Standardized.

Notes: Washington reports an average boring depth of 300 feet and that hundreds of these boreholes are constructed in the state every year.

Table 7 provides an outline of many, though not all, standards contained in Washington's Well Construction Standards.

Table 7

Washington Department of Ecology – Chapters 173.160 & 173.162 Washington Administrative Code (WAC)[112]	
Driller Qualifications	Drillers must have at least 600 hours of drilling experience working under the direct supervision of a licensed operator who has held a Washington state water and/or resource protection well drilling license for at least three years, have obtained six continuing education units as approved by the Department, and pass a written examination. The application fee for the license is $75.
Reporting	Water well report must be submitted 30 days after well completion.

110 Conversation with William Lum, Washington State Department of Ecology, October 6, 2009.

111 Conversation with William Lum, Washington State Department of Ecology, October 6, 2009.

112 http://www.ecy.wa.gov/programs/wr/wells/wellhome.html and http://apps.ecy.wa.gov/welllog/

Location	A ground source heat pump boring shall not be located within one hundred feet from any water supply well. The setback from public water supply wells for ground source heat pump borings must comply with applicable dU.S. EPArtment of health sanitary control zone regulations for the public water supply wells. Where the sanitary control zone is greater than one hundred feet the setback should reflect the expanded distance. Variances to the standard setback for water supply wells can be obtained.
Exclusions/Exemptions	None specified.
Sealing the borehole	Site-specific conditions shall be assessed to determine the best method and materials to be used for sealing the well annulus to protect the ground water. Grouting (sealing) the bore hole of a ground source heat pump boring must be completed immediately after the heat exchange loop is installed to avoid cave in of the uncased hole.
Sealing materials	Sealing must be done with an active solids content Bentonite grout slurry (minimum twenty percent active solids by weight) per WAC 173-160-221. Use of controlled density fill (CDF) and fly ash is prohibited.
Heat Pump Loop Materials	The material used to make up the heat exchange loop that is placed into the ground must be able to withstand the typical forces, which act upon it during and after construction. It shall be resistant to the corrosive effects of the surrounding formations, earth, water, and heat exchange fluids within the pipe.
Loop Fluids	All fluids used in the construction and testing of ground source heat pump borings will be handled and utilized in a manner that does not contaminate the ground water or surface water.
Fee Schedule	The fee for a ground source heat pump boring or a grounding well is forty dollars for construction of up to four ground source heat pump borings or grounding wells per project and ten dollars for each additional ground source heat pump Boring or grounding well constructed on a project with more than four wells.
Testing Requirements	Pressure testing will be done in accordance with manufacturer recommended specifications. The Closed-loop assembly pipe within the borehole shall not leak or cause contamination to the ground water.

APPENDIX C: County and Jurisdictional Data

County	Alameda
Special Jurisdiction	None
Agency	North Alameda County Public Works Agency
Contact	510.670.6633
Drilling Classification	Geothermal Well
Rationale	
Regulations	California Department of Resources Water Well Standards DWR Bulletin 74-99
Permits	Required and available online
License	C-57
Fees	$345 for inspection costs
Additional Comments	The applicant applies for a permit under which they specify "geothermal well". The agency then has to go back to the applicant to see what kind of system they want to install (vertical, closed loop, horizontal etc). The applicant submits a site map of what they want to install and where they want to install it. The agency prefers installations in the backyard vs. the front yard due to potential problems with easements in the front yard. Concerns particular to Alameda are the shallow groundwater zone which requires permitting for drilling even at shallow depths. Their process is guided by a 1997 U.S. EPA manual (U.S. EPA 430-B-97-028).

County	Alameda
Special Jurisdiction	Pleasanton, Dublin, Livermore, Sunol
Agency	Zone 7 Water Agency
Contact	925-454-5000, http://www.zone7water.com/
Drilling Classification	Water Well
Rationale	Geothermal wells have certain construction requirements that a borehole does not need, i.e., sanitary surface seal. There is no casing involved in borehole drilling – one has to back fill with native material or cement.
Regulations	California Department of Water Resources Water Well Standards
Permits	Required and must indicate the type of project
License	C-57

Fees	None to date
Additional Comments	None

County	Alameda
Special Jurisdiction	City of Berkeley
Agency	City of Berkeley (Toxics Management Division)
Contact	510.981.7460
Drilling Classification	Borehole
Rationale	
Regulations	California Department of Water Resources Water Well Standards Alameda County Code Berkeley Municipal Code
Permits	A building permit is required through the Permit Service Center and the Toxics Management Division requires a soil boring permit
License	C-57
Fees	Fees for soil boring are $188 for the first and $112 for each additional boring
Additional Comments	

County	Alameda
Special Jurisdiction	Fremont, Newark, Union City
Agency	Alameda County Water District
Contact	510.668.4460, http://www.acwd.org/
Drilling Classification	Water Well
Rationale	
Regulations	California Department of Water Resources Water Well Standards
Permits	Required
License	C-57
Fees	There is a $520 per well fee. If a job takes longer than 5 days there is an additional inspection fee $100/hour.
Additional Comments	This jurisdiction is concerned with interconnection with aquifers because they have problems with salt water intrusion. They do not allow bentonite as a seal.

County	Alpine
Special Jurisdiction	None
Agency	Environmental Health
Contact	530.694.2146
Drilling Classification	Water Well
Rationale	
Regulations	California Department of Water Resources Well Water Standards The county has a county well ordinance that contains standard well permitting conditions.
Permits	Required
License	C-57
Fees	$360 per well
Additional Comments	There are no GSHPs installed in Alpine county. It is the state's smallest county, with a population of 1,100 and has a large transient population. It is a resort area and the main industry is tourism.

County	Amador
Special Jurisdiction	None
Agency	Amador County Environmental Health
Contact	209.223.6439
Drilling Classification	Water Well – “other”
Rationale	
Regulations	California Department of Water Resources Water Well Standards
Permits	Required and available online
License	C-57
Fees	Well ordinance $211 first, additional wells are $63
Additional Comments	The main concern in Amador County is cross-contamination. They have a few heat pumps installed in the county. A common issue that arises is that drillers want to use bentonite to fill right to surface and they usually resist that because it is not as structurally sound.

County	Butte
Special Jurisdiction	None
Agency	Butte County Public Health
Contact	530.891.2727, 530.538.7281

Drilling Classification	Water well
Rationale	Butte County only permits closed loop wells, they also require basic construction specifications to see how they are sealed, what materials they are using, and what the heat exchange media is.
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99
Permits	Required
License	C-57
Fees	$368 per well
Additional Comments	They probably have a total of 10 GSHP systems county-wide. They just had a series of fee changes so not sure the precise fee.

County	Calaveras
Special Jurisdiction	None
Agency	Calaveras County Environmental Health Dept.
Contact	209.754.6399
Drilling Classification	Geothermal Heat Exchange Well
Rationale	They have specified GHEWs on the well construction application because the purpose of the drilling is functionally different than well water drilling.
Regulations	California Department of Water Resources Water Well Standards
Permits	Required. The county requests that a site map accompany the application, and they also request a work plan.
License	C-57
Fees	There is a fee for the application and the permitting of the well – also if the project generates hazardous waste then you fall into a different program and there would be sU.S. EPArate fees. The per well fee is $445.
Additional Comments	

County	Colusa
Special Jurisdiction	None
Agency	Colusa County Environmental Health
Contact	530.458-0395 or 0398
Drilling Classification	
Rationale	

Regulations	
Permits	
License	
Fees	
Additional Comments	

County	Contra Costa
Special Jurisdiction	None
Agency	Contra Costa Environmental Health
Contact	925.692-2500, 925.692.2533
Drilling Classification	This type of well would be designated under "other" on the proposed use section of the application.
Rationale	
Regulations	California Department of Resources Water Well Standards Bulletin 74-99
Permits	A sU.S. EPArate application and fee is needed for each well.
License	C-57
Fees	$531 per well
Additional Comments	Contra Costa County has permitted a few jobs that involve Geothermal heat exchange wells. Officials expect to see more in the future as there has been increasing interest in this type of work within driller forums.

County	Del Norte
Special Jurisdiction	None
Agency	Dept of Health and Human Services - Environment
Contact	707.464.3191 ext 295
Drilling Classification	Exempt
Rationale	If they are not extracting/injecting water then no permit is required.
Regulations	Department of Water Resources Water Well Standards Although GHEWs are exempt, Del Norte county would look at the proposal to make sure it meets set-back requirements and that the circulation medium does not endanger ground water w/contamination. They must be closed loop systems. County code also has some requirements such as requiring that the drilling be 100 feet from a septic tank and leach lines. County code references water well

	standards.
Permits	Not required
License	C-57
Fees	Del Norte County would charge a $60 fee for a plan check. They would not permit each well.
Additional Comments	Depending on the area of Del Norte county they have pretty shallow groundwater (60ft or less) so they are sensitive to contamination concerns. Theylso want to make sure that the circulating medium is not a contaminant or pollutant.

County	El Dorado
Special Jurisdiction	None
Agency	Environmental Management
Contact	530.573.3451
Drilling Classification	Water Well – Other
Rationale	
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99
Permits	Required
License	C-57
Fees	$258 for the first well, $129 for each additional well
Additional Comments	El Dorado County has 10-20 GSHP systems. The seal requirement is important because of contamination concerns in El Dorado County. They prefer neat cement and bentonite would require special approval.

County	Fresno
Special Jurisdiction	None
Agency	Department of Public Health
Contact	559/445-3357
Drilling Classification	Fresno county has one application, "permit to construct a well" application.
Rationale	
Regulations	California Department of Water Resources Water Well Standards.

Permits	Required. The permit process typically takes no more than a few days if there are no land use issues.
License	C-57
Fees	The cost is $605 with the permit application.
Additional Comments	

County	Glenn
Special Jurisdiction	None
Agency	Glenn County Health Department
Contact	530.934.6102, 530.934-6546
Drilling Classification	Water well
Rationale	
Regulations	California Department of Water Resources Water Well Standards
Permits	Required
License	C-57
Fees	$475 per well
Additional Comments	They haven't had to permit any of these systems but if they did they would treat them as water wells, require a permit and require them to be sealed up.

County	Humboldt
Special Jurisdiction	None
Agency	Humboldt County Department of Health & Human Services
Contact	707.445.6215
Drilling Classification	Water Well
Rationale	
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-81
Permits	Required; not available online
License	C-57
Fees	1-2 wells $246, each additional well $22
Additional Comments	Humboldt county has at least one GSHP system installed.

County	Imperial
Special Jurisdiction	None
Agency	
Contact	760.482.4675 ext. 4278
Drilling Classification	From a building perspective there is no difference between water well drilling and borehole drilling
Rationale	Unfamiliar with technology
Regulations	California Department of Water Resources Water Well Standards Title 9 land use ordinance
Permits	Required
License	C-57
Fees	A conditional use permit is required for all wells drilled in the county. Well permit = $600, the conditional use permit is $3,500 - this is a discretionary permit that goes to planning commission for approval.
Additional Comments	They do not yet have their permits online but they are planning to do so in the future and also post a pricing schedule.

County	Inyo
Special Jurisdiction	None
Agency	
Contact	760.878.0238
Drilling Classification	Water Well
Rationale	
Regulations	California Department of Water Resources Water Well Standards
Permits	
License	
Fees	
Additional Comments	

County	Kern
Special Jurisdiction	None
Agency	Environmental Health Services
Contact	661.862.8700
Drilling Classification	Water Well – however, GHEWs may incur different fees.

Rationale	
Regulations	California Department of Water Resources Water Well Standards
Permits	Required and available online
License	C-57
Fees	$675 for most well types and $75 application processing fee.
Additional Comments	

County	Kings
Special Jurisdiction	None
Agency	
Contact	559.582.3211 ext 2670
Drilling Classification	None
Rationale	
Regulations	
Permits	
License	
Fees	
Additional Comments	They have never had a request for GHEWs. If they have a request in the future they would look in the codes to figure out how to permit them.

County	Lake
Special Jurisdiction	None
Agency	
Contact	707.263.1164
Drilling Classification	Water Well – "Other"
Rationale	If a borehole is for a purpose other than water use and intercepts a water table, then a permit is required; "other" on well permit.
Regulations	California Department of Water Resources Water Well Standards
Permits	Required
License	C-57
Fees	The county applies a basic fee for a well construction and an additional hourly rate for inspectors to perform duties associated with the well seals. Fees are approximately $248 per permit and $101 per

	hour consultation fee.
Additional Comments	There was one GSHP installation the Tallman Hotel in Upper Lake.

County	Lassen
Special Jurisdiction	None
Agency	
Contact	530.251.8852(8)
Drilling Classification	Water Well Permit, "other"
Rationale	
Regulations	California Department of Water Resources Water Well Standards County ordinance requires a bentonite seal from the bottom up
Permits	Required
License	C-57
Fees	$146 for the first well, $50 for each additional well.
Additional Comments	Permit process – download form, send in with a fee. The permit application says they need a plan of work.

County	Los Angeles
Special Jurisdiction	None
Agency	Department of Health Services, Drinking Water
Contact	626.430.5420
Drilling Classification	Water well
Rationale	
Regulations	CA well standards
Permits	Required and available online
License	C-57
Fees	$317 for each well
Additional Comments	

County	Los Angeles
Special Jurisdiction	Long Beach
Agency	Department of Public Health and Human Services, Bureau of Environmental Health, Water Quality, and Cross Connection Section

Contact	562.570.4134
Drilling Classification	N/A
Rationale	They have not had an application for one yet. The City of Long Beach would consult with Los Angeles County and Orange County to determine the guidelines.
Regulations	
Permits	
License	
Fees	Unknown
Additional Comments	

County	Los Angeles
Special Jurisdiction	Pasadena
Agency	Water and Power Department, Water Division
Contact	(626) 744-4436
Drilling Classification	
Rationale	
Regulations	
Permits	
License	
Fees	
Additional Comments	No answer forthcoming from city. They could not give an answer to how they would deal with a GHEW.

County	Los Angeles
Special Jurisdiction	Vernon
Agency	Department of Community Services and Water
Contact	(323) 583-8811, Ext. 279
Drilling Classification	Water Well – “other”
Rationale	
Regulations	California Department of Water Well Standards; Bulletin 74-99; there may be additional regulations depending on well location.
Permits	Required, one application.

License	C-57
Fees	$258 per well (might consider these wells cathodic wells).
Additional Comments	Any well over 50 ft requires a permit, plot plan and if necessary a plan to control water contamination. If they had more information, they would consider other ways to deal with geothermal boreholes.

County	Madera
Special Jurisdiction	None
Agency	Environmental Health Department
Contact	559.675.7823
Drilling Classification	Madera county does not specifically classify a geothermal well on the well permit application. The best fit per the current application would be an industrial well.
Rationale	
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-81 and 74-90 Madera County has reviewed the draft standards for geothermal heat exchange wells (Bulletin 74-99), however, they currently have not adopted them nor do they have any ordinance that addresses geothermal wells.
Permits	Permit required
License	C-57
Fees	Currently, the County water well permit application fee for domestic, agricultural and industrial wells is $205. A public water well is $285 and Monitoring Well/Test Borings are $243. The county's fees increase each year on July 1st based on the Consumer Price Index (CPI).
Additional Comments	

County	Marin
Special Jurisdiction	None
Agency	Environmental Health Services
Contact	415.499.6907, 415.499.6667
Drilling Classification	Monitoring well – for smaller systems
Rationale	
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99

Permits	The county requires different information for different systems; for larger systems they ask for elevation drawings, plans for controlling drilling fluids, emergency response plan, contact info, etc.
License	C-57
Fees	Fees $364.00 for the initial hole, $60 for each additional ($2000 max/site)
Additional Comments	Marin County has about 10 GSHP systems, several with more than 100 boreholes (Marin College, Lucas Films Big Rock Ranch)

County	Mariposa
Special Jurisdiction	None
Agency	Mariposa County Health Department
Contact	209.966.2220
Drilling Classification	Water Well
Rationale	If it acts like a well, they treat it like a well. Borehole drilling is more for testing purposes.
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99. There are no local ordinances for geothermal heat exchange wells.
Permits	Required
License	C-57
Fees	Charge $100 for first $60 for additional wells.
Additional Comments	All of the drilling in Mariposa County is hard rock/fracture drilling. During these projects they talked with drillers to make sure they didn't cross contaminate between water bearing fractures. The county is concerned about what kind of liquids they would be using in their heat transfer systems. Do have some areas with high nitrate in shallower areas. They know those areas and require those to be sealed off. If the well cluster went deeper in those areas, they would want the first 50 feet properly sealed with a seal around the casing.

County	Mendocino
Special Jurisdiction	None
Agency	Environmental Health Division
Contact	707.463.4466
Drilling Classification	Monitoring Well
Rationale	They do not have a sU.S. EPArate permitting process for geothermal wells. They used the monitoring well application because it enabled

	them to permit more than one well at a time.
Regulations	California Department of Water Resources Water Well Standards, Bulletin 74-99 The county has also consulted with the Coastal Commission.
Permits	Required
License	C-57
Fees	For 1-3 boreholes $429 total, each additional borehole $200.
Additional Comments	The county had its first GSHP project in the winter of 2008. The Environmental Health Division spoke with Sonoma county in order to get guidance on the permitting process. Sonoma informed Mendocino of Bulletin 74-99. Mendocino reports that the process went well for the one residential installation in winter '08. If the county receives more applications for geothermal heat exchange wells they might revise their policies.

County	Merced
Special Jurisdiction	None
Agency	Merced County Environmental Health
Contact	209.381.1100
Drilling Classification	Water Well
Rationale	C-57 licensed driller and property owner complete and submit the application and fees, we review and approve the permit application, driller calls in at least 24 hours in advance for inspection.
Regulations	California Department of Water Resources Water Well Standards
Permits	Required
License	C-57
Fees	$226 for a Low Temperature Geothermal Well Permit (per site)
Additional Comments	

County	Modoc
Special Jurisdiction	None
Agency	Modoc County Environmental Health
Contact	530.233.6310
Drilling Classification	Water Well
Rationale	
Regulations	California Department of Water Resources

	Bulletin 74-99
Permits	Required
License	C-57
Fees	There is a standard fee of $60 per well. If the project requires significant time to inspect or permit, the time will be billed at $122 an hour.
Additional Comments	

County	Mono
Special Jurisdiction	None
Agency	Mono County Health Department
Contact	760.924.1845, 760.932.5588
Drilling Classification	Exempt
Rationale	They do not currently permit heat pump wells. They require permits for wells that pump water; if the GSHP is a closed loop system with a water solution, the county likes to see information regarding construction however, there is no permitting involved.
Regulations	None
Permits	None
License	C-57
Fees	Fees for a standard water well agricultural/domestic/industrial $460 permit fee, Monitoring well $150
Additional Comments	The county has not permitted any of these systems. People will call sporadically about these types of wells and systems.

County	Monterey
Special Jurisdiction	None
Agency	Environmental Health Services
Contact	831.755.4511
Drilling Classification	Geothermal Heat Exchange Well
Rationale	
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99
Permits	Required
License	C-57

Fees	Fees are $542.00 for each GHEW up to the first 4 wells. The fees are $72.00 for each additional well.
Additional Comments	

County	Napa
Special Jurisdiction	None
Agency	Napa County Environmental Management
Contact	707.253.4471, 707.259.8328
Drilling Classification	Geothermal Heat Exchange Wells
Rationale	Napa County has a sU.S. EPArate application for geothermal heat exchange wells.
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99 Napa County Code specifically states that Geothermal Heat Exchange wells are wells covered by the well ordinance,
Permits	There is a specific Geothermal Heat Exchange Well permit; all wells go in under one permit.
License	C-57
Fees	The County fee for geothermal heat exchange wells is $538 for the first 5 wells and $21 for each additional well on the same permit.
Additional Comments	

County	Nevada
Special Jurisdiction	None
Agency	Environmental Health
Contact	530.265.1464
Drilling Classification	
Rationale	
Regulations	
Permits	
License	
Fees	
Additional Comments	They have one person who wants to convert a water well under his house into a GSHP system and they don't know how to proceed.

County	Orange
Special Jurisdiction	None
Agency	Orange County Environmental Health, Water Quality
Contact	714.433.6000
Drilling Classification	Geothermal Heat Exchange Well
Rationale	
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99 The Orange County Well Standards Advisory Board made revisions/deletions to the State of California standards as they pertain to the geology and/or hydrology of Orange County.
Permits	Required
License	C-57
Fees	$378 for the first well and $181 for each additional well
Additional Comments	The county does not permit open-loop systems

County	Orange
Special Jurisdiction	Anaheim
Agency	Public Works Engineering Department Subdivision
Contact	(714) 765-4231
Drilling Classification	Other
Rationale	Well permits are required for all wells, which are defined as any vertically drilled excavations that have a casing installed. Soil borings or push probes to a depth of 20 feet or more, or that encounter groundwater also require a well permit.
Regulations	California Department of Water Resources Water Well Standards
Permits	Required and available online. For heat wells they would require special classification and would require the depth of the well to be specified on the permit.
License	C-57
Fees	Each well app has $110 fee, there is also a fee for every well, $80
Additional Comments	

County	Orange
Special Jurisdiction	Buena Park
Agency	Public Works Department, Engineering Services
Contact	(714) 562-3686, 714.562.3687
Drilling Classification	
Rationale	
Regulations	
Permits	
License	
Fees	Unknown
Additional Comments	They would need to see plans to make a determination as to how they would deal with a GHEW system. They have extensive groundwater contamination concerns that would need to be addressed to their satisfaction.

County	Orange
Special Jurisdiction	Fountain Valley
Agency	Public Works Engineering Department
Contact	N/A
Drilling Classification	Orange County permits wells in this jurisdiction
Rationale	
Regulations	See Orange County
Permits	
License	
Fees	
Additional Comments	

County	Orange
Special Jurisdiction	Orange
Agency	Public Works Department, Water Division
Contact	(714) 288-2475
Drilling Classification	
Rationale	Wells less than 50 ft deep do not require permit

Regulations	California Department of Water Resources Water Well Standards
Permits	Required; fill out an application and show plans
License	C-57
Fees	No permit fee
Additional Comments	

County	Orange
Special Jurisdiction	San Clemente
Agency	Public Works Engineering Department
Contact	(949) 361-6104, 361-6179
Drilling Classification	
Rationale	
Regulations	Public Works does not know of any city or county regulations. As such, they would apply plumbing regulations for underground pipes (e.g. a re-compaction requirement)
Permits	
License	
Fees	$ 270.00 for first well, each additional $50.
Additional Comments	

County	Placer
Special Jurisdiction	None
Agency	Placer County Environmental Health – Land Use and Water Resources Section
Contact	530.745.2357
Drilling Classification	Water Well
Rationale	
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99
Permits	Required
License	C-57
Fees	$604 for the first well, $276 for each additional well.
Additional Comments	Placer county will only permit vertical closed loop GSHP systems.

County	Plumas
Special Jurisdiction	None
Agency	Environmental Health
Contact	530.283.6355
Drilling Classification	Geothermal heat exchange wells
Rationale	GHEWs are treated a little bit differently; for example, the permit fees are different.
Regulations	California Department of Water Resources Water Well Standards. Plumas county code - Ch 8, Sec 6-8.05. The standard for the geothermal wells is half the distance (set back) vs. water well.
Permits	Required
License	C-57
Fees	$514 permit fee for 1-10 GHEWs
Additional Comments	Set-backs is their biggest concern, they have a lot of septic systems in their county. The one company that does the majority of the GHEWs does the bentonite seal all the way to the top. They allow them to do that mainly because they know they are doing the seals correctly. There is another company they do not allow to do so - that company has to do cement.

County	Riverside
Special Jurisdiction	None
Agency	Department of Environmental Health
Contact	951.955.8980
Drilling Classification	Water Well "other"
Rationale	
Regulations	California Department of Water Resources Water Well Standards Riverside County Local Ordinance 682
Permits	Required and is available online
License	C-57
Fees	$260.26 for the first well, $65.28 for each additional well (same site, same time).
Additional Comments	

County	Sacramento
Special Jurisdiction	None
Agency	Environmental Management Department
Contact	916.386.6652, 916.875.8400
Drilling Classification	Borings that do not come within 10 feet of groundwater do not require a permit in Sacramento county, they are unregulated. If there is a casing in the hole, it needs a permit regardless of depth.
Rationale	Sacramento County well ordinance has a section on geothermal heat pump wells.
Regulations	California Department of Water Resources Water Well Standards Sacramento county also has its own specific ordinances.
Permits	Required and available online
License	C-57
Fees	Permit fee for geothermal heat exchange wells is $398 (2 hrs of time for permit approval and grout inspection), $199/hr for additional time (more wells may require longer inspection times).
Additional Comments	

County	San Benito
Special Jurisdiction	None
Agency	Environmental Health Department
Contact	831.636.4035
Drilling Classification	
Rationale	
Regulations	
Permits	
License	
Fees	
Additional Comments	They have no idea what they would do for a GHEW and would need to discuss exact specifics of a job to work out a procedure. They would like something from the state of California detailing how to deal with GHEW, but have no idea of how to proceed in the absence of such guidelines.

County	San Bernardino
Special Jurisdiction	None
Agency	Department of Public Health, Environmental Health, Safe Drinking Water
Contact	909.884.4056
Drilling Classification	Water Well – they would require additional information
Rationale	
Regulations	DWR Water Well Standards
Permits	Required
License	C-57
Fees	$155 per well
Additional Comments	There are at least 2-3 GSHP systems in the county.

County	San Diego
Special Jurisdiction	None
Agency	Monitoring Well Permit Section
Contact	619.441.4448
Drilling Classification	Water Well
Rationale	These types of wells would be permitted on a case by case basis by the Dept of Environmental Health.
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-81 and 74-90 The County code mimics the state law.
Permits	Required
License	C-57
Fees	$460 flat fee– this would be the only way to apply a fee to this type of project.
Additional Comments	They would like to see some sort of way to limit contamination of the heat exchange fluid into ground water.

County	San Francisco
Special Jurisdiction	None
Agency	City of San Francisco Public Works/Water Quality
Contact	415.554.5860/5810 /(415) 252-3849
Drilling Classification	Monitoring Well
Rationale	
Regulations	The construction is not regulated. However, an application to operate a well and a well completion report are required.
Permits	Monitoring Well Permit required
License	C-57
Fees	Fees are as follows: $298 dollars per site and $800 deposit. If the loops come together before entering building it is considered 1 well. Each well requires a permit to operate it which costs $47 dollars per year, per well
Additional Comments	There is one GSHP system at City College.

County	San Joaquin
Special Jurisdiction	None
Agency	Environmental Health Department
Contact	209.468.3420
Drilling Classification	Water Well
Rationale	
Regulations	California Department of Water Resources Water Well Standards San Joaquin County well standards available on county website
Permits	Required, must specify the intended use.
License	C-57
Fees	$325 for the permit
Additional Comments	The water table in San Joaquin County is reachable within 100-200 ft. Some areas of San Joaquin County are known for ground pollution for nitrates - there are known contaminated areas in the county and in these areas they require a deeper grout seal (200 vs. min 100 for other areas).

County	San Luis Obispo
Special Jurisdiction	None
Agency	Environmental Health
Contact	805.781.5544
Drilling Classification	Water Well
Rationale	They do not have very many requests for GHEWs
Regulations	California Department of Water Resources Water Well Standards
Permits	Required; not available online
License	C-57
Fees	$360 for each well
Additional Comments	San Luis Obispo is concerned with contamination of the aquifer beneath the water basin.

County	San Mateo
Special Jurisdiction	None
Agency	Division of Environmental Health
Contact	650.372.6200
Drilling Classification	
Rationale	
Regulations	
Permits	
License	
Fees	
Additional Comments	

County	Santa Barbara
Special Jurisdiction	None
Agency	Environmental Health
Contact	805.681.4900
Drilling Classification	Water well "other"
Rationale	

Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99
Permits	Required. The permitting process is based on seal inspections. They charge per permit which can be a series of holes.
License	C-57
Fees	Charge per permit is $715
Additional Comments	

County	Santa Clara
Special Jurisdiction	None
Agency	Santa Clara Valley Water District
Contact	408.265.2600
Drilling Classification	
Rationale	
Regulations	
Permits	
License	
Fees	
Additional Comments	

County	Santa Cruz
Special Jurisdiction	None
Agency	Environmental Health Department
Contact	831.454.2728
Drilling Classification	Water Well – specify geothermal
Rationale	
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99
Permits	Required; not currently available online
License	C-57
Fees	$724 flat fee for any size installation
Additional Comments	Santa Cruz County has permitted 2-3 GSHP installations

County	Shasta
Special Jurisdiction	None
Agency	Environmental Health
Contact	530.225.5787
Drilling Classification	Water well
Rationale	
Regulations	California Department of Water Resources Water Well Standards
Permits	A valid permit to drill, destroy, deepen, or recondition a water well is required in the County and the three cities. Permits are obtained from the EHD after submission of a completed application, plot plan, and fees. EHD staff must be present to verify proper placement of the annular seal around the well casing. Annular seals are usually placed around the top 20 feet of casing but may on occasion be placed just a few feet or as much as several hundred feet deep when required by local conditions.
License	C-57
Fees	$265.35 - permit fee
Additional Comments	

County	Sierra
Special Jurisdiction	None
Agency	Environmental Health Department
Contact	530.993.6700
Drilling Classification	Water Well – “Other”
Rationale	Sierra county has no specific geothermal ordinances so they treat it as a water well; they are willing to be lenient on 100 ft setback for geothermal wells.
Regulations	California Water Well Standards
Permits	Required
License	C-57
Fees	$132 flat rate for small residential projects. Commercial may be different. Not specified in fee schedule.
Additional Comments	

County	Siskiyou
Special Jurisdiction	None
Agency	Siskiyou County Health Department
Contact	530.841.4040, 530.841.2112
Drilling Classification	Monitoring well/Borehole
Rationale	
Regulations	California Water Well Standards and local ordinance.
Permits	Required
License	C-57
Fees	$318 for first 3 wells, $85 for each additional well.
Additional Comments	

County	Solano
Special Jurisdiction	None
Agency	Dept of Resource Management
Contact	707.784.6765
Drilling Classification	Soil boring
Rationale	They classified the heat wells as soil borings in fairness to the developer. The fee for soil borings is about $241 for 5 borings whereas well construction permit fees are $440 for each well. It didn't seem reasonable to charge so much for permit fees so they charged according to the boring fee schedule.
Regulations	California Department of Water Resources Water Well Standards Bulletins 74-81 and 74-90 Local ordinances reference the DWR California well standards.
Permits	Required
License	C-57
Fees	$241 per 5 borings
Additional Comments	Permitting process: one page application, on website, provide site drawings showing location of wells, and application describe work to be done. The issue of GHEWs doesn't come up very often in Solano County.

County	Sonoma
Special Jurisdiction	None
Agency	Department of Health Services
Contact	707.565.6574
Drilling Classification	Water Well
Rationale	
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99International Ground Source Heat Pump Association Standards. The county will address ground source heat pump issues by ordinance in the future.
Permits	Required; not available online.
License	C-57
Fees	$273 for the first boring, $72 each additional boring.
Additional Comments	

County	Stanislaus
Special Jurisdiction	None
Agency	Environmental Resources Department
Contact	209.525.6700
Drilling Classification	
Rationale	
Regulations	Geothermal wells are new in Stanislaus County
Permits	
License	
Fees	
Additional Comments	

County	Sutter
Special Jurisdiction	None
Agency	Sutter County Environmental Health
Contact	530.822.7400
Drilling Classification	

Rationale	
Regulations	
Permits	A building permit is required for retrofit of an existing system (no additional permit fees for a new structure). Energy compliance documentation for the system is required.
License	
Fees	Permit fees are based on the total construction valuation of the project including equipment, labor and materials. No additional permit costs are added if the system is included in a permit for a new structure as opposed to a retrofit.
Additional Comments	

County	Tehama
Special Jurisdiction	None
Agency	Environmental Health
Contact	530.527.8020
Drilling Classification	Water Well – “Other”
Rationale	Any well over 20ft deep requires a permit be it boring, geothermal or water well.
Regulations	California Water Well Standards
Permits	Required
License	C-57
Fees	Well fee schedule: $267/$255/$201 per well depending on well classification. Geothermal wells would probably fall under “other” and be charged $201 per well.
Additional Comments	

County	Trinity
Special Jurisdiction	None
Agency	Environmental Health Division
Contact	530.623.1459
Drilling Classification	Exempt
Rationale	They do not typically permit geothermal heat exchange wells
Regulations	
Permits	

License	
Fees	$197 for basic water well permit
Additional Comments	

County	Tulare
Special Jurisdiction	None
Agency	HHSA- Environmental Health
Contact	559.733.6441
Drilling Classification	Monitoring Well
Rationale	
Regulations	
Permits	Required
License	C-57
Fees	$110/hr for however long the inspector is on site.
Additional Comments	

County	Tuolumne
Special Jurisdiction	None
Agency	Environmental Health
Contact	209.533.6443
Drilling Classification	Monitoring Well – “Other”
Rationale	
Regulations	California Water Well Standards; Bulletin 74-99
Permits	Required
License	C-57
Fees	$495.75 per well
Additional Comments	

County	Ventura
Special Jurisdiction	None
Agency	County of Ventura, Groundwater Section
Contact	805.654.2024, 805.654.2907

Drilling Classification	Water well
Rationale	Ventura County well ordinance does not mention geothermal heat exchange wells at all. If someone were to come in today to drill the county would permit it as a water well.
Regulations	California Department of Water Resources Water Well Standards There is also a county ordinance
Permits	Required
License	C-57
Fees	The fee for processing an application to extend a permit pursuant to Section 4813 (E) of the Ventura County Ordinance Code shall be $25. Well fees are as follows: $610 for the initial well plus $90 for each additional well which is located on the same site and is perforated or sealed on the same day the initial well is perforated or sealed.
Additional Comments	

County	Yolo
Special Jurisdiction	None
Agency	Environment Health
Contact	530.666.8646
Drilling Classification	Water Well – other
Rationale	
Regulations	California Department of Water Resources Water Well Standards Bulletin 74-99
Permits	Required
License	C-57
Fees	The county does not have a specific fee for geothermal wells, therefore they would likely charge by the hour. The hourly rate is currently $119/hr. This may change in the future.
Additional Comments	There are 2 GSHP systems on UC Davis Campus and 2 systems on private residences in Woodland.

County	Yuba
Special Jurisdiction	None
Agency	Environmental Health/CUPA
Contact	530.749.5450

Drilling Classification	Water well
Rationale	
Regulations	California Department of Water Resources Water Resources Water Well Standards Bulletin 74-81 and74-90
Permits	Required; they have an application and require the work plan
License	C-57
Fees	Soil Boring or Excavation (Additional @ $47 each) $150.00
Additional Comments	

APPENDIX D: Stakeholder Interview Transcripts

Lisa Meline
Owner
Meline Designs
July 22, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

- *Mechanical Engineer*
- *Certified Geoexchange Designer*

What is your current responsibility and authority regarding GSHPs?

I represent the owner, the customer. We provide the end-user with a geothermal system design.

How long have you worked in this, or a closely related field?

- *Since 1999 – 10 years.*

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

Geothermal system design. Geoexchange is in some ways a more accurate description of what they're doing. However, they follow the terminology that the customer is using; as such, I will often explain in presentations the different terminology.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

No. I get it all different ways, ground source heat pumps, geothermal, geoexchange.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

There is no standard out there with regards to terminology. This is not really a problem, however, usually a good part of what I do involves educating the customer.

What terminology do you think would be most appropriate for this industry and why?

[See above]

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

General education is a bigger issue than the terminology.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Neither high nor low, - it is where you would expect. There are several individuals and organizations who are out educating and when people come to me about this technology, they've done some research and they ask more specific questions than they would 5-10 years ago. However, we have a long way to go in terms of providing better information.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

- *No petroleum based products on-site (very important to some people – all electric system)*
- *Applied correctly, there will be energy savings but it is not going to be a super quick payback. We need to be upfront about energy savings. California has higher costs for installation and electricity. 7-10 year payback. It's an investment.*
- *Very popular technology – people coming out of the word-work to make money off of it. However, if you don't do it right, you will screw it up. This could affect the entire industry.*

How have your customers become aware of GSHPs/learn of your product?

A lot of them are doing internet research – DOE website. They may have gone to Meline website. Heatspring has been doing training around the country. IGHSPA.

What do you think the primary motivation was for consumers who purchased GSHP systems/your product?

I see four primary motivations:

1) They want to save money in the long term, and they understand that they will recover their investment over time.

2) People who want to do the right thing (sustainable, green) concerned about the earth. 3) People who want to do the latest and greatest, coolest stuff – the first adopters. They want cutting edge.

4) I'll give you an example: People who want to build a huge house with single pane windows, may try to off-set energy cost/comply with energy efficiency standards – by using GSHP to trade off (see Title 24). It is a way to compensate for poor construction materials – glass etc. However, Title 24 – energy efficiency standard for CA – will be more restrictive come January 1st.

Have you observed any similarities in your customer demographics?

- *Wealthy homeowners*
- *Housing authorities (low income), and people that own multifamily apartments – it is in their best interest to put in a system that costs less to operate.*
- *A lot of Do-It-Yourselfers – they might have a backhoe or pond, a retired Prof or contractor who has the resources to do it.*
- *Schools*

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

A CA-based Geothermal heat pump consortium needs to get out there and educate. Education needs to be provided to the general public (via home and garden shows, fairs), and also needs to be provided for counties, the people who permit these types of systems.

Engineers also need to be educated. Perhaps PG&E and SMUD could be involved with education efforts.

What are some suggestions that you have to better inform consumers of this industry/your product?

[See above]

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

I have encountered barriers in the following two areas:

1) *There is no consistency among the counties re: permitting, they aren't sure how much to charge, or how to proceed.*
2) *Influencing change at the state level –geothermal heat pumps are not treated fairly in energy efficiency standards. Similarly, modeling software does not treat heat pumps correctly. I highly recommend that they change this (rally manufacturing people, talk to the CEC, costs $ to make change).*

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

Awareness is better than it has been but people don't understand how it all works. Some people see it as a fad, others see it as a way to save energy but don't understand how the technology works.

Data is a barrier. When people, they ask 2 things:

1) *How much are they going to save?*
2) *How much will it cost and who can provide services?*

They come to me saying there is no data out there telling them how much they can save. This is because there is not a lot of data being collected. Smart meters will come out and more people will want to know about their usage but right now it is hard to know from current meters what is going on.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

[See above]

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

Their costs are related to materials. The cost of heat pumps have gone up – this is across the board.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

- *Upfront costs.*
- *Permitting costs.*
- *Engineering or contracting firm fees.*

Do you believe that GSHP systems are priced too high, too low, or just right?

Between just right & too high – in some cases they are too high, others ok. A lot of this is contractors and engineers dealing with customers who are demanding and require a lot of special ad-ons. Even though the price is high, it is probably just right due to expectations of the customer.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

Depends on the project.

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

There are some things that really have to be looked at, one of which is the pump itself. You really need to do a good job sizing the pump. Also you can't just put it anywhere, you need to have land.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

From my perspective, the growth has been huge. I started with 1 project in 1999 and now this type of work is 80% of her volume. There has been so much growth, in fact, that her peers (who are not doing GSHP) are laying people off and she is experiencing growth.

My estimate for the size of industry: market-share 40% growth over the last year, at least.

As to the industry in CA, it is poorly organized. There has to be some kind of organization that pulls together key elements and that provides a consistent voice throughout the state.

Drilling

Drilling is the single largest cost component of GSHP systems and thus has a large impact on GSHP project economics. How important is it to your company to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Drilling is a huge line item cost – but so are the heat pumps.

The GSHP industry currently faces a shortage of drillers. What changes need to be made in order to attract and retain more drillers to the GSHP industry?

I disagree, I've seen more drillers in CA the past few years than the previous 8 years. Some of the water drillers are trying to switch over.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

From a design perspective I would like to see some stricter standards and guidelines. I would like to see grouting from the bottom up and I'd like to see some better requirements for how those wells get installed.

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

- *Obama $/tax credits – does not include water-to-water heat pumps. Might have to do with the rating of that particular piece of equipment. These are the two miscellaneous things floating around in her world.*

Jim Bose
President IGSHPA
July 22, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I started out in this industry in 1974. We formed an association in Indiana 25 years ago. At that time they had installed a number of systems in Oklahoma. IGSHPA offers membership, conference training, materials development and $10 million in research.

What is your current responsibility and authority regarding GSHPs?

I am the Executive Director of IGSHPA. We have an advisory council that is elected by membership and we direct the staff and student interns. We write stories for the magazine, GeoOutlook.

How long have you worked in this, or a closely related field?

Since 1974.

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

Ground Source Heat Pump – this is more in tune with the international community.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

It's all over the place. Geoexchange, Ground Source Heat Pumps, Geothermal.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

What terminology do you think would be most appropriate for this industry and why?

I don't know of anyone who has liked any of the names. The oldest name is ground source. But if we are going to be an international organization we need to be in tune with international standards.

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

I don't know.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

It's about what you might expect. I didn't think it (industry growth) would take this long – people aren't keen to change. But it continues to grow – we have workshops filled to capacity, and the booth space at our conference in Dallas sold out.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Save money*
2) *Comfort – peoples perspective changes whenever you give them an option (example of air-conditioning)*
3) *Environment*

How have your customers become aware of GSHPs/learn of your product?

Word of Mouth

What do you think the primary motivation was for consumers who purchased GSHP systems/your product?

Saving money, there are some people who talk about environment.

Have you observed any similarities in your customer demographics?

The utility company has a lot to do with who purchases these things. People look to the utilities as a trusted advisor – this is important.

Generally, people who get these systems aren't moving around a lot, they are homeowners, and a bit older than the average person.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

Raise the price of energy.

What are some suggestions that you have to better inform consumers of this industry/your product?

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

I don't have a good feel for CA. In Oklahoma regulations are increasing. There might be a shortage of drillers – not everyone can get into the drilling business overnight.

There is also poor education on their part to let people know what pitfalls they might run into.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

I don't have a large national perspective on this. It depends on building owners who are going to maintain control of building/facility vs. renter real estate.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

Higher first cost – just like an automobile. Generally you buy all the automobile you can afford. The GSHP product has a good return on investment, they can cut the utility bill in half in Oklahoma– however, people do not generally make decisions on how to save money.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

People haven't really thought about investing in energy efficiency and oftentimes the builder will talk you out of it. Ultimately, I think the utility will install these things. However, drillers are not too excited about the utility company doing the drilling. They have sessions on this at conferences. In Colorado, utilities do this. There are models out there that work.

Do you believe that GSHP systems are priced too high, too low, or just right?

The marketplace will determine the right price.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

If you go with the high performing units on both sides – they both have compressors, fans, GSHPs have the same components as an air conditioner. The additional cost is the outside ground/drilling. If you have conditions that are hard to drill, or lack of experienced driller – this affects cost.

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

I work with a local school board in trying to get them to go with GSHP – a big problem is a lack of understanding of the school's utility costs, coupled with a lack of understanding as to how they can control it. The people that you're talking to have to be educated about what you're trying to get them to buy.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

All of my installation workshops are now filled to capacity. The rate of growth is around 18-20% compounded annually and this is probably a low estimate. California is not a major market – I'm not sure why.

30% tax credit – I'm not sure what impact that is going to have.

Drilling

Drilling is the single largest cost component of GSHP systems and thus has a large impact on GSHP project economics. How important is it to your company to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Drilling is a big part of the cost for these systems. However, if you get enough work out there the drilling costs would come down to a reasonable level. You can get it down by economies of scale.

The GSHP industry currently faces a shortage of drillers. What changes need to be made in order to attract and retain more drillers to the GSHP industry?

The industry did face a shortage of drillers, and now the shortage coming back (in Oklahoma).

IGSHPA is offering drillers training courses now – they have a lot of people in there who have never drilled in their life who are trying to decide if they should get into drilling business.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

New technology is coming; everyone would like to have it lower cost.

The guys that get costs down are the ones that are deliberately thinking about how to mechanize the process.

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

It is done state by state. In Oklahoma drillers have to have a license, in CA they have to have a license.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

Growth is more than drilling the hole. We have to do a lot of training; we have a whole industry to educate. The key is to get organizations like Habitat for Humanity involved, associate the technology with things that really appeal to people and have high visibility.

Brian Hayden
President
HeatSpring Learning Institute
September 2, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I started Heatspring 3 years ago. It is a training organization, we teach installers, designers, project managers, and building owners, how to design install and care for ground source heat pump systems. We are unique in that we don't use training as a marketing effort, it is our whole business. All the leading experts are teaching you rather than selling to you.

What is your current responsibility and authority regarding GSHPs?

How long have you worked in this, or a closely related field?

Approximately 3 years.

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

Geothermal heat pumps – this bridges the gap between geothermal and ground source heat pumps.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

No it is not consistent.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

Yes, it is a problem, however it isn't the primary problem.

What terminology do you think would be most appropriate for this industry and why?

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

The name would follow if other things were figured out. The main problem is the fact that it [GSHP] is not presented as an option to consumers. There's enough confusion on part of building community due to a lack of education on the part of building community, which leads to greater misunderstanding on behalf of consumer.

There are always debates over appropriateness of the technology and we need to be clear about when it is appropriate – be open and honest about what it is. There are enough legitimate applications that if everyone had disclosure about what it is there would still be tremendous growth.

There is also a lack of warranty. Having a performance guarantee would solve a lot of the problems, but who is going to stand behind it when there are so many players on an installation.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Low. There is a lack of good information, readily available and presented in a way that is contextually relevant for people.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *It works*

How have your customers become aware of GSHPs/learn of your product?

A lot of it is online or via conferences or word of mouth. We train contractors whose customers are asking for the product so they see it as a business opportunity.

What do you think the primary motivation was for consumers who purchased GSHP systems?

Being smart or having the best – making wise decisions.

Have you observed any similarities in consumer demographics?

- *Wealthy homeowners*
- *Institutions/commercial building owners with long payback horizon*
- *Schools*

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

First thing I would do is engage state regulators and state policymakers in a conversation and educate them.

What are some suggestions that you have to better inform consumers of this industry?

The best way to get info out is via the contractors. These are the people who are getting the calls when there are problems with existing HVAC equipment. They are also the people/experts who are in the house.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

The biggest barrier I see is uncertainty about the regulations. People need to know if they are "allowed" to do something like this and if people don't get an answer right away they give up.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

There's a learning curve and a time lag. If someone's furnace breaks in the winter you have to put in furnace in the interest of time and necessity. There is an interest to decision time lag, it's a short window and it takes a while to teach people about something. The problem is missing that window.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

The manufacturer only has so much power, if they drop their prices it doesn't necessarily translate to lower prices to consumer.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Up-front cost.

Do you believe that GSHP systems are priced too high, too low, or just right?

I believe in market based pricing. I wouldn't say too high or too low, I would love to see lower prices because prices as they are now are too high for widespread adoption.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

The financing mechanisms to offset the initial investment in GSHPs is worse than other alternative energy solutions. The price consumers are seeing is much higher than for other renewables, whereas the underlying cost may actually be lower.

Federal tax credit: I am waiting for it to impact the industry; I think it will have a positive impact but it won't drive industry growth.

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

A lack of information, and a lack of a credible source of information.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

Size: growing (20-25% a year)

The industry is small, but greater access to info and lower initial costs could spur growth.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

It can be; it's the obvious thing that sets it apart from a traditional system. Reducing cost would be great. However, on the commercial side, I've seen ductwork costs right up there with drilling costs.

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers,"? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

Yes.

There needs to be a more consistent level of demand. Drillers make big investments in their businesses they are motivated to make those investments when they know they will be busy.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

I would argue that probably anything could be improved.

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

I don't have a lot of experience getting permits. It can greatly impact the cost of the job and it can drive the design to some extent.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

Carl Hauge

Department of Water Resources (Retired)
July 22, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I have worked in groundwater issues for 31 years. In the early 90s, the CEC was interested in pushing the GSHP industry because cost of electricity going up, and they wanted to avoid building new plants.

The CEC invited people from IGSHPA, bentonite industry, drilling, EPRI, - it was recognized that there needed to be some standards. The result is the DWR Draft Standards from April 1999.

I am no longer full time staff with the DWR, there is no budget for this work, but I'm doing what I can.

What is your current responsibility and authority regarding GSHPs?

How long have you worked in this, or a closely related field?

Since early 1990s.

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

Ground Source Heat Pumps

Geothermal Heat Exchange Wells – they are using the heat exchange of the earth. We're talking about a pretty esoteric field here, not many people know about wells or boreholes, when you talk to people about it – especially legislators – you have to explain things to them. Trying to standardize terminology is difficult when you have that level of ignorance at the legislative level. This is one of the problems in groundwater, a lack of standardized terminology (ex, abandoning a well = destroyed).

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

What terminology do you think would be most appropriate for this industry and why?

GSHP and Geoexchange – both are valid terms.

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

It is very important but it is difficult to achieve this. Policy-makers have to be on the same page and they will use whatever they are given by water people.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Very low – thinking in terms of water wells, even water wells fall low in terms of public awareness. People move out to the foothills and they have to build a well and they don't know anything about it. There is a lack of understanding of basic principles.

GSHPs are even more mysterious – geothermal elicits thoughts of high temp geothermal and geysers. Even people who have been living on wells, in the Sacramento and San Joaquin valleys are more aware of some of these water well issues but this does not translate into awareness of GSHP issues.

I've encountered banks that don't want to loan money to projects w/GSHP. County staff will get a proposal for GSHP, and have to call me with questions because they don't know what they are.

We need to educate architects and contractors.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Saves Energy*
2) *Good heating and cooling system*

3) *Aside from environmental issues connected with generating energy, has no deleterious environmental impact that they have found thus far.*

How have your customers become aware of GSHPs/learn of your product?

Before energy was deregulated, utilities were telling people about these systems so they could reduce their energy consumption. This may be one way to get people to know about it – to get energy companies involved.

What do you think the primary motivation was for consumers who purchased GSHP systems/your product?

Long-term savings.

Have you observed any similarities in your customer demographics?

Schools

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

I would work with building contractors groups, building industry associations, any architects who get involved in developments, or larger office buildings and I would approach PG&E SMUD, So Cal Edison to see if they might be interested in re-instituting a plan to subsidize the wells required for GSHP systems.

What are some suggestions that you have to better inform consumers of this industry/your product?

Utilities can inform customers. The GSHP industry could always get together some TV ads.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

People in the industry might look on the standards as a regulatory barrier but the contractors I've worked with, look on the standards as something they have to live with and enforce. The reason the standards are there is so that contractors, drillers know that they have to do GSHP projects a particular way to protect groundwater quality. The standards do require a level of technical expertise, but new standards have been made using input of players of stakeholders. They are an attempt to be standards that protect and can be implemented without excessive cost.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

Lack of awareness is a barrier. People move around so much that they do not realize the long-term benefits. If you are only going to be in a house for 5 years, it is not a long enough time to accrue the savings.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

There is no business.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Upfront Cost.

Do you believe that GSHP systems are priced too high, too low, or just right?

Building costs a certain amount. If you talk to a contractor in California, there are certain costs that they incur (fuel, insurance, etc). I thinks these costs are determined by the market and the market is going to keep those costs in the right place because the drilling contractors have expenses they have to cover. The out of state contractors charge a lower price but they don't know what they are doing. Inspectors have to deal with these contractors who don't understand the standards.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Lack of awareness and people not staying long enough in one home to accrue the savings.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

If the cost of energy skyrocketed, this would spur growth.

As to size of the industry, in the early 1990s it was growing rapidly, but after deregulation it slowed. More recently, interest has increased for larger projects because they will be there over the long term (10+ years) so they benefit from the savings. More of the large installations are occurring now than they have in the past and I think they will increase.

Drilling

Drilling is the single largest cost component of GSHP systems and thus has a large impact on GSHP project economics. How important is it to your company to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Yes, this is what I've been told by more than one person in the industry. This is why the power companies were subsidizing the upfront costs of wells.

The GSHP industry currently faces a shortage of drillers. What changes need to be made in order to attract and retain more drillers to the GSHP industry?

The reason drillers from out of state get contracts is because contractors need to have had a large installation under their belt. The CGA is trying to help drilling contractors to get certified by IGSHPA to become familiar with the techniques.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

There's always improvements in the technology in these fields. What's out there currently meets the GSHP standards.

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

We have 58 counties in California and almost all of them have local enforcement agencies. They are the ones who have developed the permitting process – Dir. Of Environmental Health in conjunction with County Supervisors. So, there are at least 40 different ways that the permitting process works and 40 different fee schedules. The only way to make this more uniform is to have the 40 counties get together and work something out. This is an issue that CGA is working with California Conference of Environmental Health. There is quite a difference on the fees charged by different counties.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

Dennis Terhove

City of Calgary
July 22, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I'm a regulator now. Prior to that I was involved with geoexchange.

At the city I've established a permanent inspection process for GSHPs. We are the first municipality to do that in North America. I encountered resistance from the industry but the truly legitimate contractors are happy with it, and customer confidence is good due to the 3rd party inspection process. We set up the process in September of 2006 and started from scratch. Nothing else out there, started from scratch. Have a Canadian standard, full guideline for GeoExchange systems.

What is your current responsibility and authority regarding GSHPs?

How long have you worked in this, or a closely related field?

10 years

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

Geoexchange – Canada is moving towards this, thanks in part to the Canadian Geoexchange Coalition.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

Consumers typically use the term geothermal.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

What terminology do you think would be most appropriate for this industry and why?

Geoexchange.

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

I don't know, it still is a new technology for consumers, but it's pretty much established. The name won't matter too much.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

It's about where I'd expect it to be – but you'd also have to look at the regional differences. We are in oil and gas country, and the cost of gas is lower. There has been a drop off in projects due to economics at the moment.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Bad stories are sticking around way too much*
2) *Advertising would help*
3) *Public awareness*
4) *Promote the industry as opposed to negative attitudes towards competitors.*

How have your customers become aware of GSHPs/learn of your product?

- *Primarily through publications- web-based or print.*
- *Word of mouth.*

What do you think the primary motivation was for consumers who purchased GSHP systems/your product?

- *Be green*
- *Add to a collection of toys*

Have you observed any similarities in your customer demographics?

- *Wealthy*
- *Techies*
- *Environmentally conscious.*

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

Extra lobbying. They are more proactive in Canada than we are in the US. Make the technology a lot more available, not just through websites, but through public broadcast on television and radio (they do this in Canada).

What are some suggestions that you have to better inform consumers of this industry/your product?

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

Contractors are not used to having to deal with it. Contractor awareness of value of permit can be a barrier. Regulations protect everyone – they work as a neutral agency. This needs to be realized; regulations have a purpose.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

Need to form organizations so that they could go in as a cooperative and express an organized front. Do their own local advertising and promotions – tremendous value to that.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

Cost of production – equipment costs are too high. They need higher output to drop cost. The systems are also technically demanding, they need to be fine tuned and maintained properly.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Upfront costs and drilling.

Do you believe that GSHP systems are priced too high, too low, or just right?

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Simply the operation itself can be an issue. For retrofits, if the drilling contractors are in and out, they must operate at certain times of day (there are restrictions). The operation necessitates ripping up lots and loud noisy equipment. They are immediately impacting. These sorts of things are walking advertisements for the industry and technology – for good or bad.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

GSHP industry is still in its infancy. It's growing extremely fast, almost doubling every year in Canada. One of the biggest hindrances to growth is the stand-alone, we're special attitude the industry has had. The industry needs to form organizations so that they can share experiences, new trends and technologies.

Drilling

Drilling is the single largest cost component of GSHP systems and thus has a large impact on GSHP project economics. How important is it to your company to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Absolutely I would agree, drilling is almost half of the price.

As to reducing drilling costs – I don't know if that is feasible. Drillers are dealing with very expensive equipment and people need to make a living.

The GSHP industry currently faces a shortage of drillers. What changes need to be made in order to attract and retain more drillers to the GSHP industry?

I haven't heard of anyone short a driller in my area but we are oil and gas country so we have drillers.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

I would like to see a drilling process that will go through every kind of strata – we deal with 2-3 types of drilling method and we would prefer just one.

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

The permitting process for us is the simplest part of it. Projects have to be certified and registered with the city, then they are inspected.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

CA has some pretty tough conditions. Forming an association might be even more important there.

John Kelly

Executive Director
Geothermal Heat Pump Consortium
August 11, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I am the Executive Director of Geothermal Heat Pump Consortium, we are a national non-profit trade association for the geothermal heat pump industry. We promote the technology, educate consumers. We are a member organization and we support the business efforts of our members. We also educate regulators/legislators and encourage them to pass appropriate regulations/legislation favorable to industry.

What is your current responsibility and authority regarding GSHPs?

[see above]

How long have you worked in this, or a closely related field?

Since 1995, with the Consortium.

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

Branding is an issue. We own the trademark Geoexchange and we are making a conscious effort to popularize that brand. Canada has been more successful with the term geoexchange than the U.S. This is because Canada didn't really have much of a term they used prior. In the U.S. the term "ground source" had been used for a number of years, since the1970s (IGSHPA). The other term is "geothermal" – this is the term of preference at federal government level. Geoexchange was an attempt to resolve confusion of the other terms but we only succeeded at adding a third term into the mix. It would be good to have one term that everyone uses. We came to the conclusion that the real problem is the term "heat pump". It is the hardest to explain to people, there is confusion among consumers as to what it actually does. They would go along with one name if there was industry consensus.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

Consumers still largely don't understand the technology or are not aware of it. Whatever term they hear first is what they relate to. "Geothermal heat pump" is the term on the 30% tax credit forms. There are also differences within the commercial and residential projects – we need to view this along these lines, there are different audiences.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

What terminology do you think would be most appropriate for this industry and why?

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

Very important. This is one of the reasons why I am open to using a term other than the trademark Geoexchange. It would be a net positive. Consumers are not confident that ground source means the same thing as geothermal.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Low because the industry has done a lousy job of branding.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Good deal – cost effective*
2) *Really works*
3) *Comfortable*
4) *Environmentally friendly – low carbon footprint, does not really pose any risk to the earth.*

How have your customers become aware of GSHPs/learn of your product?

Up till now consumers have found out through the media: seeing something on TV, reading an article in a magazine. Or, they have found out about it from their utility; rural co-ops have a magazine that they customize (Country Life/Living) to different areas and geothermal heat pump manufacturers advertize in these publications!

I think that a lot of people will find out about it when doing their taxes thanks to the 30% tax credit that was passed in February.

What do you think the primary motivation was for consumers who purchased GSHP systems?

What gets you in the door isn't the same as what gets you to buy. What gets people in the door is the fact that GSHPs are environmentally friendly/green and people are looking to be green. However, this won't get them to spend $20k on a GSHP system, the economics will ultimately sell them on it. The tax credit gets the price closer to conventional systems and legitimizes the technology. It is a tremendous incentive and gives consumers confidence in the technology.

Have you observed any similarities in consumer demographics?

These systems are expensive - upper middle class and higher.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

Get Warner Brothers to donate bugs bunny – as a spokesman. He crosses generational lines (kids, baby boomers) and can start educating kids about the technology. The environmental movement took root through education.

What are some suggestions that you have to better inform consumers of this industry?

Generically, the industry needs to do a better job of doing outreach and media advertising. You could have some very effective outreach. Most common question I get from consumers is: does it really work, and how does it work? We need to get some materials out that explain the technology simply by using diagrams and taking a common sense approach to media marketing.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

Yes, the barriers are:

1) uncertainty – people don't know what licenses/permits are necessary or if it is allowed where they live. A factor that amplifies this is the fact that there are 100s of different rules that apply. Each state has their own set of regulations. Also, local jurisdictions have different regulations as well. There is significant uncertainty as to what rules and regs are – however, this is a rapidly changing environment. Many jurisdictions do not have any regs and or do not understand the tech. There are a lot of jurisdictions that say they cannot do it. Regulators are trying to do their jobs. No professional wants to be the first one to try something because there is significant risk of ruining their career if something goes wrong. Significant uncertainty creates risk for both consumers and regulators.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

Residential – lack of consumer awareness

Commercial – lack of awareness by engineers. Engineers will talk folks out of the technology, this is the biggest failure as an industry. If they had put all of their money putting into a college course for geothermal heat pumps for engineering grads they would be more comfortable in the future. 2-3% of engineers are comfortable/have done this before. The liability if things don't work is huge.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

Economy of scale. Except for Bosch, of the geothermal heat pump manufactures who are focused/dedicated to technology, none are big enough to risk very much. It takes a long time to deliver – if things pick up they cannot deliver enough in time. Construction scheduling is important! You have to fit into their construction schedule – this means you may have to wait 12 weeks for a geothermal heat pump *and this can put a project in jeopardy. Once someone decides they want a GSHP – one of the biggest barriers is fitting into construction schedule.*

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Up-front cost. The tax credit, there is a lot of uncertainty about the tax credit. A 30% tax credit can make or break it. Until the IRS has a few test cases, we don't know how it will turn out.

Do you believe that GSHP systems are priced too high, too low, or just right?

I think it's about as good as it's going to get. It is realistic. Heat pump units themselves could get a little cheaper. Units themselves are probably close to the right price. There's not much economy of scale in doing the ground loop. Uncertainty drillers face when they do a job – if they do it wrong it costs them a lot of money. In my opinion, people are barking up the wrong tree when they pound on drillers, asking them to make the ground loops cheaper.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

GSHPs are competitive with something like solar – the problem is that you don't get credit for it. The problem with geothermal is that it is invisible whereas solar panels are visible. If you put in a geothermal system and no one knows you've got it. Big projects are impressive and people like to have big projects. Public perception is important.

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Confidence.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

Size: tiny, 2% of the total heating and cooling market. Tax credits are going to be a big deal but it will take a few years to sink in. Once this starts taking hold the other big problem is having enough people to do it. We will need trained people to do good jobs and we need to avoid bad installations. Having the necessary infrastructure is the key.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Agree. Not real important to reduce the cost of drilling.

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers,"? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

Yes. Drillers could use help with business planning. If you can convince a driller that they won't get in trouble by doing these projects, they wouldn't hesitate so much to do it. At the moment, water well drilling is the safe choice. Drillers are open to new ideas but they need help w/business plan for geothermal wells. Regulatory certainty will help as drillers need to know the environment they are working in.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

I don't have the technical knowledge to answer this but my guess is that while there are opportunities for improvements with new technologies for drilling, ultimately it has more to do with geology than drilling equipment. Drillers need to make the hole and not cause environmental damage.

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

The permitting process is very fragmented. It is different in every state, and local jurisdictions.

If the industry (geothermal industry and drilling industry) could get together and agree on a campaign of what the model regulations for permitting and licensing should be and went to 50 states to educate regulators and got a consistent set of regulations established in all 50 states – that would be a big help. I am not in favor of a federal regulation.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

Mike Thomas

ClimateMaster
Regional Manager
August 6, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I am a Western Regional Sales manager for ClimateMaster, I do all the promotional sales.

What is your current responsibility and authority regarding GSHPs?

How long have you worked in this, or a closely related field?

I've worked in the HVAC/Geothermal industry for 38 years.

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

I've changed from "geothermal heat pumps" to "ground-coupled pumps". One of the issues when you use geothermal is that it brings up hot rocks, steam, that kind of thing. It is confusing for lay people, they think you are talking about some exotic form of using deep earth steam or hot water. I still have to do some explanation of what the process is. "Earth coupled" helps explains ground source vs. air source. Usually by the time I'm talking to customers they've done some investigation to research the technology but there is still some confusion as to how it works.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

What terminology do you think would be most appropriate for this industry and why?

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

Most people are using different terminologies, and this is one of the biggest problems they have is that there is no consistency the terms people are using. I sees terminology as a big problem.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

I think it's about where you would expect, however there is a growing interest (residentially). People are coming into green home shows knowing about GSHP. They are looking to retrofit their existing system or building a new home. The difference between this year vs. 4 years ago is almost meteoric – people know so much more than they used to.

Why is this? It's due to the rise in energy costs. Consumers are looking at stabilizing household expenses and people are acutely aware of rising energy costs. .

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Energy conservation*
2) *Affordability*
3) *Reliability*

How have your customers become aware of GSHPs/learn of your product?

Local TV stations have had 5-minute spots on ground-coupled applications. It's also been in local news, newspaper. The local electric utility has put on seminars for architects, homeowners, engineers re: green homes and ground coupled is part of that. They've put on 3 in the last 15 months and they have turned people away due to over subscription.

What do you think the primary motivation was for consumers who purchased GSHP systems?

Energy conservation, comfort are the two drivers of the people who I talk to.

Have you observed any similarities in consumer demographics?

It's all over the board. I've got 40-50-60 year olds. Most people you talk to have done some research so they are cognizant of the basic principles and basic application.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

We need to push contractors to more specific advertising and trade shows and work with utilities to do more seminars that are green related. People are looking to combine solar with ground coupled. We need to work harder with utilities and contractors to get them to do more promotion of the technology.

What are some suggestions that you have to better inform consumers of this industry?

This is really difficult on a national level because the target audience is so fragmented. Demographics are probably older and higher income (majority) – but how do we attract this demographic? Perhaps tie into groups like AARP. This demographic looking to minimize their household expenses and this is one of the ways they could do it. He's never seen any article in AARP magazine about ground-coupled technology. Some of the jobs are 20-40-50k $, the end user is working with an architect/builder this is different than convention because they are very involved.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

The water quality people; I've had a number of barriers thrown up especially in northern California. The local water quality people have said they are going to do whatever it takes to stop the technology and they try to make it cost prohibitive to do. I've heard inspectors requiring the drillers to call the inspector out to watch driller drill each borehole, this compounds the cost and may shut the technology down.

The biggest problem is turf wars from local regulators. This is one of the biggest problems or barriers that CA has is the water quality people + the cost of drilling. It limits what you can do.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

The only barrier they have is getting the loop in the ground. It's not the cost of the equipment.

1) *Contractor knowledge – business has been so good for last 15 years for HVAC contractors. They've been doing new construction, 2 systems a day for HVAC.*

2) *Salesmen are paid on what they sell. It takes no effort to sell conventional HVAC, even in a downtime, they are scrambling to sell as many furnaces and air conditioning units as possible. Why waste 4-5 weeks to sell one unit (GSHP) where the salesperson has to hand hold the contractor. It takes a lot of effort for a distributor salesman and why do it? He could sell 20 units a month of conventional HVAC equipment and only 20 GSHP units a year. To sell ground coupled units you have to know a lot of information. You also have to meet with the contractor salesman, and handholding is involved. It takes a lot more effort to sell one unit. The Midwest might be different/easier. But in the west – this is one of the biggest barriers we have*

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

The cost of getting it in, the limited number of contractors that are actually involved in it.

Do you believe that GSHP systems are priced too high, too low, or just right?

The pricing is fine on the equipment side. Really the barrier is getting the loop into the ground ($) in the west because there is a limited number of drillers who will even participate in it. The new ones who show an interest, water well drillers, will charge $30-$40/foot to drill, if they could get it to $14-$18/foot it would be more reasonable but they won't touch that. There are a limited number of people doing the loop side.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Local municipalities and local regulations.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

Size: overall it is going largely – 15-20% growth a year, realistically (in the west). The Midwest and northeast are growing faster than that due to factors such as utility interest and more contractors doing it.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Yes. It is important to reduce the cost of drilling. There are different technologies that people are looking at to bring down the cost of drilling and new technology will be important. New pipes, new drills are possibilities.

Drilling barriers: Drilling conditions, size of drill rigs. From a drillers perspective they need to break even. Drill bits are expensive! ($2,000 per bit). Soil/geologic conditions are important factors when it comes to cost. Drillers can lose money on the job. Drilling conditions in the west are different vs. Midwest or the South.

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers,"? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

Yes. Driller expectation of what they need to earn per foot on ground-coupled jobs is unrealistic. To grow the industry, they have to be willing to work for less money and the water well drilling business has gone downhill- as a result they are getting more interest from water well drillers but when you talk to them about the cost expectations per foot ($18/foot) they are not interested, they need like $40/foot. The *driller doesn't know anything about heat pumps. They are drilling the hole, and they think they can sell/install the unit but it is not always so easy.*

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

In northern California it is very restrictive. Every county has a different permit process – they throw up barriers, there's no consistency. They seem to want to restrict the application by having no consistency in permit process, no consistency on price (permit fee).

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

In California it is turf battle/turf war – each municipality wants to run its own serfdom. There has to be more consistency in permit process, as to what's required and what's not required. Drillers won't waste their time in places like this. There has to be consistency on drilling side permit process. There's interest but also so many barriers.

KC Spivey & Brian Bailey

Customer Energy Efficiency, Emerging Technologies
PG&E

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today? Tell me a little bit about your involvement or experience with the GSHP industry?

I am a Summer intern with PG&E's emerging technologies group. I have been looking into ground source heat pump technologies. My colleague KC – has been with the Emerging technology group for about a year. We are focused on trying to get customers to save energy.

What is your current responsibility and authority regarding GSHPs?

How long have you worked on GSHP issues?

Brian has been working on GSHP issues for about 10 weeks. PG&E did a large study in the late 90s with the Davis energy group. There are people who have looked at it off and on and the study found they were competitive with traditional electric heating but not as competitive with natural gas heating. The interest waned for a while and now picking back up.

How would you characterize utilities interest in GSHP technology?

PG&E is very interested, this is why they assigned Brian this project. KC – had previously been a HVAC program manager and they did have an incentive – a rebate program. This program went away with the DOE min efficiency standard on Jan 1, 2006. They haven't had an HVAC incentive program since then.

I understand that in the early 90s, SMUD and SO CAL EDISON were subsidizing the upfront costs of the wells required for GSHP systems – what has PG&E's involvement with GSHPs been? What role for the future? (what needs to happen in order for utilities to play a greater role?)

PG&E had a program that was limited to education and training in the late 90s, when they were directed to undertake market transformation programs, these sunset in 2001. In the late 90s, early part of the decade, they were trying to reach customers in the foothills. They had training for the contractors to *install the systems, sponsored out of training center in Stockton. They also had a mobile training facility. One of biggest issues out West vs. Midwest is that customers don't know of GSHPs.*

Renewable Portfolio Standards – as I understand it, GSHP technology (since it is not a power generation technology) is excluded from renewable portfolio standards. Do you think inclusion in the RPS is a possibility and how might this impact the industry? Would this spark greater interest on behalf of utilities?

They are just starting to look into this but haven't made any headway. Brian is trying to talk to other folks around PG&E to see what opportunities exist. They would need a large-scale roll out of technology to make an impact. KC thought he heard that GSHP – may have been RPS eligible at this time. The RPS angle is important.

Industry Branding

What terminology does PG&E use to describe the industry and why?

PG&E does not have a terminology that it uses exclusively. Brian typically uses geothermal heat pump because more people are familiar with that. Probably the most correct term to use is ground source heat pump.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

What terminology do you think would be most appropriate for this industry and why?

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

PG&E probably underestimates the importance of standardized nomenclature.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Very low. Brian has been very surprised after talking to people discovering that most people don't know about the technology. However, a lot of people around PG&E know of them.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Energy savings*
2) *Carbon implications moving forward*
3) *Complementary liability*

The downside of GSHP – is the name "heat pump", customers have negative thoughts when they hear heat pump. Another challenge to getting this technology deployed is the temperate climate relative to where this technology has market share.

How have your customers become aware of GSHPs/learn of your product?

What do you think the primary motivation was for consumers who purchased GSHP systems?

Have you observed any similarities in consumer demographics?

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

Increase the organizational capacity of industry – manufactures have trouble tracking down dealers and it is difficult to track down people to talk to who know what they are talking about. Brian hasn't seen much of a push to advertise this technology to consumers in California.

The industry needs to improve awareness and work with the manufactures, place ads in industry magazines. Get some of the big names like ClimateMaster and WaterFurnace to do collaborative advertising.

What are some suggestions that you have to better inform consumers of this industry?

Create a push around quality and maintenance.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

The major barrier to large-scale implementation is the installation cost. What has come up multiple times is drilling in California. There are no regulations that limit PG&E's involvement and there are other utilities that are quite proactive in this space because they are seeing an opportunity to create benefits for their customers and themselves. However, PG&E is highly regulated by the Commission and they would be much more limited than other utilities.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

There is a lack of data collection. This makes it challenging to determine how much energy these systems use. There is a reason for this – the data differs on a case-by-case basis.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

PG&E has a complex rate structure (inverted block rate) and they want to try and get a better understanding of how that might impact customer choice. If a person implements this GSHP technology – costs are highly variable.

Do you believe that GSHP systems are priced too high, too low, or just right?

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

A major issue in California (for the residential market) is our relatively temperate climate. There is not a lot of heating and cooling loads in the summer as in other parts of the country. Thus the overall energy savings are lower. Another issue is that technology of conventional systems have come a long way, thus the effect of GSHP may not be what it was 10 years ago.

On the commercial side, there is a lot of potential for GSHP because heating and cooling loads are much more consistent.

Another issue is installation infrastructure – if contractor not available in immediate area, how far is he willing to travel.

Another issue is the fact that California has a relatively affordable supply of natural gas – not very expensive for people to heat using natural gas.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

In California the GSHP industry is small. Growth seems to be pretty slow recently although there have been some commercial installations done.

In order to spur growth we'd need to remove some of the barriers we talked about. Reducing the price of installation would be significant. The Commercial market is where there is real potential.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Don't totally agree.

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers,"? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

In California definitely. GSHP technology involves close collaboration between two very different trade types – drilling and HVAC contractors. There is the potential to grow some alliances here and get the two groups to work together more closely.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

Highly variable by jurisdiction and this is one of the challenges. Maybe this could change – if there were a way to do it through title 24 or a way the California Energy Commission could assist.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

If the cost of drilling could be taken down to what it is in the Midwest then that could have big implications in California.

Randy Dockery

Supervisor
Gregg Drilling
August 14, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I am a Supervisor with Gregg Drilling. I've spent almost 30 years in the drilling industry. Geothermal is about 2% of what they do.

What is your current responsibility and authority regarding GSHPs?

How long have you worked in this, or a closely related field?

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

The industry has an identity problem. I prefer the term geoexchange – it's what the systems do, they are basically heat exchangers. The term geothermal conjures up the wrong image (deep geothermal).

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

Yes, for geothermal they are. Consumers don't understand drilling in and of itself.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

What terminology do you think would be most appropriate for this industry and why?

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

It would be really helpful but I don't see it happening. There are too many regional terminologies.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Low, and I can't explain why that is. Geothermal has been around for many years and its come along way but for the age of the industry, it is still in its infancy. There has been a lack of education.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *It is a clean energy*
2) *It's very passive – doesn't require a lot of energy*
3) *Environmental (could become more cost effective w/carbon pricing)*

How have your customers become aware of GSHPs/learn of your drilling services?

Most of the work they've done has been good work. Customers learn of our services through word of mouth, the internet, and the phone book. Generally contractors contact drillers for this kind of work. They don't market it. The majority of their work, they've had to bid on. Gregg Drilling pushes safety in their bids, technology, compliance with regulations. Total containment of drilling fluids – clean water act (Federal) and U.S. EPA directives – most people don't understand that states are required to enforce these laws. There are hazardous materials involved in drilling.

First 5-10 ft are pretty bleached, a lot of minerals and salts are bleached out but once you get down deeper you bring them up (salt, naturally occurring chemicals- arsenic, chromium) that are above the limits – it's not your products that are causing problem it's what you're bringing out of the ground. You can't just dump this anywhere! Gregg Drilling started drilling geothermal wells in early 2000s. They started back doing them in July of last year.

What do you think the primary motivation was for consumers who purchased GSHP systems?

- *Cost-savings over conventional systems based on knowledge that energy will not be cheap forever.*

- *Trying to do something for global warming.*

Have you observed any similarities in consumer demographics?

- *Residential work: all high end*
- *Commercial work: economic calculation. Long-term payback.*
- *Schools: upfront cost*

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

What are some suggestions that you have to better inform consumers of this industry?

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local? Other states?

The cost of permits is the biggest barrier. Counties are used to dealing with small-scale projects, they are not geared for large numbers of wells. One geothermal project may have more wells than the entire county had the previous year. Counties have not quite figured out their fee schedules.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

I don't know enough about this aspect to comment.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Up front cost.

Do you believe that GSHP systems are priced too high, too low, or just right?

Just about right. Until there is a radical technological advance to increase production the cost isn't going to come down really.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

I think they're actually more competitive than other solutions.

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Room to put it in (you have to have the real estate).

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

There's a potential for a lot of growth. There's a lot of people wanting to do it but coming up with the upfront money/financing is very difficult in this economic environment. It could easily become 20-30 % of what they do in 2-3 years but it all hinges on the economy. I don't see residential going up much even with 30% tax rebate. Commercial will be the big area of growth because they can get a grant instead of a tax credit. However, a lot of businesses are just as strapped as the consumer.

Drilling

Would you agree with the statement, “Drilling is the single largest cost component of GSHP systems?” How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Yes, easily. There really isn’t any good technology out there that will increase production enough to drop the cost. In certain areas of the county you can drill extremely fast, there are other areas that are slowly. 300-400 foot per day is all you’re going to get on average due to geology.

Do you agree with the statement, “The GSHP industry currently faces a shortage of drillers,”? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

There is a lot of excess capacity in the drilling industry as a whole right now. Geothermal is actually very easy, it is one of the easier techniques.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

I would describe it as Byzantine. Each county and/or municipality has a different process; it adds some time in getting projects started but I don’t see getting that changed right now.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

Raymond List

CEO
Enlink
July 24, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I am President and CEO of Enlink, we are an engineering and contracting firm. We built the two biggest projects in California within the last year.

What is your current responsibility and authority regarding GSHPs?

How long have you worked in this, or a closely related field?

I've been in this business for 1.5 years.

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

They use geothermal heat pumps (GHP)

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

There is a major lack of understanding by end users and engineers. The name is just a symptom of a bigger problem.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

What terminology do you think would be most appropriate for this industry and why?

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

You can call the technology whatever you want but you have to have an underlying understanding of what it is/value of technology.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Low – there is a lack of understanding and no grasp of the bigger picture. There is also a lack of leadership in the industry compared to the solar industry. Solar has been big time, out in front for years. It will take a major transfusion to get this going for the GSHP industry.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Value (economic, environmental, cultural) – it is fundamentally undervalued in the eyes of potential end-users.*

How have your customers become aware of GSHPs/learn of your product?

The way it's being introduced in CA is by opinion leaders. In other places, now it is word of mouth.

What do you think the primary motivation was for consumers who purchased GSHP systems?

Value and a willingness to look at lifecycle costs.

Have you observed any similarities in consumer demographics?

The similarities are: opinion leaders, engineers, architects, people who are willing to look at value.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

I would do everything I could to get geothermal heat pumps into the same place that solar is now. If GHP became eligible for solar incentives – it would create artificial value because it would drop the initial capital cost immediately. It's all about value and economics and that can be fixed.

What are some suggestions that you have to better inform consumers of this industry?

Same answer. The value proposition has to be understood. We need to make it more valuable in the short term by getting incentives to drop the initial cost.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

Utility incentives. When you look at what's going underground and the life of that, it looks like it ought to belong to a utility rather than a particular owner. It brings up the whole question of what role utilities should be playing in subsidizing or owning, or feed-in-rates.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

Technology for in-building stuff is very straightforward. There are 5 manufactures that essentially build the same thing.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

First cost.

Do you believe that GSHP systems are priced too high, too low, or just right?

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

The industry is like the wild west – there's no real good standards and the standards that do exist aren't enforced. When you look at the quality of the companies and individuals it is 3rd class on average. There is a lack of professionalism, discipline, and standards. It desperately needs standards, discipline, certifications. There should be further development of certification standards.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

The industry's size in California is miniscule compared to what it could and should be.

The economic situation has damaged growth, everyone has slowed down. In order to spur growth we need to get the value proposition right and get industry leadership.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Drilling is probably half of the cost. Everything underground is about half the total cost in general (this is a broader definition than drilling alone).

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers,"? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

I don't think this is true in California although there is a lack of qualified drillers.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

Immature. For example for a big project with 500 boreholes, the municipality cannot decide who has jurisdiction then they decide it is the health dU.S. EPArtment. They are not sure if they are going to issue one permit or 500 permits @ $800 per permit. The whole process of licensing geothermal installers and drillers in CA is much behind a lot of other states.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

Dave Bisbee, CEM
Project Manager
Customer Advanced Technologies Program, SMUD

August 27, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today? Tell me a little bit about your involvement or experience with the GSHP industry?

I manage an emerging technologies program we try to test technologies in the field to see if they fit for them. We provide research grants to customers in exchange for the right to monitor the technology.

What is your current responsibility and authority regarding GSHPs?

How long have you worked on GSHP issues?

I came in right as they were winding down the geothermal heat pumps, circa 2001. SMUD had provided subsidies via research grants to test geothermal systems – they did about 200 of them, most with the Sacramento Housing Redevelopment Agency (SHRA). SHRA had a problem with disappearing air conditioning units, people were stealing them, and geothermal units were installed because they could not be stolen.

How would you characterize SMUD's interest in GSHP technology?

SMUD doesn't have much interest in this technology. It doesn't seem to make sense in our climate and the cost can be prohibitive. I personally do not think that the tax credit will have an impact.

Industry Branding

What terminology does SMUD use to describe the industry and why?

Depends on who you talk to. Water source, heat pumps, geothermal, ground source.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

There is consistency, ground source or geothermal.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

What terminology do you think would be most appropriate for this industry and why?

Ground Source Heat Pumps - it is the clearest. Geothermal strikes up the idea of geothermal power plants.

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

I don't perceive this as a big problem. The industry should form a committee and agree upon nomenclature and certain standards. They need to get together. More important than nomenclature would be agreeing on rating systems and how to communicate efficiencies.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Low – there's relatively few contractors that offer it. Contractors seem to be the number one way that technologies are communicated at the customer level. Usually when a call comes into me it's because a contractor has told them about it.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Cost Effective – it always comes down to the money.*
2) *Reliability – heat pumps have a lot of moving parts when those parts are (compressor) are operating year round there's a lot more to go wrong.*
3) *Environmentally friendly*

How have your customers become aware of GSHPs/learn of your product?

- *Contractors.*
- *Utility company was the one who suggested they look at it because of their circumstances.*

What do you think the primary motivation was for consumers who purchased GSHP systems?

Again, cost effectiveness and reliability.

Have you observed any similarities in consumer demographics?

They are technically savvy people. The ones who actually do something tend to be engineering types. Not your average consumer.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

I would nail down the issue of the ground loops better – in terms of cost effectiveness. Then focus on geographic areas that make sense for your market, don't try to reach everyone. Also take into consideration that a 10-year payback is usually the max that people will consider. Most people move before the payback period.

What are some suggestions that you have to better inform consumers of this industry?

Figure out where it makes sense to do business and partner with progressive utilities to hold seminars and workshops. SMUD has an energy & technology center and they have classes. They would probably not do a geothermal because it does not make sense for their service territory. Another way would be to work with the contracting community to get additional contractors on board to be at the home and garden shows.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

Drilling is an issue, another is geography. Well drillers may change their prices once a project starts due to unexpected soil conditions. Costs are highly variable.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

There is a general lack of contractors and market share. You don't want to waste a lot of time on applications in areas that don't make sense so you need to be surgical with your efforts.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Engineering costs. A significant amount of engineering needs to go into this vs. "normal" systems, such as where to site the system (especially in a retrofit situation). It begs the question do you align with well drilling and train them for what you need or do you have your own company? Part of what he saw was well drillers not quite sure what you want and padding bids.

Do you believe that GSHP systems are priced too high, too low, or just right?

I think GSHP systems are priced too high and I would like to know why. It would be helpful for the industry to look at that and figure out where they can do better. The industry should look at ways to optimize the process, standardization so you can minimize the customization of each project.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

Too high

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

Too high for residential, too high for small commercial, large commercial it depends on the alternatives.

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Yes, the reliability can be a scary thing.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

From my perspective the industry is stagnant. The core issues have never really been solved – cost effectiveness and reliability.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Drilling & loop installation – yes. Some projects will give a rough estimate and have contingencies in case they run into problems, and these tend to be deal-busters. Ultimately it comes down to a knowledge of local geology. If the drillers are experienced they will know what they are dealing with.

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers,"? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

Yes. There needs to be more partnerships with well companies, and the development of independent drillers for multiple companies. Again it comes down to educating and working with the well drillers on making more of an exact science.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

There could be an improvement in the sharing of information about local geologic conditions. This would give a better understanding of what the local conditions are for various communities, as well as what the options are. An industry association could create and maintain this.

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

It is one added step. If the project is anything other than the normal stuff – it takes a lot more handholding with local building inspectors. This is a general comment for geothermal and other projects.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

I would urge the industry to look at what is cost effective. Figure out where you are cost effective and go after it, don't waste time competing with a standard technology where you don't stand a chance.

Matt Ebejer
Vice President-Health Care, Syska & Hennessy Group, Inc

September 30, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I am a consulting engineer, I design systems in the field. I currently run a health care group in Los Angeles.

What is your current responsibility and authority regarding GSHPs?

I am a Designer/Specifier.

How long have you worked in this, or a closely related field?

I've worked in this field since 1981.

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

I normally call it geothermal but it depends on the audience. I also use the terms ground source and ground coupled. People seem to be leaning towards ground coupled, but this term leads to closed systems. In some areas of the country we do open systems so Ground Coupled limits the discussion.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

Everyone calls it a million different things.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

What terminology do you think would be most appropriate for this industry and why?

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

I don't think that it is a hindrance. I also design buildings and there isn't standard nomenclature within that industry, it differs from the east to west coast.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

I think it's extremely low. I was doing pump and dump systems and pond systems in the early 80s and I don't consider this a new technology. Part of the problem hindering the industry is that people think that using geothermal is new and it is not. The oldest project in US is in Chicago and it is about 100 years old; Frank Lloyd Wright's Falling Water is geothermal with stream running through the home.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *It is the greenest of all technologies – PV isn't very green, the gas that is released during the manufacturing process will kill you. Also, what do you do with the panels afterwards?*
2) *Reliability – It has the greatest reliability compared to conventional system. Furthermore, eliminating cooling towers could save billions of gallons of water a year.*
3) *Energy Savings*
4) *Lack of noise generation*
5) *Lifecycle savings*

How have your customers become aware of GSHPs/learn of your product?

Usually I tell them about it, or Craig at the CEC refers people to him. Generally it is through referrals.

What do you think the primary motivation was for consumers who purchased GSHP systems?

Reliability and overall cost of operation.

Have you observed any similarities in consumer demographics?

I haven't noticed anything like that. They are looking for the reliability as well as comfort and noise reduction. On the commercial side, they are tired of the maintenance staff they have to have on hand for conventional systems. If you can eliminate your boilers you can also eliminate the 5 operators needed to operate it.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

A lot of this work needs to start within. I don't think ASHRE stands behind the technology and promotes it and this is a major problem. In addition, the government right now is pushing PV and wind turbines and they never say anything about GSHP. Even the tax breaks favor the other technologies over GSHP. There need to be comparative tax credits for PV and GSHPs.

What are some suggestions that you have to better inform consumers of this industry?

The things I mentioned in the previous question need to occur first.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

There are ridiculous permitting fees from local municipalities. I just moved out to CA a year and a half ago and I'm not sure why the drilling costs out here exceed any other state – it makes no sense. Here drilling costs $15/20 a foot vs. $6/8 a foot other places. Maybe there is a lack of drillers in California. Based on a few projects I'm working on – available drillers are not there and you have to bring them in from Montana and pay for them to stay in hotels.

Also, when you do projects, you have to prove to cities/counties what you are doing. The dU.S. EPArtments need to be educated as to what this stuff really is – the first thing they do is say no.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

Again – the drillers.

Another barrier is the income tax in California – businesses have to fork out the income tax to the state, that's hurting them.

Incentives from utilities – other places offer a reduced rate for GSHPs, here that does not exist. They don't have these incentives even though it reduces load on the grid.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Financing. I am able to bridge some financing gaps by finding outside funding but most people aren't able to. I've worked with cities where we created utility service districts so that people could get low interest loans. The city would put the infrastructure in and people would pay the city. Sandusky, Ohio – created a redevelopment district, it would create 50,000 jobs in 10 years.

Lake Tempe, AZ

Do you believe that GSHP systems are priced too high, too low, or just right?

Horizontal systems don't work on commercial buildings.

Land is a premium so it is hard to get enough room for a horizontal system. There's quite a few jobs out there that have been bad jobs – engineers say they know what they are doing but they do not. Furthermore, it is hard to sU.S. EPArate the drilling from the system! Much of the cost revolves around the drilling. It's very expensive but it still pays back in California due to the high costs of electricity here.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

The economics doesn't work for PV that's why they give a 30% tax credit.

Even with the high price, GSHP projects have payback of 2 -7 years.

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Space and the geology of the ground because that effects the efficiency. There are a lot of issues that can be addressed by using ponds. If you have very little land, a little pond or fountain can do wonders. You can use your swimming pool can heat and cool your house no problem. I'm working on a project where it will take 9 acres of field to accomplish what a 1-acre pond can do for a ¼ of the cost.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

In California the industry is not very big – compared to other states it is a fraction of other states. California compared to MI, probably has 1/10 of the projects that Michigan has going on. California probably has 1% of projects going on in Nebraska. If there are 5-6 projects going on at a time, that's a lot.

In order for the industry to grow, drilling prices and awareness/education, and the state coming out and doing programs and tell people about it are the main components. Even with drilling costs where they are at, it discourages the industry but the technology still pays back.

Those that even do it here, they get a job – but they're not really pushing it. Geothermal is not just about energy savings, it's about lifecycle costs (replacement, maintenance, water savings). Not enough people know how to do it.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Yes. But I don't know how you drive drilling costs down.

Do you agree with the statement, “The GSHP industry currently faces a shortage of drillers,”? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

Counties are like little fiefdoms – no one has authority. In a place like Michigan, the state can override the counties but here that is not the case.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

Drilling costs are a lot different here in California. We need to shift from PV and wind and realize that there's another thing out there that is more energy efficient.

Phil Henry

Consultant
October 2, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I've been active within the industry for about 10 years. I started as a engineer with a mechanical contractor firm and then went to a position working as a territory manager with WaterFurnace covering the western U.S. including California. Most recently, I left WaterFurnace to represent a start up manufacturer and in the last few months I've been doing consulting and web-based work within the industry.

What is your current responsibility and authority regarding GSHPs?

[See above]

How long have you worked in this, or a closely related field?

[See above]

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

I use all of the terms depending on the conversation and who I am talking with. If I'm speaking with an engineer and he's talking about the nitty gritty – then I use the term ground coupled heat pump. The most common term is geothermal heat pump or geoexchange.

My preference is to use geoexchange. Part of what I've been doing the past few years is developing the Geothermal Heat Pump Consortium's (GHPC) website and as I've done that I've used the terms geoexchange and geothermal interchangeably to increase search indexing. Just a few days ago as the GHPC Director John Kelly and I were sorting out the directory, we decided to make a switch and use geoexchange exclusively and move to do that site-wide. The sites are indexing so well that the GHPC needs to take a leadership role and move to geoexchange. The federal government is also starting to use geoexchange – although geothermal is in the documents.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

No.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

It is not consistent. Overall, this does limit the industry and the industry has done a poor job of providing a common front e.g. having multiple terms to refer to the same technology. Commercial reps work predominately with engineers and that consumer has a different level of sophistication. On the open consumer side, it's mostly contractors and dealers and they typically call it geothermal.

What terminology do you think would be most appropriate for this industry and why?

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

One way is for the association/organizations in a leadership role (like IGSHPA and GHPC) to adopt a term and then use that term throughout their marketing programs. If IGSHPA and GHPC use the terms geoexchange instead of ground source that would be a help. It would also be very helpful if the manufacturers referred to it as geoexchange. Similarly one-way to accelerate the change is the continued use of geoexchange instead of geothermal in government documentation.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

In California – low. Its where I'd expect it to be for the industry in CA – it's off the bottom of the chart compared to where it could be/should be. As an industry we've done an abysmal job of promoting the industry in this state. Given the size of California's economy and the overall opportunity, it amazes me that there hasn't been more of a concerted effort in the state. With that said I understand that you go for the low hanging fruit and California has some challenges – its moderate climate being one. That's part of the reason the uptake has been a bit slower.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *The technology is the most efficient way to actively heat and cool any building anywhere on the planet. It is available and has been around for a long time (20-30 years) – it is a mature technology.*
2) *Demand side reductions should be our focus in terms of energy usage in our state as opposed to supply side management. That will run afoul of the solar stuff. GSHP offers permanent demand side reduction without lifestyle change.*
3) *This is your best solution if you are heating and cooling. If you are interested in being part of the solution to our state becoming sustainable then there's no greater area for you to impact your energy consumption. 60% of energy goes into heating and cooling in a building.*

How have your customers become aware of GSHPs/learn of your product?

The geo consumer is a different anima; part of this is due to sustainability/green component and the other is the large expense. The overall sales process for geo is quite long term – months up to years. There's quite a bit of research that that consumer does. Direct interaction between contractors and the consumer is how many people find out about the technology. I'm a huge advocate of home shows. They work.

What do you think the primary motivation was for consumers who purchased GSHP systems?

If you're talking about the residential consumer – in California particularly, you do have some early adopters but the lion's share of the work has been has been with the mega-mansions. There you have a lot of keeping up with the Jones' and trying to do the right thing as well. Then you have folks like one of my best friends who put it in cause he wanted to do the right thing. This is the market segment that is the baby boomers.

Have you observed any similarities in consumer demographics?

The similarities are: wanting to do the right thing balanced with economics and what makes sense. One of the drawbacks/issues in CA is less awareness and the need for more availability of the parts and pieces to get an install done in a reasonable time/cost.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

I would make sure that the association's web presence was state of the art and top in the industry. This would be first and foremost. Then I would make sure that web presence provided the means for the industry players to reach the consumer in that specific area. This is one of the things that is intrinsic to the geo purchaser as a whole – they do their research. Putting the right tools out there – making them available - is the first step. Then I would provide the right certification for the industry and training and *sales and marketing training to the players in the industry. Currently if done it is done by manufacturers.*

What are some suggestions that you have to better inform consumers of this industry?

Getting folks like our sitting governor up to speed on geo and having him talk about it when he talks about sustainability. I would apply that to the rest of the California legislature. Then certainly the CEC could take a more active role in how it treats the industry and the State's Architect's office could also get involved.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

One of the greatest barriers is the Title 24 issue. Title 24 specifies that any building that is going to be put into service has to meet certain energy consumption guidelines. There has to be a Title 24 certificate of compliance and there are various types of software that are available to do this that are approved by the CEC. Last I heard there are some changes to this, at least in draft, but essentially a designer/mechanical engineer cannot show Title 24 compliance if they are putting geo into a client's home w/o manipulating the software. They are comfortable doing that because they know the performance will far surpass the minimums so they do it. But the issue remains that Title 24 statues and compliance software give short shrift to geo. They make it very easy to deploy a supply side management tool. This is a very big issue.

On the positive side – you have a states architect's office that is pro geo.

However, local ordinances are all over the map and this is potentially a huge impediment. Most recently there was a California courthouse in Susanville that was going to go Geo but it unwound because of local ordinances.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

Every day we experience this government-wise. There was a huge number of schools being built in last few years and almost none of them are going geo.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

[See above]

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

There's essentially 3 main players in the industry and there's a 4th emerging: ClimateMaster, WaterFurnace, FHP Bosch Group and the current federal incentives for geo are almost completely due to the efforts of one industry player. In the industry we are still faced with the fact that no one wants to pay for lobbying efforts. There isn't an unlimited amount of money – they are not running at monster margins – and there's not enough money from manufacturers going into increasing public awareness and lobbying efforts.

I think that other stakeholders need to take more of an active role – starting with the contractors. The GHPC site is set up to facilitate that. The folks in the industry, earning their living off of it need to be more active. Additionally, the heretofore unheard of major stakeholders are the utilities. We need to find a way legislatively and from a federal perspective to facilitate the embracing of the demand side management issues by the utilities. They're the ones that should be in the thick of this and they're not.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Assuming that everyone wants to do the right thing, it'd be very difficult to justify spending an extra 10-15-20-30k on an heating and cooling system if the break evens are not reasonable. It needs to make sense beyond just doing the right thing. In a lot of our climate they don't make very much sense because they are out too far. Drilling costs and costs of doing business in the state are high. Furthermore, profit ticking and risk mitigation – increases the drilling price – they charge more due to this.

Do you believe that GSHP systems are priced too high, too low, or just right?

That's a question that only the individual that is going to write the check can answer. The market should drive that. If they were cheaper there would be more deployment.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

I'd say too low and the reason is the break evens are better than solar and the life is much longer. With PV systems, by definition they have limited life. The batteries are not going to last very long and the break even at a subsidized price for solar PV is up in the low teens and that's also the time the panels start increasing degradation. We achieve the 10-12 payback range w/o subsidies. When looked at in terms of value – you send the money once and the loop is done. That is a fixed asset.

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Virtually any subdivision has a driveway and you can tear up the driveway, put the loop in the same space and put the driveway back.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

Size: very, very small.

Growth: prior to incentives 20%+ per year

The price of oil needs to go up for greater growth. Or, there needs to be a greater wiliness on the part of our leaders to get us out of oil dependence. If we just let the market drive it then we're just going to run out of time.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Yes. It is very important to reduce drilling costs. In order to do so we need, education, improved comfort level with the technology on behalf of drillers, lower the cost of doing business, and improve regulatory issues.

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers,"? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

Yes. In order to retain more drillers we need continued education of water well drillers, continued active liaison with folks with NGWA and the drillers association. Stepping up those sorts of efforts is *what is needed. Also, if you can ease the cash flow of the driller that is certainly helpful. If you look at an install, most are done by relatively small contractors (residential) – you have a heat pump that have parts and pieces that aren't a whole lot different from air source heat pumps. That business is comfortable/able to manage the cash flow of those types of projects. To go into geo – it is a whole different animal. Part of the risk mitigation on the part of the drillers is – am I going to get paid and who's going to pay me? If there is a way to ease that risk that would help – lower price and greater comfort zone with new drillers to the industry.*

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

It's all over the map. It really needs to be streamlined. It needs to be like it is for having a heat pump put in your house or having a septic tank. It needs to be straightforward and mainstreamed. A related issue and huge problem, is education! Permitting agencies just don't understand it so they error on conservative side and try not to do something that will jeopardize their job.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

No.

Jim Piasecki

Regional Manager
CETCO Drilling

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

> *SW Regional Manager for manufacturer of drilling fluids, well rehabilitation, water well monitoring and GSHPs.*

What is your current responsibility and authority regarding GSHPs?

How long have you worked in this, or a closely related field?

> *35 years in MN and ND doing any kind of drilling application, grouting, etc.*

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

> *"Geothermal Loops" "Geothermal Little Loops" = small footprint; Big G vs. Little G*

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

> *It's all over the map – Big G/Little G*

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

> *Some.*

What terminology do you think would be most appropriate for this industry and why?

Industry needs to include language about earth's renewable resource, no greenhouse gases and no or low maintenance when describing geothermal.

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

It's very important; I believe IGSHPA is driving standardization and nomenclature for the industry.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Low - no one has ever really promoted industry; never made it into political debates

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Cost Savings/immediate payback*
2) *Environmental Impact*
3) *Ease of installation/ease to convert*

How have your customers become aware of GSHPs/learn of your product?

Local marketing by contractors, e.g., home & garden shows, water wells national expo

What do you think the primary motivation was for consumers who purchased GSHP systems?

Cost savings - most customers can live with 5-7 year pay back

Have you observed any similarities in consumer demographics?

Opinion leaders, engineers, architects

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

National campaigns, e.g., Oprah; conversion of public buildings, e.g., schools; traditional media out of date.

What are some suggestions that you have to better inform consumers of this industry?

Increase conversion of public buildings such as schools to help build awareness.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

Same for residential and commercial - CA is lax on regulations, one out of state contractor screwed it up for all (cited example of out of state contractor for Santa Rosa Jr. College that screwed up project and then left town for locals to fix).

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

CA has a big problem with counties charging anywhere from $300 to $15,000 for permitting residential installations. Permitting costs are not included in incentive reimbursements.

Hard to find the contractors – have to rely on word of mouth which is not getting the job done…how do you find the 3 different contractors needed??

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

N/A

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Consumers not inclined to pay for preventive improvements.

Do you believe that GSHP systems are priced too high, too low, or just right?

Just right for equipment; too high for contractors and permitting.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

[See above]

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

All the contractors needed - 3 major contractors; out of state water well drillers are cheaper ($7-10 ft vs. $20/ft in CA) but will leave home owners high and dry if something goes wrong with project because they are not local.

Need standards for the whole installation.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

Contractors need to take responsibility for entire project. Industry is missing the boat on conversion. Utilities should take a major role in marketing. Drillers not investing to drive demand.

Drilling

Would you agree with the statement, “Drilling is the single largest cost component of GSHP systems?” How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

No. Do away with permitting charges and reduce workman's compensation and liabilities. There is too much checking up on everyone, e.g., emissions rules one equipment, C-57 status.

Do you agree with the statement, “The GSHP industry currently faces a shortage of drillers,”? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

It's not as complex as water well drilling…you're just a hole puncher.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

Build smaller, fuel-efficient drill equipment; technology otherwise more than adequate: "you're a hole puncher."

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

Too much checking up on everyone - 3 contractors so there's three visits by inspector.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

Justification through climate is harder to do in CA.

Andy Fracicia
Marketing Director
WaterFurnace

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

Director of Marketing

What is your current responsibility and authority regarding GSHPs?

How long have you worked in this, or a closely related field?

Been in HVAC industry for 30 years last 2 ½ years in Geothermal. First 15 years sold – worked for one company selling GSHP.

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

Geothermal is not the smartest term – they can't get past how it works. Better term is "Geoexchange" but it's less well known.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

No.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

It is not consistent. Never heard of Big G/Little G.

What terminology do you think would be most appropriate for this industry and why?

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

It's OK to be different across building types. ¾" for residential and 1 ¼ for commercial. In the US there are 3 major businesses: in Florida, there's Waterloop which services condos and apartments; Climate Master does commercial boiler towers; and Water Furnace does ground loop heat sink.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

Low - replacement occurs as a result of an emergency; not a lot of planning and research.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Most efficient system*
2) *Reduces greenhouse gases*
3) *Reduces carbon footprint*

How have your customers become aware of GSHPs/learn of your product?

Need to market directly to customers. Pull marketing - provide ads to dealers to use in their local markets.

What do you think the primary motivation was for consumers who purchased GSHP systems?

Return-on-investment, ultimately will save money; payback is wrong message.

Have you observed any similarities in consumer demographics?

Customers are highly educated, have already done their homework, they want to know how it works before they care benefits, air to air vs. air to ground. Household income is $70K plus, age is 35 to 55 years however changing to a wider age bracket of 30 to 65 years – getting older clientele who want to manage their monthly expenses in retirement.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

> *Have the utilities install loop and lease back to house for 20 years; don't do national campaign, let local reps sell it.*

What are some suggestions that you have to better inform consumers of this industry?

> *It's like a refrigerator, you need it and don't look for a payback.*

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

> *Regulations are not a problem.*

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

> *The drilling cost of vertical loops for small footprint lots, especially finished yards.*

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

> *For all, the right sized loop!*

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

N/A.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

Biggest barrier is cost of loop-half life of 100 years; unnecessary costs from not using right sized loop: vertical, horizontal, pond.

Do you believe that GSHP systems are priced too high, too low, or just right?

For new construction you can finance the cost into the mortgage and it's an easier sell. You might pay $30 more per month on your mortgage but save $60-70 in utilities.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Loop skews payback; extra investment includes soft cost quantification such as GSHP is the most comfortable, little temperature fluctuation, kicking on and off, dehumidifies and is quiet.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

First cost loops are biggest barrier. Next is consumer education - how it works and how it saves money. The industry will grow faster if you take first costs from consumer.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Biggest barrier is cost of loop - half life of 100 years; average life of furnace is 15 years vs. 24 years for geothermal. The driving factor is the amount of land you have to work with and the kind of equipment you need to service it.

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers,"? What changes need to be made in order to attract and retain more drillers to the GSHP industry?

There is a shortage - you need to educate drillers that they can make $$. Making connections requires additional certifications.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

There's always room for improvement but we have what we need.

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

Most contractors understand the process - not an issue.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

You don't see geothermal so it's not sexy.

Greg Schillianskey
Owner
All Year Heating and Cooling
October 14, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I am the owner of All Year Heating and Air and my expertise is in residential large homes, up to 25,000 square feet.

What is your current responsibility and authority regarding GSHPs?

How long have you worked in this, or a closely related field?

My company has been doing geo since about 1994-95 primarily in the Sacramento area.

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

We use "geothermal" mostly because when people are starting to search online for the technology that seems to be where the most information is. I prefer "geoexchange" because "geothermal" can get confused with geysers and "geoexchange" makes it easier to sU.S. EPArate. However, for the search engines you have to include "geothermal".

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

All over the board.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

Yes, it is a problem because it gets mixed up with geysers.

What terminology do you think would be most appropriate for this industry and why?

Geoexchange for the reasons mentioned above.

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

Awareness is what is going to standardize the technology. The biggest hurdle we have is utilities and once we can get electricity at a cheap rate then probably the utilities would start marketing geothermal/geoexchange. It's the people who have green blood, they are the ones that are seeking out the alternative technologies.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

We've done it for so long, but I thought we would be doing a lot more than we are presently. The problem is that the contractors are out there for the quick buck. With traditional HVAC systems, you can make $3-4k in a day or 2 days vs. $8-10k in two weeks with a geothermal system. What's polluting the industry are the guys that think there's big money in doing it but don't have much experience - they want to get a job under their belt and they screw the job up – this creates bad press for the industry and is a poor reflection on the technology.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *No outdoor equipment*
2) *Reduces Carbon Footprint – this presents an opportunity to perhaps tie carbon footprint to utility rates and create something like a "green power rate".*

How have your customers become aware of GSHPs/learn of your product?

The home shows have done a pretty good job. The television show "This Old House," they do a great job of consumer education re: new things that are out there. We did a job for This Old House back in 96/97 and we still get calls from people back east or all over wanting to talk about geo. There was a geo job on the TV show "Dirty Jobs" – after that episode things picked up. Then we've got the internet. Once they see it on the home shows or TV, they search online. We pay a lot of money each month to have those key words that they search for come up on our website.

What do you think the primary motivation was for consumers who purchased GSHP systems?

I think it is a mixture of things: they are a little bit green, want to save as much energy as they can, and they want bragging rights.

Have you observed any similarities in consumer demographics?

I've done it for everyone: young, old, rich, not so rich. There's not a true demographic there. A problem some of our customers encounter is that the banks sometimes will not front the money. The banks say that heating and cooling should be 3% of the total cost of the building, whereas geo is 10% and as a result, the banks won't front the money. Mortgage loans can also hold up the spread of geo.

There are some programs out there that help, for example, SMUD has financing for replacing heating and air-conditioning. They will finance the job at a reasonable interest rate for 10 years. Maybe there could be a state bank that lends money for these green types of projects/low carbon footprint projects. Clearly, there's people out there who want to do it but cannot get hands on money.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

I would probably be subsidizing some of the home shows – almost like infomercials. The problem that you run into with rebates is that it starts becoming a subsidy.

Building dU.S. EPArtments are not much help either – the inspection of the bores are done by the health dU.S. EPArtments and there is one for every county. When the bores go in, one of the things you have to do is grout the bores. The geo system won't function unless the bores are grouted. Some dU.S. EPArtments want to see you grout each hole because they are afraid that the straw you put in the ground is going to pollute the aquifer. This leads to some pretty high dollar inspections – you have to drill hole, call someone, come out and inspect before the driller can drill the next bore. Sometimes we might have $5-10k more on a job just for inspections.

What are some suggestions that you have to better inform consumers of this industry?

The California Energy Commission, they should feature the technology on their website, perhaps on a page for new technologies. Websites like that might be a big help.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

Mostly the health dU.S. EPArtments. On the last job we did in Monterey, they made us put cement plugs on the top 50 feet of the bore because they don't understand that we are digging 3, 4, 5 feet down and then tying all the bores together so there's no open straw to the surface. When you put the plugs on, you are compromising the integrity of the system because you have concrete around plastic pipe that will expand and contract depending on the season.

Plumas – Sierra has the best process – they've embraced it and they are doing a lot of it.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

We used to belong to an association that was being subsidized by the DOE or something AEEES – when you went to get a permit in a county that had no experience with the technology, you could say "call AEES," and they would send someone to the dU.S. EPArtment to educate them. Counties used to have someone they could call. Contractors belonged to it – AEEES would get grant money – and they would put on the one-day seminars for different building dU.S. EPArtments.

There has to be something in the state apparatus to deal with it – a ground source dU.S. EPArtment. It's all about liability – no one wants to be liable.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

See above.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

All manufacturers are doing pretty good economically. I don't know if there is something out there that measures the growth of the industry but the equipment – there's enough being sold where it is fairly affordable and at a fair price.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

High first cost, availability of financing from banks. Maybe there could be an Energy Commission bank that gave 2% loans for low carbon or green systems – and listed acceptable green systems. There are areas where geo is going to be impossible, it's not like every homeowner in the state is going to go for it – you need to have the space.

Do you believe that GSHP systems are priced too high, too low, or just right?

They are priced fairly.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

Our niche is high efficiency. When we get into the PG&E service area you have to get creative to find the lowest way to heat and cool a house. Sometimes doing PV and a conventional heat pump makes more sense than doing a geo unit. It depends on your circumstances.

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Having the space is one issue. People have experimented in different areas with neighborhood systems (suburbia), they've hooked into the domestic water supply and you can take the water run it through the geo unit and send it back to the water line. There's a lot of dreaming about ways for geo units to be put in ways that are less costly. I just did a duplex down by the Sacramento zoo and we have one bore field there on two sU.S. EPArate units for the duplex – mom lives downstairs, son lives upstairs. Using common bore fields could lower costs.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

Size – small and slow; to spur greater growth – cheap electricity.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

Yes. Reducing the cost of drilling is very important but you also have fuel costs connected to drilling. When diesel is $3-4.00 a gallon and it takes $50 per borehole, the hard costs are expensive.

No suggestions as to how to reduce drilling costs. I don't think the drillers are gouging in any way.

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers? "What changes need to be made in order to attract and retain more drillers to the GSHP industry?

I don't have any problem finding drillers. Our driller has done our work since 94-95. He's been burnt a lot of times about people who haven't paid him. I know that sometimes he won't even take people on because he doesn't know anything about them.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

There's no way for me to get a license to be able to drill holes – it takes a certain contractor license. If there was a sU.S. EPArate drill for geo units maybe you could make the technology better.

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

It's a piece of cake for us only because of who we've worked with in the past. We've done a lot of them.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

We love doing geothermal systems. It's so different than our regular work that it's almost an escape for us. The people that want this type of work are great people to work for.

The biggest hurdle we got is cheap money – it'd be nice if drilling were cheaper. It might be a little cheaper if we could drill our own.

The Federal Tax Credit – that's helped a lot, 30% off the total install is huge. They only thing they did wrong is not including water-to-water units and they are supposed to change that in the next month or so. We can use less equipment with water-to-water units which make them more cost effective.

Sharon Schwilling
Ground Source Heat Pump Program Administrator
Sierra-Plumas Rural Electric Cooperative
October 14, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I am the Ground Source Heat Pump Program Administrator at Sierra-Plumas REC.

What is your current responsibility and authority regarding GSHPs?

I run the entire program at Sierra-Plumas REC.

How long have you worked in this, or a closely related field?

Since 1996 – 13 years

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

I used to use "geoexchange" but I prefer "ground source heat pump". "Geoexchange" is branding and doesn't make sense.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

No.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

Yes, people don't understand what geoexchange is.

What terminology do you think would be most appropriate for this industry and why?

If the industry wants it to make sense they need to call it GSHP.

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

No clue. The issue is who to start with? Possibly the GSHP consortium – but they do not touch the public, that is part of the problem with the industry, they do not touch the public. No TV ads, media etc. There is untapped potential.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

It is about where I'd expect it to be, because the government focuses on solar and wind and there is no publicity for GSHP. You've got to really look to find it.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Environmentally friendly*
2) *Cost efficient to run*
3) *No CO emissions*

How have your customers become aware of GSHPs/learn of your product?

The builders, we educate them and then they educate the customers. We also have resources on our website. Customers can call in to have a packet mailed to them and in that you get a CD along with PDF.

What do you think the primary motivation was for consumers who purchased GSHP systems?

Cost savings on heating bills. The loop lease is attractive to a lot of people (there is a cap on it for $15,000 and it is non-transferrable).

Have you observed any similarities in consumer demographics?

They are mostly retired folks, older. We also see work in subdivisions that are high end. I'd say the breakdown is primarily affluent people and around 30% normal guys.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

Again, touch the public somehow and we are not doing that.

What are some suggestions that you have to better inform consumers of this industry?

Everyone watches TV. This is the best way to touch them.

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

We don't have any barriers – we have a great county (Plumas) and 90% of our GSHP systems go in there. I've directed other counties in our service area to Plumas because they have been doing this for years.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *residential* applications?

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

The systems are priced too high. The literature out there says that GSHP systems are 10-20% higher than traditional system, but I've found them to be higher than that.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

I don't have a lot of commercial – we did a 17-ton animal shelter, 40-ton golf course. They've got the money, so there are not really barriers in that regard but they also took advantage of our loop lease program. They took barriers away by covering part of it with the loop lease.

Do you believe that GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

It's cheaper to go GSHP – solar is more expensive and wind is more expensive. This could be why the manufacturers are pricing higher. I think the tax credit will help a ton.

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

Lack of education; lenders don't get it.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

Get the word out and start educating people. Solar and wind are natural to the public and ground source is not. They don't get it. We need advertising.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

No, I do not agree. It's a big chunk but we have been able to secure the low per foot cost and maintain this for a long time with the promise of consistent work for our drillers. We have a competitive per foot price due to the fact that we do bulk drilling and coordinate subdivisions to economize the drillers. We have set up our loop lease pay back with that in mind. Basically our cap is at a 6-ton system – and customers have to pay any overages. Technique and experience in doing that particular kind of *drilling is important. It's not that hard of a technology, if they understand it. Some drillers come in thinking that this is a chance to gouge people and this is part of the problem.*

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers?" What changes need to be made in order to attract and retain more drillers to the GSHP industry?

For me there's not a shortage but I don't know about other areas. I know there are a lot of them but some don't want to have anything to do with residential.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

Having an experienced driller is more important than the technology

.

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

We have a great county.

Roy MacBrayer
Deputy State Architect
State of California
October 19, 2009

Introductory Questions

In order to better understand your perspective, I'd like you to describe your area of expertise in the Ground Source Heat Pump (GSHP) Industry. Specifically, what is your role/title today?

I am the Deputy State Architect for the State of California. My primary focus is school construction in California. Secondarily, I am the program manager for the Governor's Green Building Program which focuses on state building construction and improving the performance of state building.

What is your current responsibility and authority regarding GSHPs?

See above

How long have you worked in this, or a closely related field?

I've been with the state of California for about 7 years.

Industry Branding

What terminology do you use to describe the industry/your product and why is that your preference?

I've been using Ground Source Heat Pumps and the reason is because that's the way it was introduced to me.

In your experience, do industry participants and consumers use the same terminology when referring to this industry?

I hear a lot of the use of the term "geothermal" – and a lot of the people who are using that term don't discriminate between GSHP and the extraction of geothermal energy from the earth. There's a lack of knowledge about the GSHP technology.

And within the industry, do you find GSHP industry vernacular to be consistent? If not, is this a problem for the industry in terms of building market adoption?

It is not consistent and it is a problem for market adoption.

What terminology do you think would be most appropriate for this industry and why?

I don't know. To me, GSHP is very descriptive but people in CA may associate the term "heat pump" with less efficient, less cost effective technology. I have known some people to react against the term heat pump.

How important is standardized nomenclature across all segments of the industry and how could the industry achieve it?

I think it's important to the extent that it would give people a way to recognize what this technology is. Branding it with the right terminology would be good so it doesn't get confused with geothermal extraction and heat pumps.

Industry leaders' perspective on consumer decision-making

Would you describe public awareness of GSHP to be high, low or about where you'd expect it to be given the industry's maturity? Why?

I think it is low in this part of the country and I don't know why. I don't know that there's been as much an effort to penetrate the market here. The construction industry is sort of balkanized and sluggish to accept new technologies. They tend to follow historical patterns and they're not all that easy to change. This is poised to change if it's not changing already.

What do you think are the three most important messages to communicate about GSHP in order to generate positive public sentiment for GSHP systems?

1) *Efficiency – to me GSHPs operate at a more consistent efficiency. The fact that a GSHP can operate efficiently in high ambient temps, even when you have spikes in temp, has a lot of implementations in terms of equipment longevity. GSHPs also lower long term ownership costs and lead to more predictable level of performance. One of the things that needs to be understood about this technology is that it gives you more predictable energy and ownership costs.*
2) *A message that would focus on disputing any misconceptions that people might have about the ground loop portion of the system. The other side of the system is pretty much standard technology that people understand – the compressor and all that. However, there are misconceptions about the ground loop and boreholes. There are concerns about leakage and the piping failing as well as the longevity/durability of that part of the system.*

I don't see a lot of information on how to remediate problems with this part of GSHP systems out there. I just don't think a lot of people really understand what that part of the system is – how it works. Issues such as seismic instability, rock formation, geology, some of those may have an effect on the performance of the system, and there's not a good understanding of all of that. People are familiar with the problems with cooling towers and know how to deal with it whereas GSHPs have a lot of unknowns associated with it. I think there needs to be more information that is put out about these wells and how they perform and how to mitigate issues. This will help people evaluate it in terms of other alternatives.

How have your customers become aware of GSHPs/learn of your product?

I became aware after being approached by a GSHP company, they came in and gave a presentation and I went out and did some research on my own. There isn't a lot out there, you don't hear a lot about the technology unless it is a result of some marketing effort on a project or something, and my sense is that a lot of people are oblivious to it.

What do you think the primary motivation was for consumers who purchased GSHP systems?

I think that there may be a number of motivations in play. The promises of system efficiency is the #1 item I think. The long-term lower cost of ownership and management also might be a consideration. The renewable aspect/green aspect is also attractive to people – government and schools place value on this aspect.

Have you observed any similarities in consumer demographics?

I don't know enough of the installations to really know. It seems to me that school districts seem to be very amenable because they have the landmass typically on a school site to support it. That seems to be one group that is more positive.

If you were the head of an industry association, what would you do to increase public awareness of GSHP technology?

The obvious thing of getting it in front of the public so that they understand what it is, the branding of it, so that people can understand why these systems perform better. Secondarily, early adopter installations – school districts, and give tours of the installations. It would be good to have those tangible installations in communities where they are working to demystify the technology. In a sense I almost compare this to what was going on in the plumbing industry over the discussion about plastic piping – vs. copper. There was a mythology about plastic pipe and its lack of performance and it took quite a while to get over that. The use of plastic pipe changed the economics of projects. A lot of what made that possible *is the lack of information. I see a parallel here in the sense that you have industries geared in a certain way and for them to accept new systems/designs they have to get over some phobias.*

What are some suggestions that you have to better inform consumers of this industry?

Adoption of Ground Source Heat Pump Technology

As with any industry, there may be certain barriers that interfere with the market adoption of products and services. I'd like to ask you about your perception of barriers, if any, in relation to regulations, awareness and project economics for GSHP.

For both residential and commercial GSHP applications, what barriers, if any, have you encountered because of regulations – both state and local?

The only barriers regulation-wise that I have been aware of are the issues with getting the wells permitted. However, it seems to me that there may not be enough in the way of incentives from utilities. These systems have a huge potential to address the problems that utilities are facing – you'd think they'd get behind it more than they have. It could be the kind of system that would warrant special targeting by utilities. These types of systems are serious efforts to deal with peak load.

As to Title 24, in general, it would seem to me that Title 24 could be more helpful than it is. The whole emphasis on improving Title 24 and developing new green building code has been kind of a forced effort – it causes the California Energy Commission (CEC) to grab the quickest, easiest solution. If they were to take this on as a more reasoned or deliberative effort you might see this problem be less of an issue. Sometimes the CEC tends to grab a solution almost at the exclusion of others that are almost as good because they get overlooked. Educating that group in particular would be very good.

What barriers, if any, have you experienced due to lack of awareness of GSH technology for *residential* applications?

I just don't think it comes up – people are so oblivious to it. If I had known about GSHPs when I bought my home 12 years ago – I had enough landmass to put in a decent ground loop. I would have been friendly towards the technology if someone had been out there marketing.

What barriers, if any, have you experienced due to lack of awareness of GSHP technology for *commercial* applications?

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe manufacturers/deliverers of GSHP systems are experiencing?

I think anytime the first cost is higher it creates a problem because even though there's been a lot of change in terms of looking at lifecycle costs, the industry still seems to be dominated by first cost mentality.

For both residential and commercial GSHP systems, what economic barriers, if any, do you believe consumers are encountering?

High first cost.

Do you believe that GSHP systems are priced too high, too low, or just right?

I don't know. I didn't understand why the mechanical side of the system was priced so high, although this was probably due to the volume of production with manufacturers. It did seem to me like it was a little bit of a problem, why should the mechanical part cost more when in fact you could economize that part of the system? It doesn't have to be quite as robust as traditional systems.

When compared to traditional HVAC systems, do you think GSHP systems are priced too high, too low, or just right?

When compared to other alternative energy solutions, do you think GSHP systems are priced too high, too low, or just right?

Solar is the big paradox – it really isn't very cost effective and there are many things you can do that would give you a better Return on investment than PV systems. With PV you barely get ROI by time systems wear out. One of the reasons people get them is the visual factor; you wonder if you were to get into the walls of the house if there were other things have they done that would be less costly like insulation etc.

For both commercial and residential applications, are there other issues besides cost that are a factor in the adoption of GSHP?

(If needed probe for: time, space, and permitting)

It gets back to a general lack of understanding. The issue for a potential retrofit – particularly where you have a small lot (a commercial building w/o a lot of useful land) people don't have a feel for what you can realistically do with these systems. I heard about a system that was installed in a guy's *driveway. He had a typical tract home on a postage stamp lot but yet they installed a system by drilling through his driveway. I didn't realize you could do that. A key element is what size of a ground loop do you need and how could it be integrated into an existing building? DMV field offices might be good candidates for a retrofit but I don't really know – what would a typical system really look like and does that make sense? Visual examples of what the systems may look like in different types of facilities it would give it a more tangible understanding. There is the perception out there that we need open land for this but we don't really know what we need.*

If there was a way for people to tap into some kind of a quick calculator or model that people could run to see what kind of system was appropriate for them, that could be really helpful.

How would you characterize the size and growth of the GSHP industry, why, and what would need to happen in order to spur greater growth in this industry?

It's my understanding that there are areas in the Midwest where it is growing at a fairly stable rate but out here it is just emerging. We need better awareness and more visible support from the utilities – people look to the utilities as litmus test. We also need think tanks like the Western Cooling Efficiency Center at UC Davis promoting this technology.

Drilling

Would you agree with the statement, "Drilling is the single largest cost component of GSHP systems?" How important do you think it is to reduce the cost of drilling? Do you have any suggestions as to how to reduce drilling costs?

I don't know – I presume so. I would rate that fairly important because that might be an area with a great potential to reduce costs with different technologies.

Do you agree with the statement, "The GSHP industry currently faces a shortage of drillers?" What changes need to be made in order to attract and retain more drillers to the GSHP industry?

I have heard is that they are so far removed as an industry from the traditional HVAC industry that it is really an issue; people out there drilling wells are far removed from HVAC installers. To integrate across the industries is important. To me the drilling industry is a thing all its own centered on water and oil – how do you bridge the two? I've heard about this being a challenge.

Does the drilling technology currently available meet GSHP industry needs or is there a wish list you have for how the technology could be improved?

How would you characterize the permitting process for the drilling required for GSHP systems? If you are dissatisfied with the process, what suggestions do you have as to how the permitting process could be improved?

I don't know – I would characterize it as being fraught with a lot of local idiosyncrasies based a lot on experiences people have had with drilling. A lot of people may have perceptions that the drilling industry is not a very sophisticated industry, a dirty industry.

Is there any other information you would like to share about the GSHP industry, or topic that I did not touch upon that would be useful to this survey?

The state has no projects where GSHPs are an active component. I'm looking for opportunities to incorporate it into retrofit projects – DMV field offices might be potential candidates if we could ever bundle it just right. We have to get over the hump with the federal stimulus money that is focused on retrofits – quick paybacks will be the first projects. However, the State Architect is very familiar with the technology and we talk it up with school districts, as they are good candidates.

APPENDIX E: Advisory Board Minutes

Meeting Minutes

In general, Advisory Board discussions covered the following topics:

- Overall impressions
- Literature Review
- Task 2.3 Certification and Regulations
- Task 2.5 Stakeholder Interviews
- Task 2.9 Financial Model Research
- Task 3.3 Survey Analysis
- Task 5.1 Financial Overview

Not all Advisory Board members spoke to every topic listed above. The one exception is the Advisory Board meeting with Patrina Mack, which dealt primarily with the GSHP consumer experience. The meeting minutes from each discussion are below.

Dan Bernstein and Paul Boney

Meeting Date: March 18, 2010; 2pm

The discussion began with Dan Bernstein and Paul Boney giving their overall impressions of Project Negatherm. Dan Bernstein noted concern over the "Bad Apple" cowboy contactors who reflect badly on industry.

Comments on the Literature Review: Paul called the documents assembled, "impressive," and suggested adding recent USDA and Texas Foundation articles.

Comments on Task 2.3 Certification and Regulations: Dan Bernstein emphasized that water wells do not equal boreholes. There is the perception that California environmental regulations are much higher than other states.

Comments on Task 2.5 Stakeholder Interviews: The Geo Exchange Organization has branded the industry "geo." Paul Bony commented that there has been a slowdown in shipments this year, natural gas prices and consumer demand (cause/effect?) both down. There are also carbon issues out there – tradable EE credits.

Comments on Drilling: Drill technology improving, smaller rigs, more machine innovation, new loop technologies, third party performance data needed (DB).

Comments on Task 2.9 Financial Model Research: Paul Boney noted that ARRA and PACE influencing the financing. Sonoma has a $50M EE/RE plan and CaliforniaFIRST is an exciting proposition. Dave Bernstein pointed to the estimate that 100,000 GSHPs is equivalent to a

500MW Power Plant. The USDA Rural Electric Service (RUS) also has micro loans, where the utility puts the loop into a tariff and uses micro loans for equipment inside house.

Comments on Consumer Survey: Paul Boney noted that this is a rare look at consumers. There has been very little industry study and nothing publicly available. Dave Bernstein added that the GSHP industry needs to improve its public relations abilities.

Comments on Driller Survey: “Interesting”, but no comments of note.

Liz Battocletti

Meeting Date: March 22, 2010; 10am

Liz Battocletti was impressed with the breadth of Project Negatherm. She discussed how Project Negatherm’s study dovetails well with the upcoming DOE funded study she will be conducting.

Comments on the Literature Review: Liz did not have anything to add to the Literature Review. She noted that there is a market report put out by a private firm but it is not publicly available.

Comments on Task 2.3 Certification and Regulations: It is important to distinguish between water wells and closed loop boreholes. Liz noted how the GSHP industry is an industry marked by regional differences. In California, Sonoma has been a thought leader, they’ve included GSHPs in their PACE program.

Comments on Task 2.5 Stakeholder Interviews: In terms of branding, “Geoexchange” is a trade name; “Ground Source Heat Pumps” may be a more accurate term. Liz refers to them as Geothermal Heat Pumps – because her grant money came from the geothermal dU.S. EPArtment @ DOE and that is their terminology. WaterFurnace refers to them both as GSHP and geothermal heat pumps. Branding also falls under the scope of regional differences and this will be further investigated in Liz’s upcoming report.

Liz has noticed that many contractors are becoming interested in GSHPs due to increasing consumer demand. At an IGHSPA training/test in Maryland, HVAC guys and drillers were there because customers have been asking about it. The 30% tax credit has played a big role in pulling demand.

Liz also spoke about the role Renewable Portfolio Standards (RPS) could play in accelerating demand for GSHPs. Since GSHPs are in the Energy Efficiency (EE) space and not the Renewable Energy (RE) space, they are not currently eligible to play a part in RPS standards. There is a need to change this and add GSHPs to renewable portfolio standards (RPS).

Comments on Drilling: Liz disagreed with the costs of drilling being the largest cost component of a GSHP system, in her experience it is closer to half the cost. The shortage of drillers, again, is a very regional thing.

Comments on Consumer Survey: Liz suggested that we need something like the California Solar Initiative for GSHPs. Liz is going to further investigate where geographically GSHPs make the most sense. Liz noted that the consumer survey is key to understanding who is going to purchase this technology.

John Geyer

Meeting Date: March 22, 2010; 12pm

Overall impressions:

Comments on Literature Review: John suggested merging the Project Negatherm library with the consortium library that spans GSHP literature from 1996 to 2001. The library is maintained in storage in Pennsylvania. John suggested that a collection of manufacturers' historical and current technical publications would make for an interesting library.

Comments on Task 2.3 Certification and Regulations: The consortium put effort into educating the Department of Water Resources (DWR) about GSHPs. Eventually, the DWR came out with a publication, Bulletin 74-99. However, in California, they failed to identify anything that needed regulation. There's nothing different or unknown in California that hasn't been addressed in the other states. John commented that the fees issue is a decade-old red herring, suggesting that there is a problem with the fees and permitting but it doesn't have to do with the work.

John suggested a way to standardize the regulations could be to create a categorical exclusion review for horizontal and vertical GSHP work. John stressed the importance of regulating the industry, saying wherever work is done, there should be a permit and there should be a nominal fee. However, he believes the regulations should be protective of existing sanitation and groundwater standards, not proscriptive of geothermal practices.

Furthermore, John highlighted how utility involvement in the GSHP industry could change the playing field. If PG&E and So Cal Edison had an active role in GSHP system construction, they would not be dealing with 69 different jurisdictions. Rather, they would have a standard fee and permitting process because no small players could stand up to them. Absent their (utilities) unique coverage of these different jurisdictions, there is no one with sufficient clout to push for unified regulations/fees. An example of a state that has been proactive in streamlining regulations is Idaho.

As to California regulations, no one has come forward with a positive suggestion since '98 as to how to better accomplish state leadership. The issue is that boreholes are not water wells – they are not open to the atmosphere and they are not a threat to groundwater.

Comments on Task 2.5 Stakeholder Interviews: As to the issue of industry branding, in the beginning the Environmental Protection Agency (U.S. EPA) report in 1992 referred to them as geothermal heat pumps. When the consortium formed, they developed geoexchange as a unique and identifiable name but it was not embraced by manufactures. IGSHPA seems to have the longest thread in terms of naming. John stated that his own approach to naming is to go along with whatever the customer wants to call it, so long as he is helping them get what they want. However, when John is training he sticks with IGHSPA's "ground source heat pump" terminology. John commented that he's not so concerned about branding as he is about endorsements, confidence and credibility.

Through his earlier work, John established early on the 5 main reasons to buy GSHPs (we identified in 1997) in no particular order:

- Economy
- Environment
- Safety: no onsite fuel storage, indoor air quality, leaky pipes.
- Comfort
- Novelty

However, they found that at the end of the education and selection process – it always comes down to what the customer can afford.

As to barriers to adoption, John suggested that utility endorsement and creating a list of utility-qualified contractors could accelerate customer confidence and access to GSHP technology. There are two examples of utilities in California that got involved with GSHPs and created programs: Truckee Donner Public Utility District and Plumas-Sierra Rural Electric Cooperative. Truckee Donner experimented successfully with bulk purchasing and Plumas-Sierra did a loop lease program. John noted that mass drilling of subdivisions by a utility who would do it at cost w/bulk buying could be an absolute natural if the utility can rate-base the GSHP system and get RPS credits.

However, the overall lack of utility endorsement means there's no one telling customers that this is a good thing. There's only one way they (utility) make money – selling power! If they can rate base the infrastructure and get a return on that and lease the loops, it sweetens the deal. They can sell less power and look good doing it. Barriers to rate-basing include the lack of an internal champion to carry it through to the PUC or the legislature.

John believes that investor owned utilities (IOUs) will take GSHPs to mainstream when:

- IOUs can rate-base some portion of the (investment) geothermal system most likely the ground loops.
- IOUs can get credit for environmental benefits towards RPS targets.

John concluded this train of thought by saying that IOUs need to aggregate greenhouse gas savings and be authorized to trade them on the secondary market; once this happens, utilities will be on board and they will create a list of qualified contractors who can do the work.

Comments on Drilling: As to the cost of drilling, John pointed out that drilling is risky and if the driller has to absorb all the risk, he's going to charge more. IF the risk is distributed amongst customer/driller, cost will come down. John suggested distributing the risk between customer and driller by doing the following: a bid comes in for $X, if the drilling goes better than expected (average drilling of more than 60 ft per hour), the cost goes down by up to 10%. If there are problems, the cost of drilling can go up by 20%. This way the driller is communicating with the owner and his books are open. John stated that he's done this successfully with a number of commercial jobs.

As to the availability of drillers, John suggested that the number of drillers in California who can convert to geothermal may be the greatest in the nation. As groundwater regulations tighten, traditional water well drillers are being squeezed, one might find that there are more potential drillers ready to convert to geothermal in CA than anywhere else in the country.

John pointed out an area of opportunity for the GSHP industry: anywhere in the central valley, as soil conditions are very similar to the great plains (which we all recognize as heat pump heaven).

John pointed out that there are great opportunities in California. California has thousands of school buildings and every one of them has the land for a ground loop so why not go with geothermal? Schools are the low hanging fruit but we've only done 100 of them - there are guaranteed savings on operating and maintenance.

Comments on Task 2.9 Financial Model Research: John asserted that the utilities need to get savings to customer, loop lease, rate-base authorization. The economic incentive for customers is low monthly bills, and the customer should get 75% of savings. Utilities can easily rate make or rate base but no one has pushed them to. Until they get real enforcement of RPS and until they are authorized to trade emissions offsets and gain yet another revenue stream they will not do so. I have heard of rate-basing/geothermal rates for the Midwest; John Kelly should have a list of geothermal rates in the country.

Comments on Consumer Survey: Again, Comfort, Economy, Safety, Novelty, Environment but at the end of the day the decision always revolves around can they afford it.

Comments on Driller Survey: There are a lot of Father and Son businesses. The HVAC is a big issue for the GSHP industry; 98% of HVAC is served by traditional manufactures and they have no interest in GSHPs going forward. All of their dealers on the ground are a traditional sales force. The idea of diverting a finite labor force into a different segment is not attractive.

John expanded this point by pointing out that the mechanical industry has no real interest in GSHPs because they make their living off of service contracts. He sees this as an intrinsic problem. If the ultimate goal of GHSP is 5% of the market – that'd be good, but we'd be seeing some push back from the traditional mechanical industry. Furthermore, there's also a bait-and-switch that goes on – contractors offer GSHP systems and then dissuade customers from GSHPs.

As to the typical gestation of a job: 3 -6 months (residential) – meeting with project manager, coordination, logistics; 6-18 months for (school and commercial) – because they have to get through their budget cycle. Furthermore, if a geothermal job has to be done when other people (contractors) are on the job can be troublesome. There can also be endless meetings with project teams.

John has not encountered problems getting permits, he noted that a good driller knows where to get the permits.

John pointed out that billing innovations could also impact the GSHP industry. In California this year they are going to implement conversion of the billing format thanks to smart meters. We will see peak pricing in the upper 30s to low 40s per kW hour. The smart grid and interactive meter shift 100% of the market risk off of the utility and onto the customer.

In order to increase widespread adoption of GSHP technology John suggested we need more schools instructing about this technology and we need to streamline existing processes. If we could recreate the western training center or get a legit training program out of PG&E. In state sponsors for a regional training center and a geothermal designation on the testing, would help on the drilling aspect.

Augie Guardino

Meeting Date: March 23, 2010; 11am

Overall impressions: Augie started off the conversation by giving some of his background in the GSHP industry. He stated that his company has known about geothermal for the past 15 years. Augie and his brother went out to Oklahoma and got fired up about the technology. He noted that there's a lot of positive energy back there in Stillwater for GSHPs.

In his experience, IGSHPA is telling you that people out there want drillers but they don't tell you how to go about it. For Augie, the process of finding customers has been a little unique. He's never solicited work or customers, rather when they got credentialed they just went through the IGSHPA registry. Augie sent out letters to everyone who was IGSHPA certified in California and this is how he drummed up business.

Most of Augie's jobs are for the green clientele or for people looking to add more windows to their home and still comply with Title 24 Building Standards.

Augie mentioned that in California it's about trying to get the word out; there are ill-informed naysayers out there. There are not enough people that know about it and getting to the market is the hard part. It also gets peddled by people who don't have the best interests at heart.

Comments on Task 2.3 Certification & Regulations: In Augie's experience the Santa Clara Valley Water District is a very GSHP friendly jurisdiction. They have the water district and they have a well commission with 6-8 people on staff. They have people assigned to doing permits, they have geologists on staff. As a result, they can give it the time it needs and be realistic about it.

Augie noted that a lot of the counties don't know what they're up against and they are charging fees for water wells. The permitting schedule affects us and project design – the fees are per well. Furthermore, a lot of these counties justify the permitting expense because they have to have an inspector out there when the holes are sealed.

As to the DWR Draft Standards, Augie did a lot of work with Carl Hauge at DWR on that. The Southern California region of DWR put it up on their website and as a result, Southern California kind of adopted it even though it's just a draft. In Northern California, it's a different story, each county has been kind of been making it up as they go along. It is hard to educate counties on GSHP systems while you're trying to get a project through and thus counties can be a big hurdle for us. The basic understanding that boreholes for closed loop systems are not water wells needs to be there.

Comments on Stakeholder Interviews: Augie stated that they always refer to the technology as "geothermal," however this requires explanation so it does not get confused with deep geothermal resources. Augie also pointed out that consumer awareness is going to be a little grass roots unless the industry finds some money for proper radio/internet/TV time.

Augie discussed how the biggest and most difficult chunk of the market to serve is that of retrofits. He explained that on a retrofit it's very difficult because you have to have a perfect storm. You need an ac/heater unit to go out and you have to have the room to do it. Augie says they haven't aggressively gone after the residential retrofit market but commercial retrofits are different and may have fewer constraints.

Augie shared his insight into the drilling: no matter what you're doing, you have to be able to make your footage. The more you can drill in a day, the lower your costs. Even if you're not lowering your costs, the more production in a day the more profitable you can be. This is why a lot of guys don't want to do residential because it's not as economically feasible if you're only drilling 4 holes.

Augie further explained the issue of economies of scale by saying it would take a lot of work and coordination. But there are many opportunities for GSHP technologies in planned communities, for example, new housing communities often have to put in a community park, so why not load a GSHP under that park and do a distribution system?

Compared to other alternative energy solutions – GSHPs priced too high, too low, just right?

I think that they're priced alright. With solar coming down then we may have to take a look at it. But if you look at the big picture as far as what you're getting for your money, I don't see a problem with the pricing as a deterrent. Customers aren't the ones saying we need to get the drilling down – that sentiment comes from someone else.

Comments on Driller Survey: Augie has seen a lot of projects where the drillers subcontract for the mechanical and then the mechanical is subcontracted to the general contractor. In his experience, this can add a 30% mark-up for the customer. Drillers take on a lot of risk, as you don't know what you may run into underground. Augie pointed out that there's a shortage of qualified drillers. Augie mentioned that IGSHPA certification is good; if you have the IGSHPA training you're able to be involved in the first line of talking to the customer. However, once you're certified there's not a rush of business. When they do get GSHP projects, Augie says that they generally deal with middle men and people who are saying we need to be $3 a foot cheaper – this starts drillers out on the defensive.

Augie does not anticipate big changes in the driller classifications in California. He is a licensed C-57 contractor and he mentioned that he would be opposed to a lesser classification.

Patrina Mack

Meeting Date: March 11, 2010

Patrina's conversation with Project Negatherm researchers varied from the other Advisory Board members in that her comments focus on her experience as a potential GSHP system customer. While consulting with Project Negatherm, Patrina's heater cracked and so she explored several heating options, including GSHPs.

She began her research by contacting a national referral service and found that instead of offering solely GSHP HVAC installers, they provided only traditional HVACs dealers. She was able to schedule 5 appointments with HVAC contractors who offered GSHP systems. The first contractor knew nothing about GSHP and was 20 minutes late. The next guy outsourced GSHP to an outfit in Santa Rosa. The next appointment talked a lot about a Mitsubishi air-source heat pump as an alternative for A/C, declaring that there was no point in pursuing GSHP because of the costs – too many cheaper alternatives to choose from especially given our usage levels and improvements in natural gas furnaces.

The next contractor gave an estimate of $20-30,000 for the trenching and another $10,000 for the system. He also emphasized replacing the ductwork and insulating the house to ensure we didn't oversize the GSHP system.

The last appointment turned out to be an experienced contractor; the husband and wife team learned about this technology 10 years ago, and proceeded to get certified at UC Davis in the design of systems. They have been in business doing geothermal exclusively for the past 9 years.

The breakdown of their estimate (which turned out to be uneconomic in the extreme at over $22,000 a ton) was as follows:

$20K for equipment and installation (heating unit, A/C and desuperheater) - $12K was equipment only for heating unit and A/C

$35K for drilling (design, permitting fees, vertical drilling, drilling spoils removal and cleanup)

Patrina uncovered several costs for a GSHP system that would not be required for a conventional HVAC application. She found that in San Mateo County, permitting fees are $500 each for the first 5 bore holes and then $50 each thereafter. Another special cost in California is the environmental impact costs for cleanup.

Due to her knowledge of Project Negatherm, Patrina asked several more questions to uncover some of the challenges that this particular contractor faces with GSHP technology. The contractor said that there are two challenges their company faces: out of state drillers who underbid their projects because they don't understand and don't include the costs for CA regulations, and new-to-geothermal HVAC contractors who create poor designs that inspectors have to QA, which keeps permitting costs high. In both cases, these situations they believed that it also created opportunities for their business. They are often brought in to fix what the out of state drillers have missed. Another practice this company employs is to bid "bad design" projects but not warranty them, which invites the conversation about what's wrong with the design and leads to the chance of suggesting a new design.

Patrina mentioned to the contractor that she was working on a project to help overcome barriers to geothermal adoption in California and then asked the contractor what top 3 issues she would like to see resolved by this project. They are:

- Establish a consistent permitting process
- Create a special geothermal permit (not water well drilling) at a reasonable price
- Help increase the design expertise of engineers designing the systems
- (She had 4 issues) Resolve the issue around environmental impact to help remove that cost from the equation

The contractor mentioned that it was really tough for them to make the case for geothermal over natural gas in urban and suburban areas. They have been most successful when being called to replace propane or fuels other than natural gas, custom homes (on large lots which can handle the drilling spoils) or schools, which have mandates to reduce energy consumption and lots of land.

APPENDIX F: Driller Survey Questions

The State of Drilling for Ground Source Heat Pumps

1 Does your company currently provide ground source heat pump (GSHP) drilling?

YES NO

2 How would you categorize your revenues from the GSHP product category?

- As your primary business
- As an important segment of your business
- As a small but growing part of your business
- As an inconsequential part of your business (only if someone calls in)
- We have no revenues from GSHP but hope to get into this segment
- We have no revenues from GSHP drilling and do not plan to enter this market.

3 Does your company do any GSHP business or plan to do any GSHP business in California?

YES NO

SUBMIT

Survey Page 1

The State of Drilling for Ground Source Heat Pumps

4 How did you first learn of GSHP technology?

5

Have you seen demand for GSHP borehole drilling increase, decrease or remain about the same since you started offering this service?

- Decrease
- About the same
- Increase
- N/A – no revenues yet from GSHP drilling

SUBMIT

Survey Page 2

The State of Drilling for Ground Source Heat Pumps

6

How would you rate the relative importance of each of these factors in increasing demand for GSHP related bore hole drilling?

	1 Not at all important	2 Somewhat unimportant	3 Neutral	4 Somewhat important	5 Very important
Government/Utility Incentives	1	2	3	4	5
Rising cost of energy	1	2	3	4	5
Word of mouth	1	2	3	4	5
Green building trends	1	2	3	4	5
Increase in contractors/engineers/designers for GSHPs	1	2	3	4	5

7

And have you been able to keep pace with the increased demand?

YES NO

SUBMIT

Survey Page 3

The State of Drilling for Ground Source Heat Pumps

8

How would you rate the relative importance of each of these factors for the static or decreasing demand for GSHP related bore hole drilling?

	1 Not at all important	2 Somewhat unimportant	3 Neutral	4 Somewhat important	5 Very important
Too much trouble/too much of a mess for customers	1	2	3	4	5
Not enough contractors in my area doing GSHP	1	2	3	4	5
Permitting too complicated/expensive	1	2	3	4	5
Hard to compete against solar incentives	1	2	3	4	5
GSHP systems too expensive	1	2	3	4	5
Too few certified drillers	1	2	3	4	5
Too much expense/hassle removing drilling spoils	1	2	3	4	5
Too few competent engineers/designers	1	2	3	4	5

SUBMIT

Survey Page 4

The State of Drilling for Ground Source Heat Pumps

9

At what point in the sales cycle do you become involved with an installation project? (Check the one that best applies to your company.)

- At the beginning, we market directly to customers
- After the sales process has started, to consult with installation design.
- After the heating/cooling system has been selected
- After the contract for the installation has been signed

10

Who is typically your main point of contact for a GSHP drilling project?

- HVAC dealers/reps
- General Contractors
- Designer/engineer
- Property owner/manager
- Other, please specify

SUBMIT

The State of Drilling for Ground Source Heat Pumps

11

What is the typical sales cycle to close a deal with a ***residential*** customer?

- Less than 1 month
- 1 to 3 months
- 4 to 6 months
- More than 6 months
- Do not serve this market

12

What is the typical sales cycle to close a deal with a ***commercial*** customer?

- Less than 1 month
- 1 to 3 months
- 4 to 6 months
- More than 6 months
- Do not serve this market

13

What is the typical sales cycle to close a deal with a ***school/government /military*** customer?

- Less than 1 month
- 1 to 3 months
- 4 to 6 months
- More than 6 months
- Do not serve these markets

SUBMIT

Survey Page 6

The State of Drilling for Ground Source Heat Pumps

14

What role, if any, do you play in educating the customer about the benefits of ground source heat pumps?

- No role in customer education
- Complete responsibility for customer education
- Give additional information to help primary point of contact for the project
- Other, please specify

SUBMIT

Survey Page 7

The State of Drilling for Ground Source Heat Pumps

15

If an information resource, such as a website, existed that helped ***educate customers*** about the benefits of ground source heat pumps, the costs associated and the overall process for installing a system, how likely would it be to lower your marketing and sales expense?

Not at all likely	Somewhat unlikely	Might/Might not	Somewhat likely	Very likely
1	2	3	4	5

16 What, if anything, could be done from an industry perspective to help reduce your marketing and sales costs and cycle time?

SUBMIT

Survey Page 8

The State of Drilling for Ground Source Heat Pumps

17

There are new federal residential and commercial tax incentives for GSHP. In what way do you think they will impact demand for your drilling services?

- Incentives are not substantial enough to impact the industry or my business
- Will increase customer awareness overall but not impact my business
- Will increase demand for my drilling services
- Other, please specify

SUBMIT

Survey Page 9

The State of Drilling for Ground Source Heat Pumps

18

From the time you get involved to the time the project is completed, about how many weeks have elapsed?

- Less than 1 week
- Less than 2 weeks
- Less than 4 weeks
- Less than 6 weeks
- Longer than 6 weeks

19

Of the following activities for a typical job, which ones take more time or adds more cost to your bottom line than you'd like? (Please check all that apply.)

- Site survey
- Test borehole
- Meeting with property owner
- Meeting with project manager/contractor
- Permitting process (inconsistent local rules)
- Drilling
- Working with engineering (loop field)
- Inspections
- State reporting
- Removal of drill cuttings
- Other, please specify

SUBMIT

Survey Page 10

The State of Drilling for Ground Source Heat Pumps

20 How satisfied are you with your ability to find certified and trained drillers to meet the demands of your business?

Very dissatisfied	Somewhat dissatisfied	Neutral	Somewhat satisfied	Very satisfied
1	2	3	4	5

21 Several schools located throughout the country are creating special "Green Collar Job" GSHP installation and borehole drilling programs. Some states, for example California, currently require four years of water well drilling field experience to drill closed loop vertical boreholes for GSHPs.

If a shorter certification program for closed-loop borehole drilling were put in place, do you think it would be possible to provide a ***sufficient, or equal level,*** of groundwater protection?

YES NO

22 Please describe how this new sub-classification would improve your business, if at all?

23 Would you support legislation for a special ***shorter*** "Green Collar Job" GSHP installation and borehole drilling certification?

YES NO

SUBMIT

The State of Drilling for Ground Source Heat Pumps

24 In most states drillers are required to submit drill logs to permitting agencies detailing number of bores and depths. Assuming this information could be made available in a public database, what other information would you find useful in these reports?

25 If a website were available with this information, how useful would it be to you in lowering your costs of doing business?

Not useful at all				Very useful
1	2	3	4	5

SUBMIT

The State of Drilling for Ground Source Heat Pumps

26 Permitting processes and fees vary greatly by state, county and municipality. Please rate how important is it to your business to have ***uniform statewide permitting processes and fees***?

	1 Not at all important	2 Somewhat unimportant	3 Neutral	4 Somewhat important	5 Very important
Uniform permitting ***process***	1	2	3	4	5
Uniform permitting ***fees***	1	2	3	4	5

SUBMIT

Survey Page 13

The State of Drilling for Ground Source Heat Pumps

27

Please rate the following in terms of how they ***negatively*** affect the profitability of your company:

	1 No affect at all	2	3	4	5 Very negative affect
Regulatory issues	1	2	3	4	5
Availability of drillers	1	2	3	4	5
Quality of driller training	1	2	3	4	5
Permitting fees	1	2	3	4	5
Lack of public drilling information	1	2	3	4	5
Upfront cost to buy drilling equipment	1	2	3	4	5
Ongoing equipment maintenance costs	1	2	3	4	5
Operational costs to run equipment	1	2	3	4	5
Travel costs	1	2	3	4	5
Sales costs	1	2	3	4	5
Inspection process	1	2	3	4	5
Disposal of drill spoils	1	2	3	4	5
Diesel Emission Regulation	1	2	3	4	5

28 In your opinion, what change would do the most for growing the borehole drilling industry?

SUBMIT

Survey Page 14

The State of Drilling for Ground Source Heat Pumps

29 Which of the following industry associations are you familiar with, participate in and/or are a member of?

	1 Aware of	2 On mailing list for	3 Attend workshops	4 A member of	Not familiar with
Geothermal Heat Pump Consortium	1	2	3	4	
International Ground Source Heat Pump Association (IGSHPA)	1	2	3	4	
California Groundwater Association	1	2	3	4	
National Ground Water Association	1	2	3	4	
American Ground Water Trust	1	2	3	4	

30

Which of these industry associations have provided the most value to your business?

- American Ground Water Trust
- Geothermal Heat Pump Consortium
- IGSHPA
- National Ground Water Association
- California Groundwater Association
- Other, please specify

Survey Page 15

The State of Drilling for Ground Source Heat Pumps

31

How many years has your company been drilling GSHP boreholes?

- None
- Less than 1 year
- 1 to 5 years
- 6 to 10 years
- More than 10 years

32

Please select the category that best describes the total number of employees at your company.

- Under 10 employees
- 10 to 19 employees
- 20 to 99 employees
- 100 or more

SUBMIT

Survey Page 16

APPENDIX G: Driller Survey Responses

Driller Survey FINAL2

Results Overview

Date: 3/25/2010 12:28 PM PST
Responses: Completes
Filter: No filter applied

1. Does your company currently provide ground source heat pump (GSHP) drilling?

Yes	109	78%
No	31	22%
Total	140	100%

2. How would you categorize your revenues from the GSHP product category?

1	As your primary business	53	37%
2	As an important segment of your business	38	27%
3	As a small but growing part of your business	32	23%
4	As an inconsequential part of your business (only if someone calls in)	4	3%
5	We have no revenues from GSHP but hope to get into this segment	15	11%
6	We have no revenues from GSHP drilling and do not plan to enter this market.	0	0%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%

2.23	2	1	4	1.27	0.11	[2.02 - 2.43]

3. Does your company do any GSHP business or plan to do any GSHP business in California?

Yes		41	29%
No		101	71%
	Total	142	100%

5. Have you seen demand for GSHP borehole drilling increase, decrease or remain about the same since you started offering this service?

1 Decrease		3	2%
2 About the same		17	12%
3 Increase		108	76%
4 N/A – no revenues yet from GSHP drilling		14	10%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
2.94	3	3	3	0.55	0.05	[2.85 - 3.03]

6. How would you rate the relative importance of each of these factors in increasing demand for GSHP related bore hole drilling?

Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.	Not at all important 1	Somewhat unimportant 2	Neutral 3	Somewhat important 4	Very important 5
Government/Utility Incentives	4 3%	3 2%	11 9%	38 31%	66 54%
Rising cost of energy	1 1%	1 1%	4 3%	28 23%	88 72%
Word of mouth	1 1%	7 6%	21 17%	43 35%	50 41%
Green building trends	1 1%	5 4%	20 16%	58 48%	38 31%

Increase in contractors/engineers /designers for GSHPs	4 3%	9 7%	26 21%	49 40%	34 28%

	Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
Government/Utility Incentives	4.30	5	5	4	0.97	0.09	[4.13 - 4.48]
Rising cost of energy	4.65	5	5	4	0.67	0.06	[4.53 - 4.77]
Word of mouth	4.10	4	5	4	0.94	0.09	[3.93 - 4.27]
Green building trends	4.04	4	4	4	0.85	0.08	[3.89 - 4.19]
Increase in contractors/engineers /designers for GSHPs	3.82	4	4	4	1.03	0.09	[3.64 - 4.00]

7. And have you been able to keep pace with the increased demand?

Yes		108	89%
No		14	11%
	Total	122	100%

8. How would you rate the relative importance of each of these factors for the static or decreasing demand for GSHP related bore hole drilling?

Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.	Not at all important 1	Somewhat unimportant 2	Neutral 3	Somewhat important 4	Very important 5
Too much trouble/too much of a mess for customers	1 5%	4 21%	4 21%	8 42%	2 11%
Not enough contractors in my area doing GSHP	3 15%	4 20%	7 35%	5 25%	1 5%
Permitting too complicated/expensive	3 15%	5 25%	5 25%	5 25%	2 10%
Hard to compete against solar incentives	6 32%	5 26%	2 11%	5 26%	1 5%
GSHP systems too expensive	0 0%	2 10%	3 15%	3 15%	12 60%
Too few certified drillers	5 25%	3 15%	6 30%	4 20%	2 10%

Too much expense/hassle removing drilling spoils	1 5%	3 15%	6 30%	6 30%	4 20%
Too few competent engineers/designers	3 15%	3 15%	6 30%	5 25%	3 15%

	Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
Too much trouble/too much of a mess for customers	3.32	4	4	4	1.11	0.25	[2.82 - 3.81]
Not enough contractors in my area doing GSHP	2.85	3	3	4	1.14	0.25	[2.35 - 3.35]
Permitting too complicated/expensive	2.90	3	2,3,4	4	1.25	0.28	[2.35 - 3.45]
Hard to compete against solar incentives	2.47	2	1	4	1.35	0.31	[1.87 - 3.08]
GSHP systems too expensive	4.25	5	5	3	1.07	0.24	[3.78 - 4.72]
Too few certified drillers	2.75	3	3	4	1.33	0.30	[2.17 - 3.33]
Too much expense/hassle removing drilling spoils	3.45	3.5	3,4	4	1.15	0.26	[2.95 - 3.95]
Too few competent engineers/designers	3.10	3	3	4	1.29	0.29	[2.53 - 3.67]

9. At what point in the sales cycle do you become involved with an installation project? (Check the one that best applies to your company.)

1	At the beginning, we market directly to customers		77	54%
2	After the sales process has started, to consult with installation design.		31	22%

3	After the heating/cooling system has been selected		20	14%
4	After the contract for the installation has been signed		14	10%
		Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
1.80	1	1	3	1.02	0.09	[1.63 - 1.96]

10. Who is typically your main point of contact for a GSHP drilling project?

1	HVAC dealers/reps		42	30%
2	General Contractors		32	23%
3	Designer/engineer		13	9%
4	Property owner/manager		38	27%
	Other, please specify		17	12%
		Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
2.38	2	1	3	1.24	0.11	[2.16 - 2.59]

11. What is the typical sales cycle to close a deal with a residential customer?

1	Less than 1 month		31	22%
2	1 to 3 months		75	53%
3	4 to 6 months		17	12%
4	More than 6 months		3	2%

			Count	Percent
5	Do not serve this market		16	11%
		Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
2.28	2	2	4	1.17	0.10	[2.09 - 2.47]

12. What is the typical sales cycle to close a deal with a commercial customer?

1	Less than 1 month		7	5%
2	1 to 3 months		46	32%
3	4 to 6 months		31	22%
4	More than 6 months		32	23%
5	Do not serve this market		26	18%
		Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
3.17	3	2	4	1.21	0.10	[2.97 - 3.37]

13. What is the typical sales cycle to close a deal with a school/government/military customer?

1	Less than 1 month		4	3%
2	1 to 3 months		15	11%
3	4 to 6 months		24	17%
4	More than 6 months		51	36%
5	Do not serve these markets		48	34%
		Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval

						@ 95%
3.87	4	4	4	1.08	0.09	[3.69 - 4.05]

14. What role, if any, do you play in educating the customer about the benefits of ground source heat pumps?

1 No role in customer education		6	4%
2 Complete responsibility for customer education		56	39%
3 Give additional information to help primary point of contact for the project		74	52%
Other, please specify		6	4%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
2.50	3	3	2	0.58	0.05	[2.40 - 2.60]

15. If an information resource, such as a website, existed that helped educate customers about the benefits of ground source heat pumps, the costs associated and the overall process for installing a system, how likely would it be to lower your marketing and sales expense?

1 Not at all likely		22	15%
2 Somewhat unlikely		22	15%
3 Might/Might not		51	36%
4 Somewhat likely		33	23%
5 Very likely		14	10%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%

2.96	3	3	4	1.19	0.10	[2.77 - 3.16]

17. There are new federal residential and commercial tax incentives for GSHP. In what way do you think they will impact demand for your drilling services?

1 Incentives are not substantial enough to impact the industry or my business		8	6%
2 Will increase customer awareness overall but not impact my business		22	15%
3 Will increase demand for my drilling services		89	63%
Other, please specify		23	16%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
2.68	3	3	2	0.60	0.05	[2.57 - 2.79]

18. From the time you get involved to the time the project is completed, about how many weeks have elapsed?

1 Less than 1 week		2	1%
2 Less than 2 weeks		5	4%
3 Less than 4 weeks		22	15%
4 Less than 6 weeks		26	18%
5 Longer than 6 weeks		87	61%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
4.35	5	5	4	0.96	0.08	[4.19 - 4.50]

19. Of the following activities for a typical job, which ones take more time or adds more cost to your bottom line than you'd like? (Please check all that apply.)

1 Site survey		11	8%
2 Test borehole		8	6%
3 Meeting with property owner		17	12%
4 Meeting with project manager/contractor		28	20%
5 Permitting process (inconsistent local rules)		55	39%
6 Drilling		33	23%
7 Working with engineering (loop field)		32	23%
8 Inspections		21	15%
9 State reporting		19	13%
10 Removal of drill cuttings		34	24%
Other, please specify		30	21%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
6.07	6	5	9	2.46	0.15	[5.77 - 6.37]

20. How satisfied are you with your ability to find certified and trained drillers to meet the demands of your business?

1 Very dissatisfied		14	10%
2 Somewhat dissatisfied		24	17%
3 Neutral		45	32%

4 Somewhat satisfied		30	21%
5 Very satisfied		29	20%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
3.25	3	3	4	1.24	0.10	[3.05 - 3.46]

21. Several schools located throughout the country are creating special "Green Collar Job" GSHP installation and borehole drilling programs. Some states, for example California, currently require four years of water well drilling field experience to drill closed loop vertical boreholes for GSHPs.If a shorter certification program for closed-loop borehole drilling were put in place, do you think it would be possible to provide a sufficient, or equal level, of groundwater protection?

Yes		86	61%
No		56	39%
	Total	142	100%

23. Would you support legislation for a special shorter "Green Collar Job" GSHP installation and borehole drilling certification?

Yes		86	61%
No		56	39%
	Total	142	100%

25. If a website were available with this information, how useful would it be to you in lowering your costs of doing business?

1 Not useful at all		13	9%
2		16	11%
3		28	20%
4		43	30%
5 Very useful		42	30%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%

3.60	4	4	4	1.27	0.11	[3.39 - 3.81]

26. Permitting processes and fees vary greatly by state, county and municipality. Please rate how important is it to your business to have uniform statewide permitting processes and fees?

Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.	Not at all important 1	Somewhat unimportant 2	Neutral 3	Somewhat important 4	Very important 5
Uniform permitting process	8 6%	5 4%	21 15%	34 24%	74 52%
Uniform permitting fees	8 6%	8 6%	29 20%	45 32%	52 37%

	Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
Uniform permitting process	4.13	5	5	4	1.14	0.10	[3.95 - 4.32]
Uniform permitting fees	3.88	4	5	4	1.14	0.10	[3.69 - 4.07]

27. Please rate the following in terms of how they negatively affect the profitability of your company:

Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.	No affect at all 1	2	3	4	Very negative affect 5
Regulatory issues	16 11%	13 9%	48 34%	35 25%	30 21%
Availability of drillers	24 17%	24 17%	45 32%	25 18%	24 17%
Quality of driller training	18 13%	24 17%	46 32%	33 23%	21 15%
Permitting fees	16 11%	31 22%	45 32%	29 20%	21 15%
Lack of public drilling information	18 13%	14 10%	45 32%	34 24%	31 22%
Upfront cost to buy drilling equipment	9 6%	9 6%	22 15%	33 23%	69 49%
Ongoing equipment maintenance costs	6 4%	16 11%	51 36%	47 33%	22 15%

Operational costs to run equipment	6 4%	12 8%	53 37%	45 32%	26 18%
Travel costs	9 6%	14 10%	52 37%	46 32%	21 15%
Sales costs	17 12%	23 16%	56 39%	32 23%	14 10%
Inspection process	18 13%	34 24%	53 37%	27 19%	10 7%
Disposal of drill spoils	15 11%	15 11%	54 38%	36 25%	22 15%
Diesel Emission Regulation	20 14%	20 14%	43 30%	22 15%	37 26%

	Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
Regulatory issues	3.35	3	3	4	1.23	0.10	[3.15 - 3.55]
Availability of drillers	3.01	3	3	4	1.31	0.11	[2.79 - 3.22]
Quality of driller training	3.11	3	3	4	1.22	0.10	[2.90 - 3.31]
Permitting fees	3.06	3	3	4	1.21	0.10	[2.86 - 3.26]
Lack of public drilling information	3.32	3	3	4	1.27	0.11	[3.11 - 3.53]
Upfront cost to buy drilling equipment	4.01	4	5	4	1.21	0.10	[3.81 - 4.21]
Ongoing equipment maintenance costs	3.44	3	3	4	1.02	0.09	[3.28 - 3.61]
Operational costs to run equipment	3.51	3.5	3	4	1.02	0.09	[3.35 - 3.68]
Travel costs	3.39	3	3	4	1.06	0.09	[3.22 - 3.57]
Sales costs	3.02	3	3	4	1.13	0.09	[2.84 - 3.21]
Inspection process	2.84	3	3	4	1.10	0.09	[2.66 - 3.02]
Disposal of drill spoils	3.25	3	3	4	1.16	0.10	[3.06 - 3.44]
Diesel Emission Regulation	3.25	3	3	4	1.36	0.11	[3.03 - 3.48]

29. Which of the following industry associations are you familiar with, participate in and/or are a member of?

Top number is the count of respondents selecting the option. Bottom % is percent of	Aware of 1	On mailing list for 2	Attend workshops 3	A member of 4	Not familiar with

the total respondents selecting the option.					
Geothermal Heat Pump Consortium	61 43%	11 8%	12 8%	37 26%	21 15%
International Ground Source Heat Pump Association (IGSHPA)	13 9%	2 1%	1 1%	123 87%	3 2%
California Groundwater Association	43 30%	3 2%	1 1%	12 8%	83 58%
National Ground Water Association	43 30%	15 11%	13 9%	56 39%	15 11%
American Ground Water Trust	51 36%	13 9%	14 10%	11 8%	53 37%

	Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
Geothermal Heat Pump Consortium	2.21	1	1	3	1.34	0.12	[1.97 - 2.45]
International Ground Source Heat Pump Association (IGSHPA)	3.68	4	4	3	0.90	0.08	[3.53 - 3.83]
California Groundwater Association	1.69	1	1	3	1.22	0.10	[1.38 - 2.01]
National Ground Water Association	2.65	3	4	3	1.34	0.12	[2.41 - 2.88]
American Ground Water Trust	1.83	1	1	3	1.10	0.12	[1.60 - 2.06]

30. Which of these industry associations have provided the most value to your business?

1 American Ground Water Trust		3	2%
2 Geothermal Heat Pump Consortium		2	1%
3 IGSHPA		106	75%
4 National Ground Water Association		20	14%

5 California Groundwater Association		6	4%
Other, please specify		5	4%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
3.18	3	3	4	0.63	0.05	[3.07 - 3.28]

31. How many years has your company been drilling GSHP boreholes?

1 None		23	16%
2 Less than 1 year		15	11%
3 1 to 5 years		52	37%
4 6 to 10 years		11	8%
5 More than 10 years		41	29%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval @ 95%
3.23	3	3	4	1.40	0.12	[3.00 - 3.45]

32. Please select the category that best describes the total number of employees at your company.

1 Under 10 employees		81	57%
2 10 to 19 employees		30	21%
3 20 to 99 employees		29	20%
4 100 or more		2	1%
	Total	142	100%

Mean	Median	Mode	Range	Standard Deviation	Standard Error	Confidence Interval

						@ 95%
1.66	1	1	3	0.85	0.07	[1.52 - 1.80]

APPENDIX H: Financial Links for Web Portal

CaliforniaFIRST: http://www.californiafirst.org/

PACE Now: http://www.pacenow.org/

Green Finance SF: https://greenfinancesf.org/systems/energy

DSIRE: http://www.dsireusa.org/

DSIRE information on PACE financing: http://www.dsireusa.org/solar/solarpolicyguide/?id=26

Sonoma County Energy Independence Program: http://www.sonomacountyenergy.org/

Plumas-Sierra Rural Electric Cooperative: http://www.psrec.coop/energy_renewable_geo.php?sec=enersol&pag=enerrenew

Delta Montrose Electric Association: http://www.dmea.com/

ENERGY STAR tax credits: http://www.energystar.gov/index.cfm?c=tax_credits.tx_index#c6

Coalition for a Green Capital: http://www.coalitionforgreencapital.com

China Leads G-20 Members in Clean Energy Finance and Investment - The Pew Charitable Trusts

SCEIP Financial Assessment Calculator | Sonoma County Energy Independence Program

Can We Put a Price on Solving Climate Change? |Triple Pundit

UK to Start $3 Billion "Green" Investment Bank |Triple Pundit

DSIRE USA Incentive Listings

DSIRE: Incentives/Policies by State: California: Incentives/Policies for Energy Efficiency

Federal Tax Credits for Energy Efficiency : ENERGY STAR

MRV: Energy Programs: Energy Efficiency

Recurrent Energy | Recurrent Energy Advantage