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(FORM UPDATED: 08/11/2010)

WISCONSIN STATE LEGISLATURE ...
PUBLIC HEARING - COMMITTEE RECORDS

2011-12
(session year)

Assembly
(Assembly, Senate or Joint)

Committee on Natural Resources...

COMMITTEE NOTICES ...

- Committee Reports ... **CR**
- Executive Sessions ... **ES**
- Public Hearings ... **PH**

INFORMATION COLLECTED BY COMMITTEE FOR AND AGAINST PROPOSAL

- Appointments ... **Appt** (w/Record of Comm. Proceedings)
- Clearinghouse Rules ... **CRule** (w/Record of Comm. Proceedings)
- Hearing Records ... bills and resolutions (w/Record of Comm. Proceedings)
  (**ab** = Assembly Bill) (**ar** = Assembly Resolution) (**ajr** = Assembly Joint Resolution)
  (**sb** = Senate Bill) (**sr** = Senate Resolution) (**sjr** = Senate Joint Resolution)
- Miscellaneous ... **Misc**

* Contents organized for archiving by: Stefanie Rose (LRB) (August 2013)

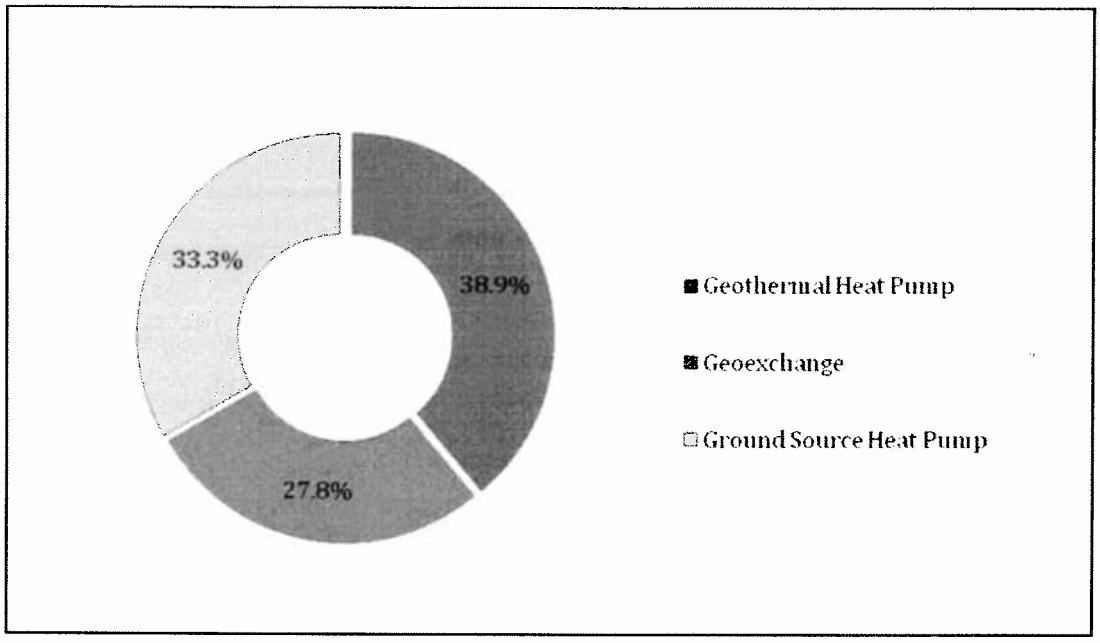
Industry Branding: The Ground Source Heat Pump Identity Crisis

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**

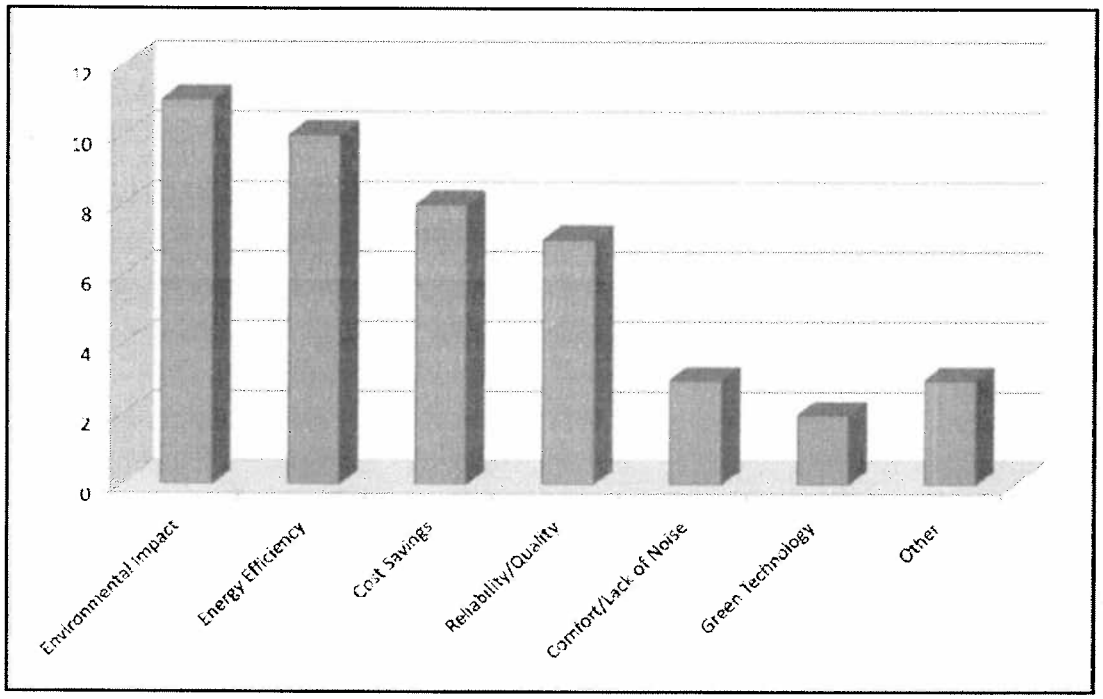
There are relatively few contractors that offer it. Contractors seem to be the number one way that technologies are communicated at the customer level. Usually when a call comes into me it's because a contractor has told them about it. **California Utility**

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?

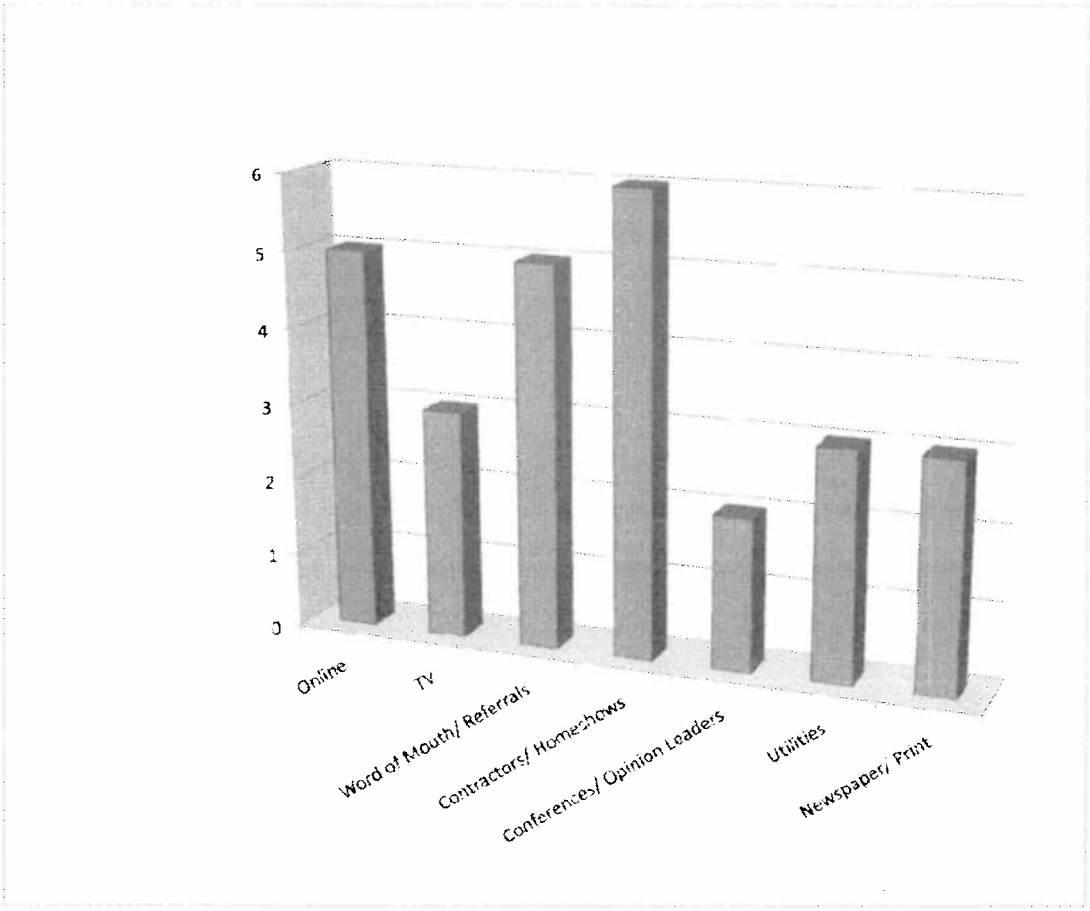
Response: As the bar chart below illustrates, customers appear to be learning about GSHPs from a variety of sources. "Contractors/home shows" were the number one cited means by which customers are learning about GSHPs but they were followed closely by "online" and "word of mouth/referrals."

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)

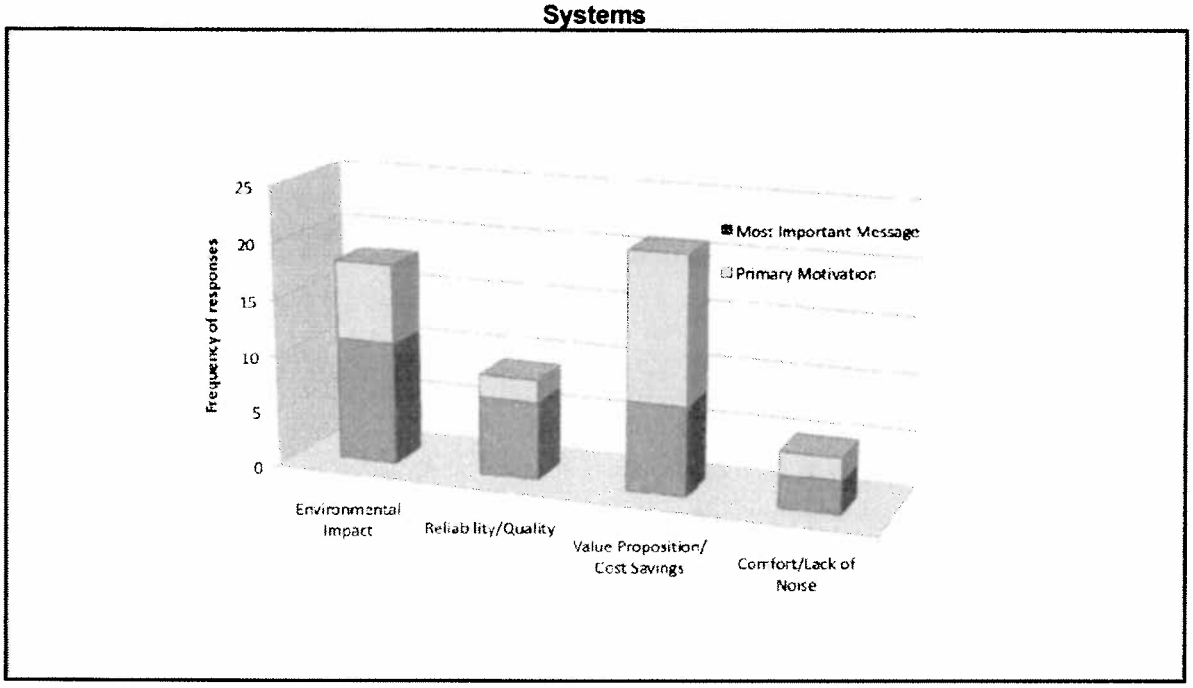
Figure 3: How Have Your Customers Become Aware of GSHPs?



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



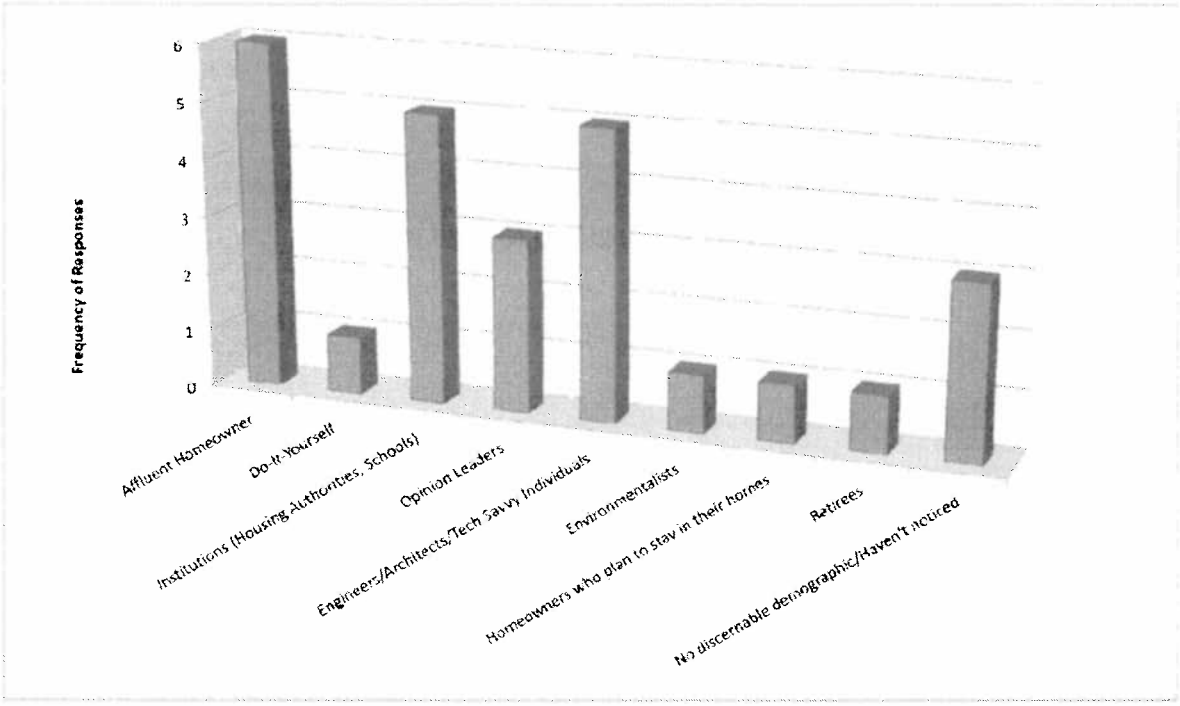
Customers focus primarily on cost savings and secondarily on environmental impact in the buying decisions.

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

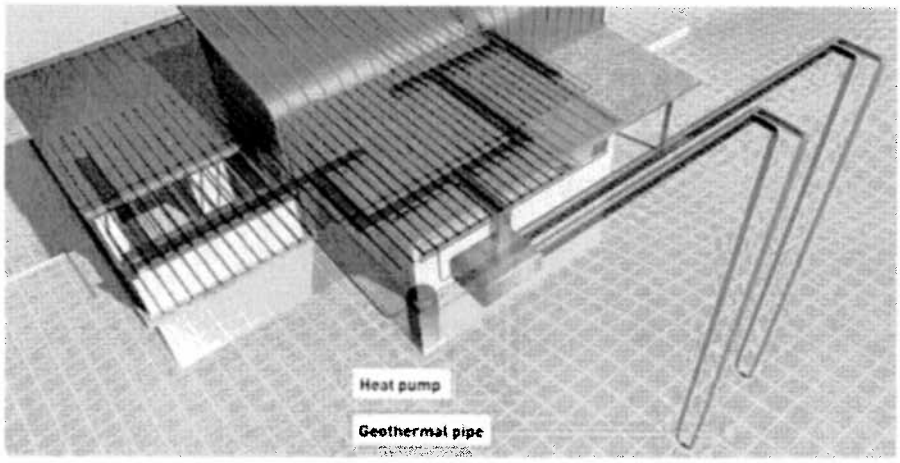
[32] http://www.hotwater.com/products/residential/voltex_hybrid.html

[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:

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

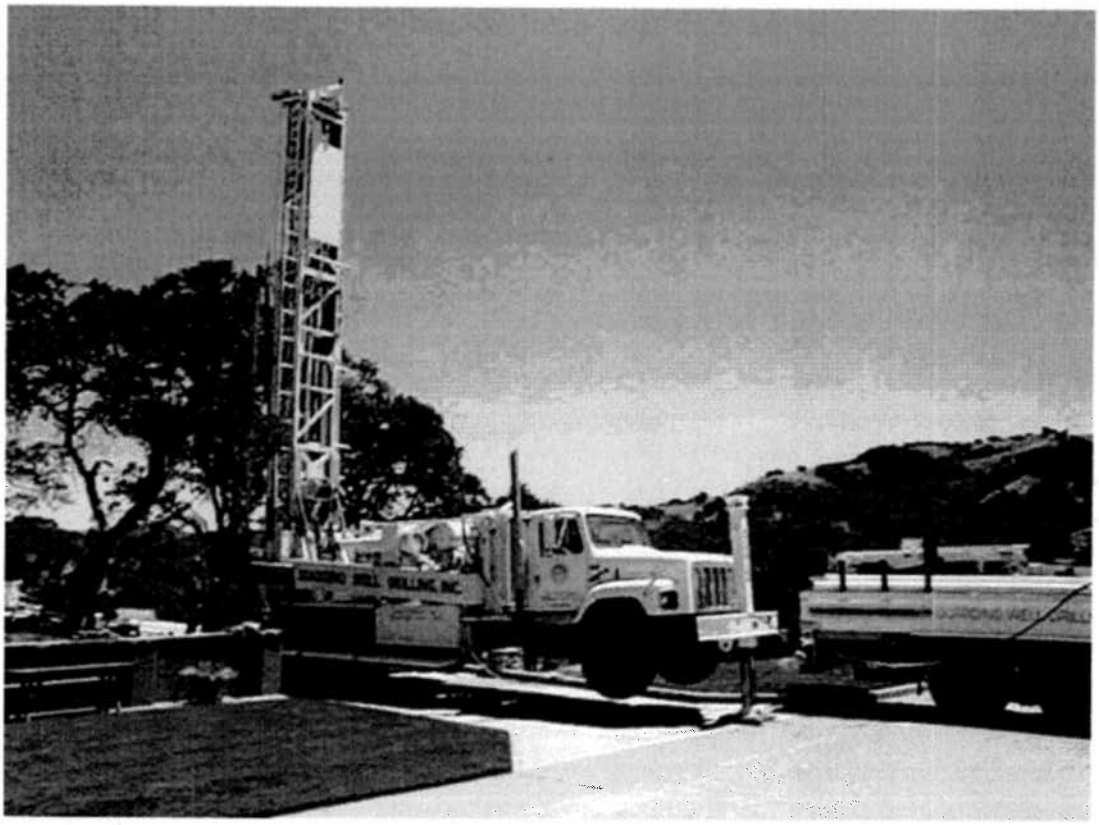
[38] http://www.kelix.com/public/default.html

- 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

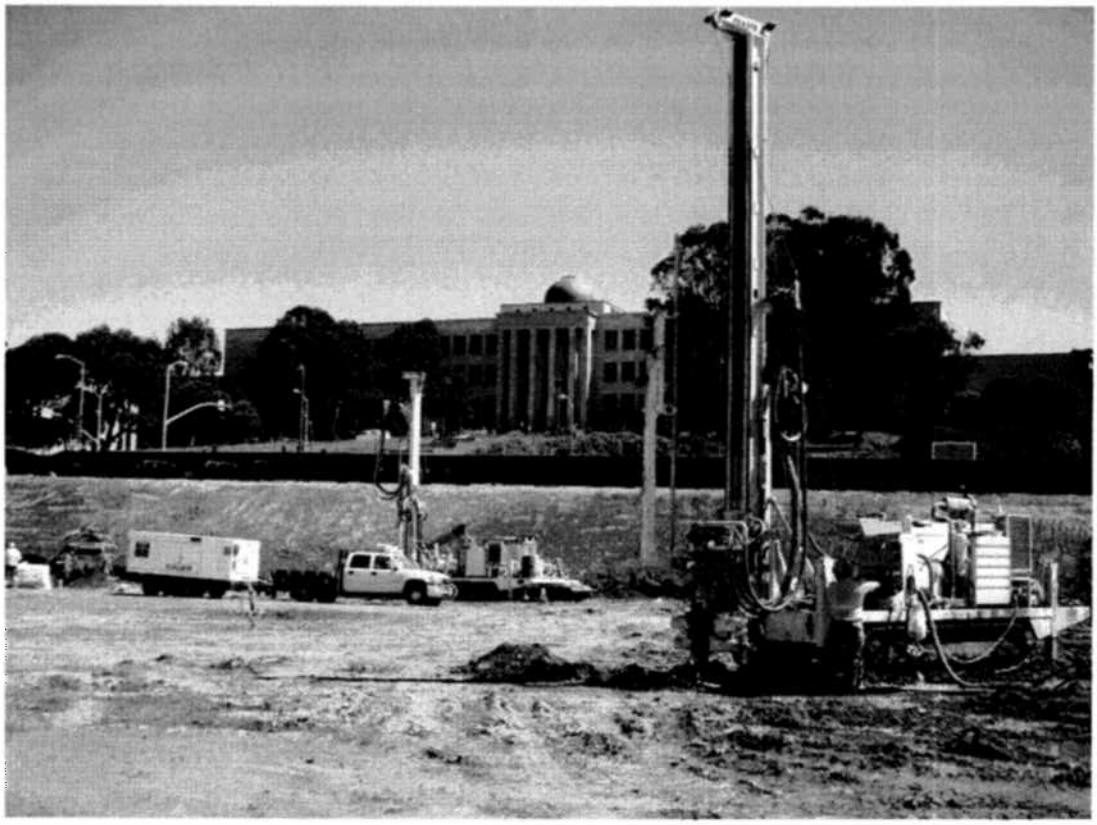
Bovis Lend Lease, Inc. and Proven Management managed construction of the 112,000 square foot development. Enlink Geoenergy of Rancho Dominguez, California was the drilling contractor who produced 400 boreholes averaging 400 feet depth through three distinct soil zones.

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.

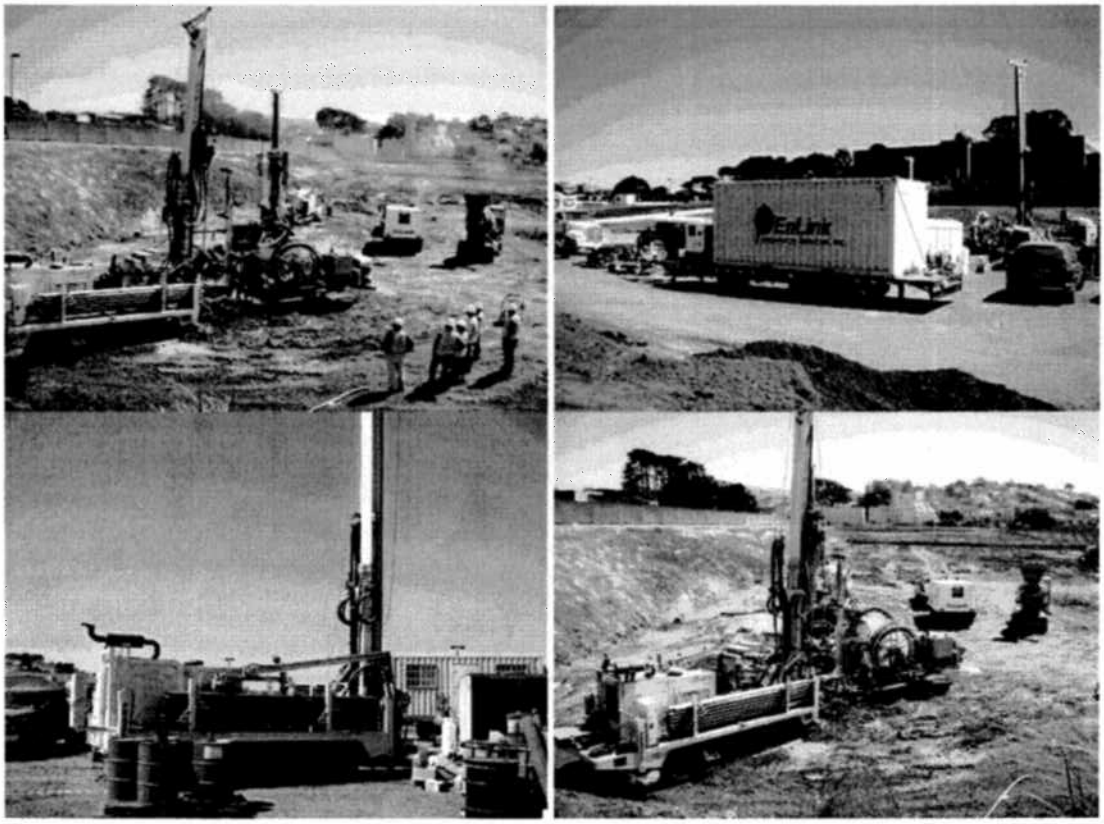
Credits: Left: Eichlervision.com; right: Dennis Murphy, Project Negatherm.

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

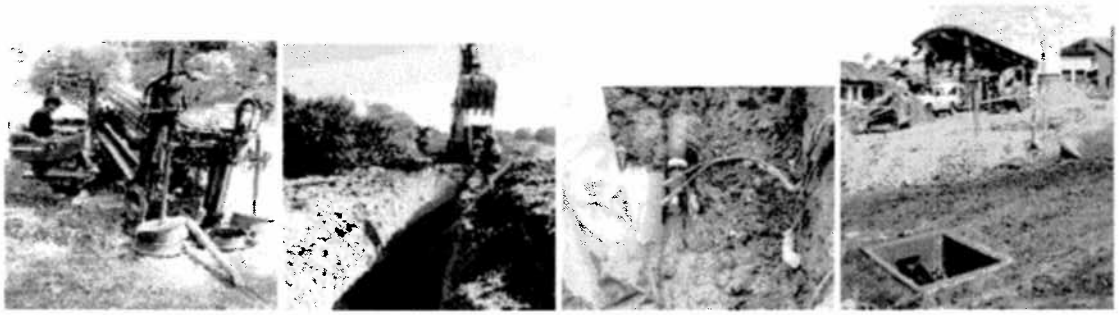
In addition, 180 bores out of the 400 drilled were installed under the building footprint, which was an unusual land usage. The extremely diverse geology ranged from clay and sand where mud rotary drills (utilizing chevron, polycrystalline diamond, drag, and wing bits) were used to green shale that required 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."



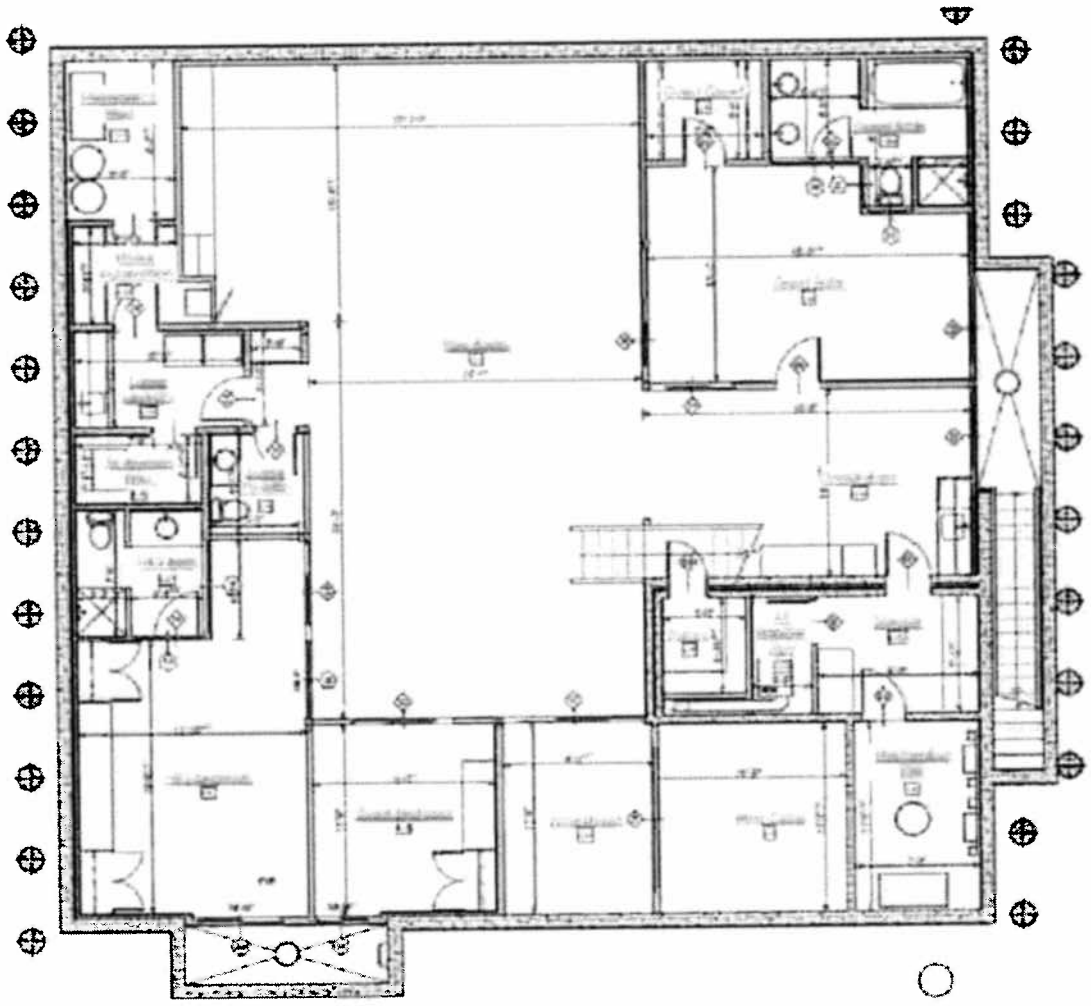
Drilling, trenching, testing and manifold view of front entrance of La Vida Real project.

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.

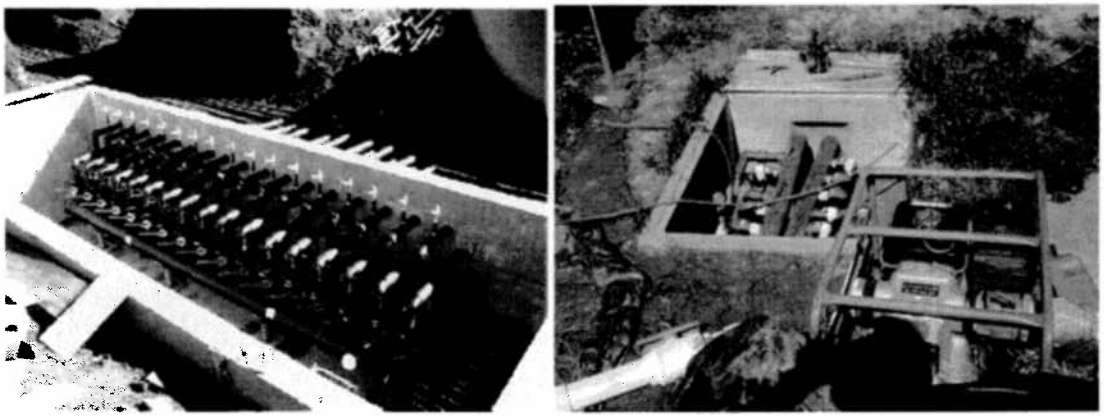
Photo Credits: Eichlervision.com



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.

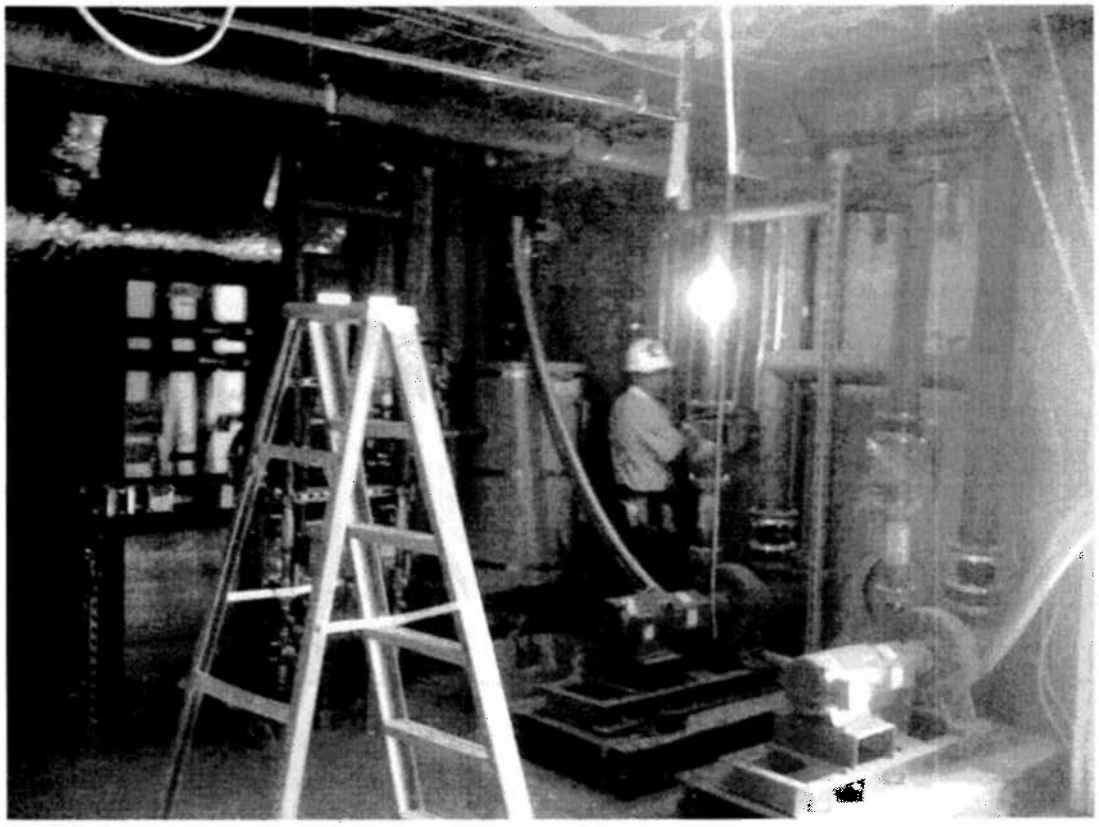
Photo Credits: Richard Butler, Enlink; Dennis Murphy, Project Negatherm

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

[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.