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WISCONSIN STATE LEGISLATURE ...
PUBLIC HEARING - COMMITTEE RECORDS

2011-12
(session year)

Assembly
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Committee on Natural Resources...

COMMITTEE NOTICES ...

- Committee Reports ... **CR**
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INFORMATION COLLECTED BY COMMITTEE FOR AND AGAINST PROPOSAL

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  (**ab** = Assembly Bill) (**ar** = Assembly Resolution) (**ajr** = Assembly Joint Resolution)
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- Miscellaneous ... **Misc**

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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

Prepared by: Dennis Murphy, GroundSource Geo, Inc.

JULY 2011

CEC-500-2011-025

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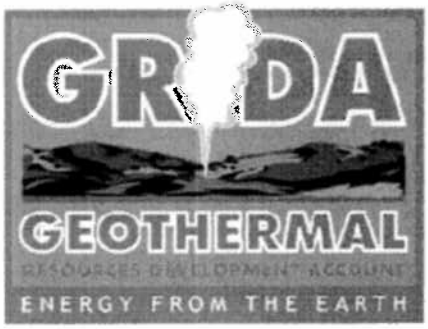

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PREFACE

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.
Types 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].

[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]

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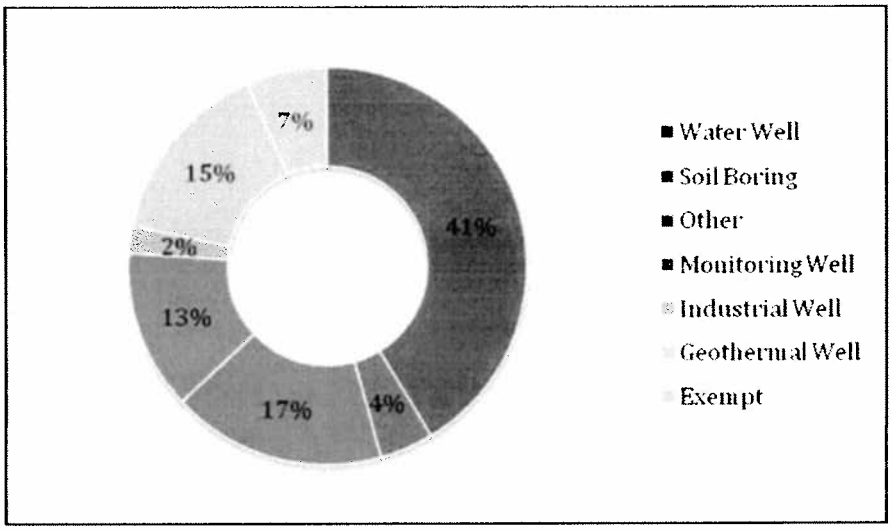
[11] There are 58 counties in the state of California and 11 additional jurisdictions including: the City of Berkeley, Alameda County Water District (Fremont, Newark, Union City), Zone 7 Water Agency (Pleasanton, Dublin, Livermore, Sunol), City of Long Beach, City of Vernon, City of Pasadena, City of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

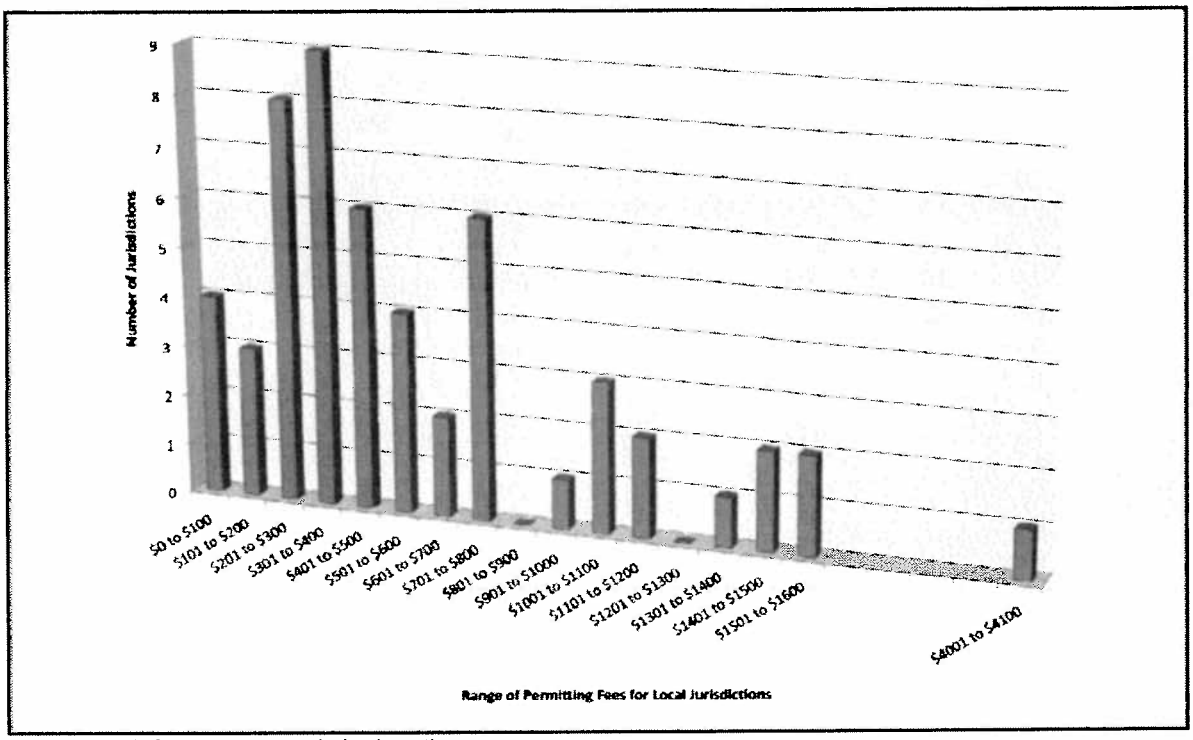


Forty-one percent of local permitting entities currently consider boreholes the same as water wells.

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.

[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

[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.

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[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

[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."