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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)

CHAPTER 10:
Driller Survey

Survey Methodology

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

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

Survey Respondents

Survey populations:

- Drillers within and outside of California.

Sample Frame:

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

Sample:

- Volunteer respondents in all cases.

Sample Size:

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

Possible Survey Error:

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

Topics

The following topics will be incorporated into the stakeholder interviews:

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

Survey Reports

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

Summary

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

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

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

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

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

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

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

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

Analysis

Driller Respondents Overview

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

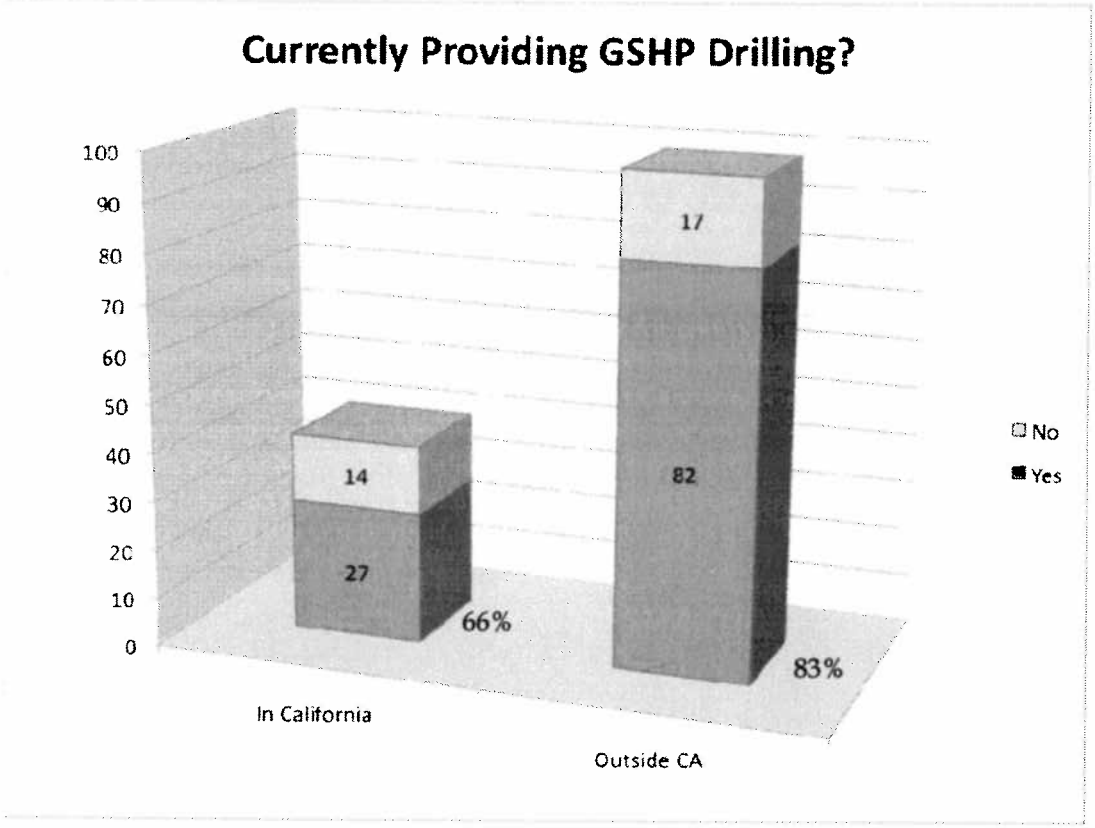

Figure 1: Proportionally fewer California water well drilling companies (66% Californian vs. 83% outside of California) have entered the heat pump market.

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

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

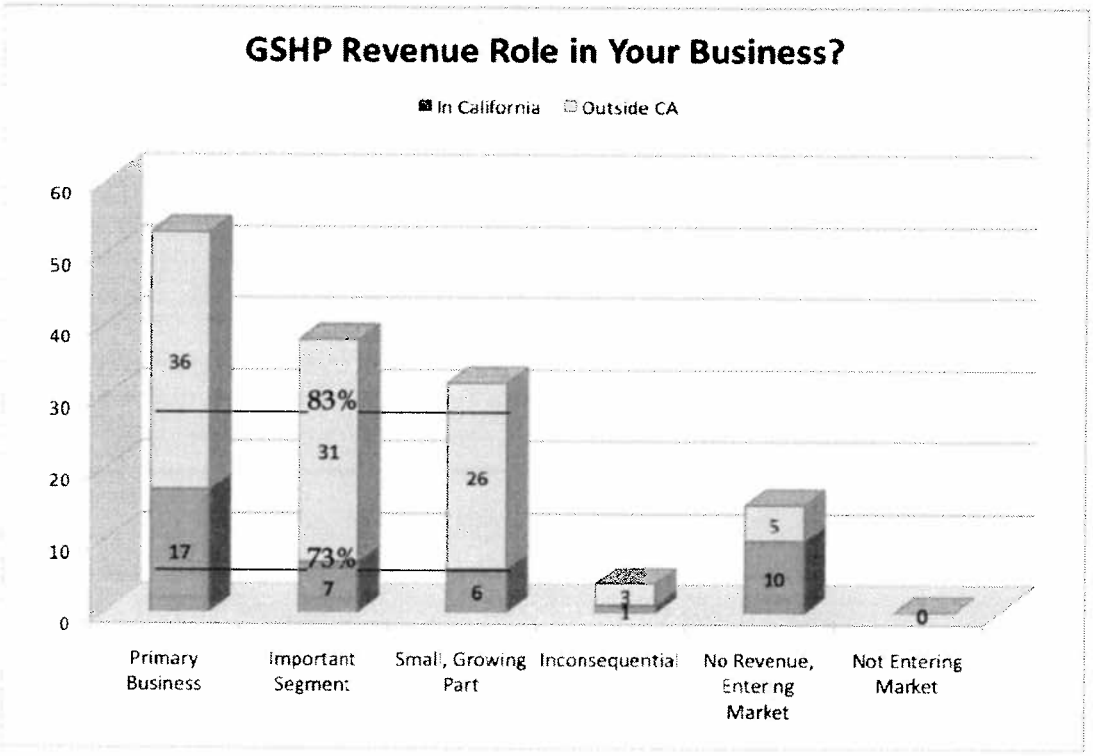

Figure 2: An overwhelming majority of survey respondents (73% Californian, 83% non-Californian) see GSHP work as strategic part of their overall business.

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

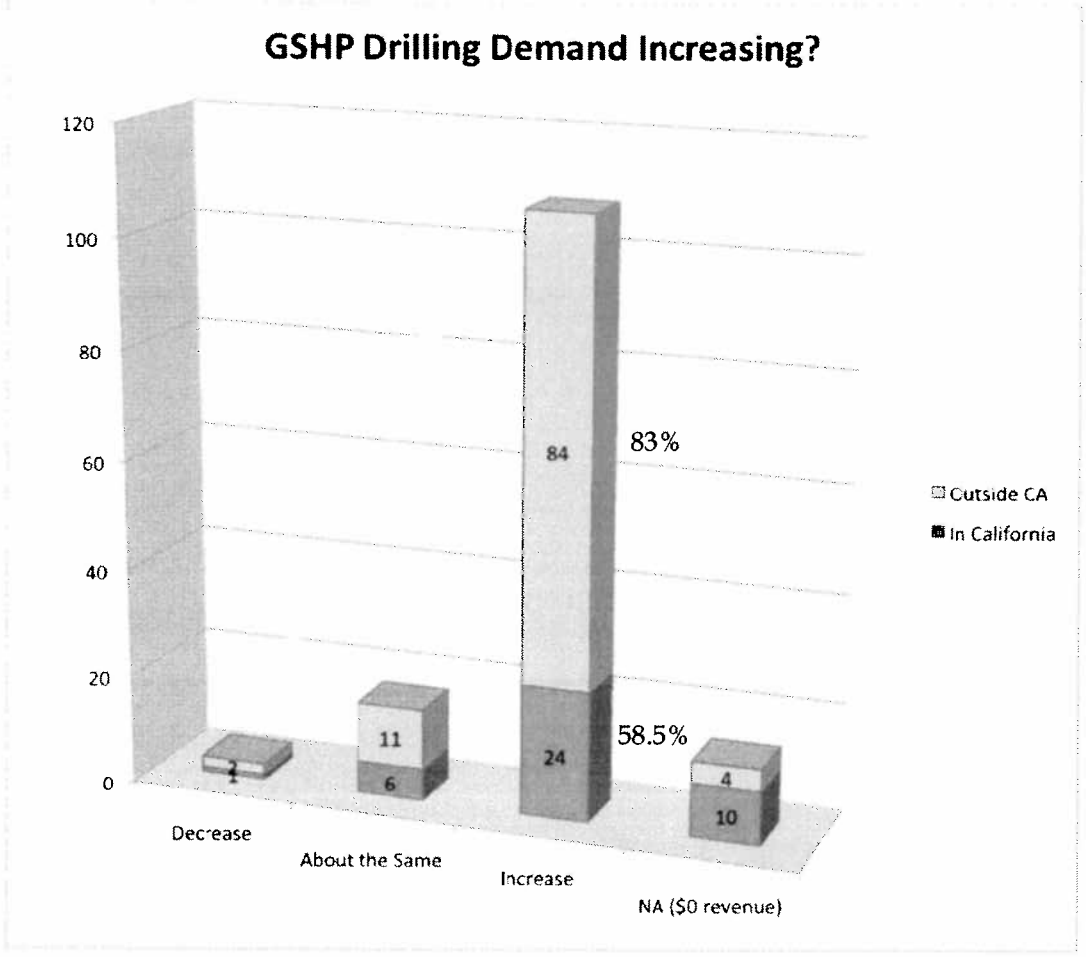

Figure 3: A large majority (58.5% Californian, 83% non-Californian) of the survey sample has seen demand for GSHP borehole drilling increase since they started their business.

GSHP Education

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

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

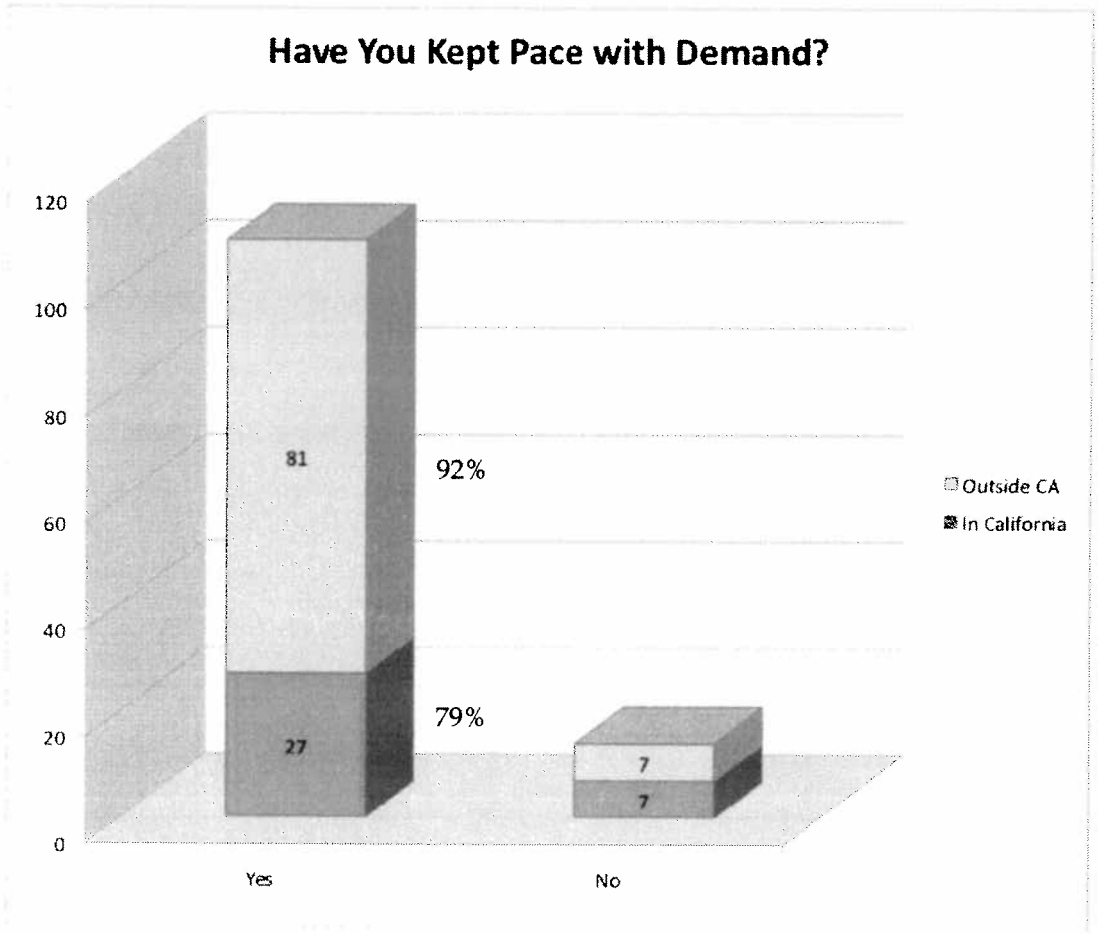

Figure 4: Companies have kept up with the increased demand spurred by tax credits and increasing awareness, but somewhat less so in California (92% Non-Californian versus 79% Californian).

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

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

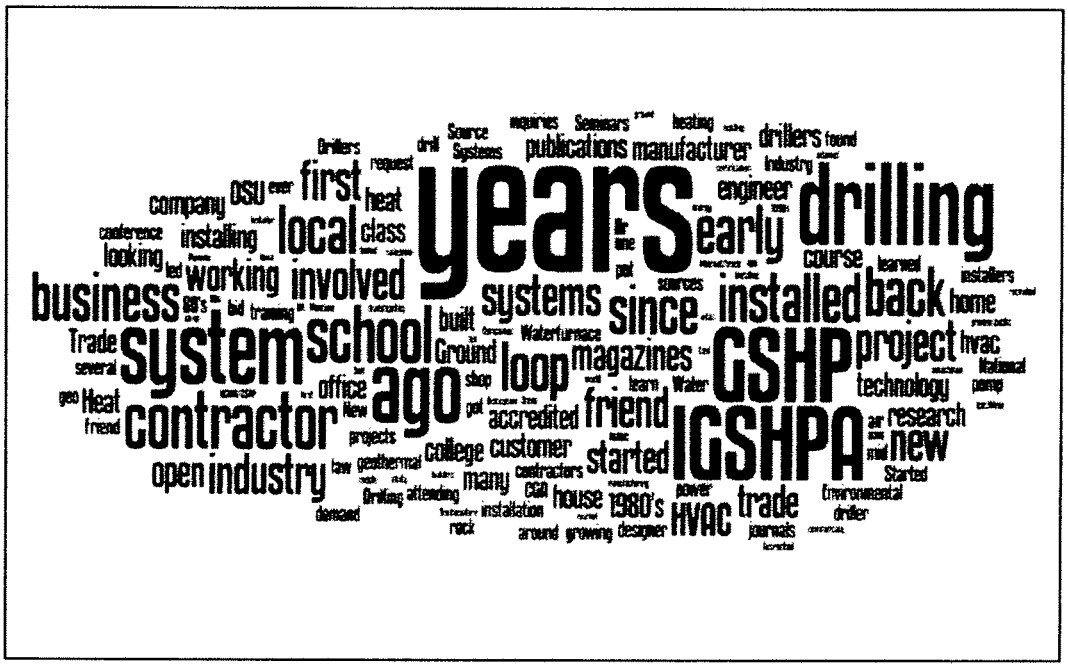

Figure 5: Tag cloud answers to survey question "How did you learn of GSHP?

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

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

Business Operations

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

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

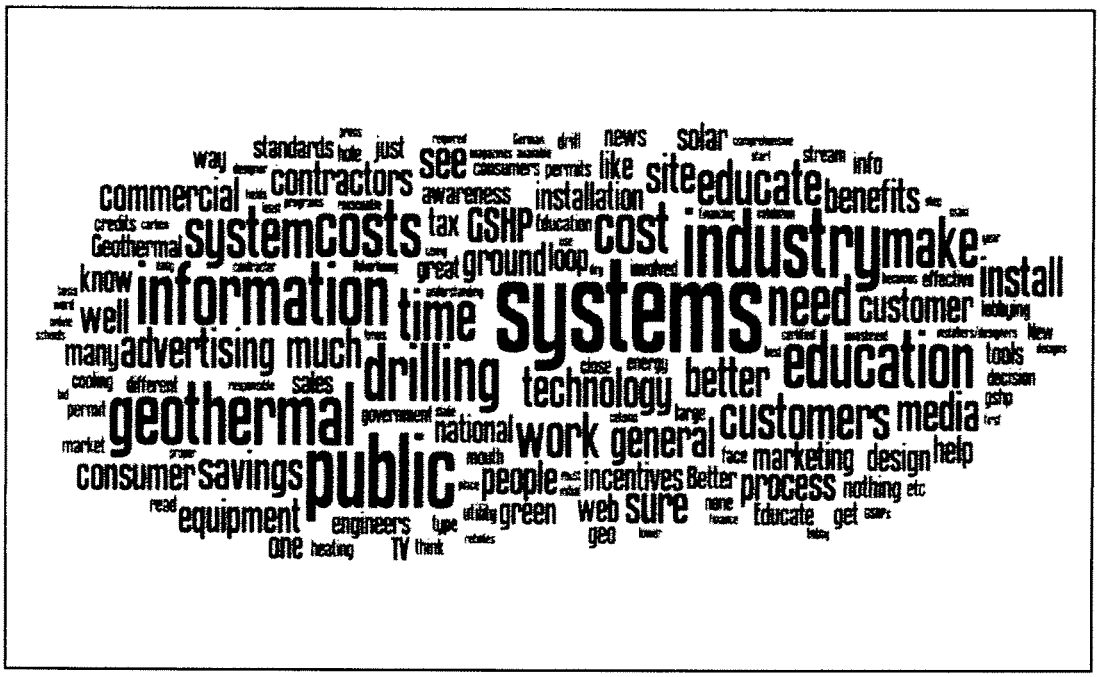

Figure 6: Tag cloud answers to survey question about reducing sales costs and sales cycle time.

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

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

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

- Focusing on concrete examples of cost savings for potential buyers to read. Case studies that show savings over other sources of heating and cooling. People will invest in geothermal and do it more quickly as it becomes a mainstay in the market. It's still seen

as extremely expensive and risky. Word of mouth sells best as we see entire neighborhoods install geothermal one at a time. Those who have it like to brag about their savings to those who don't.

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

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

Drilling Information

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

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

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

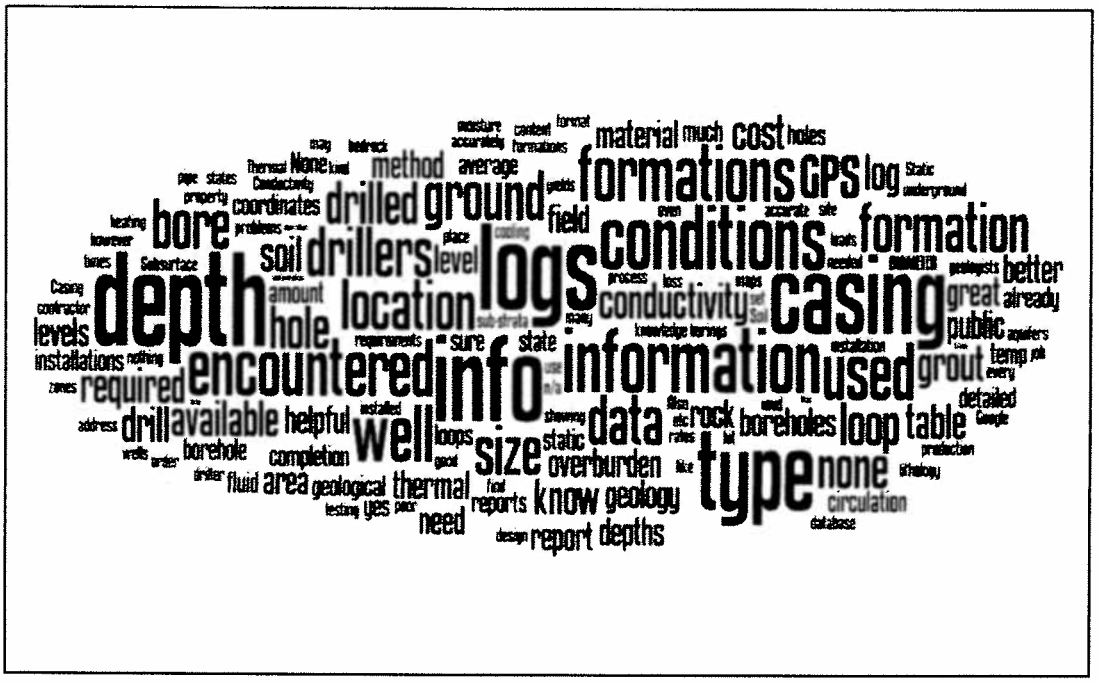


Figure 7: Tag cloud answers to survey question about what would be useful with more open and detailed drill log information.

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

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

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

Government Incentives

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

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

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

Industry Growth

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

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

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

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

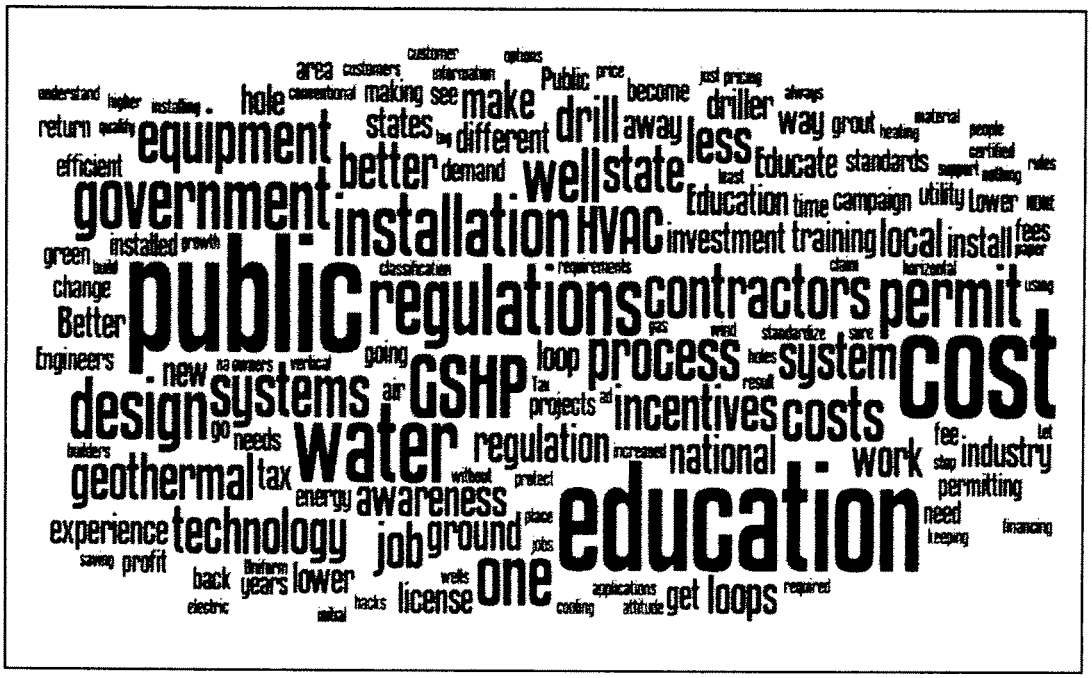


Figure 8: Tag cloud answers to the question of what would do most to grow the GSHP industry.

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

- Get the state of California to adopt the proposed Geothermal Well Standards part of Bulletin 74.
- Standardize the permits
- Adopt a permit process with one permit per project or one fee for the initial well and minimal fee for the next wells. No permit billing by the hour. There is no way to estimate this and if one gets a rogue inspector one can get punished with huge punitive permit fees. It will take the profit right out of a job.
- Really "drill" on the local ordinances -- and make them statewide. We've seen our projects delayed by 3 years because of local opposition -- often illegally.
- Standardization of the permitting process. Creation of a license for closed-loop holes i.e., less than the water well driller's license. Use of efficient purpose-built drilling equipment.
- Have a national GSHP driller's license. Have multiple states accept others CEU we would gladly pay the cost as this is just a monetary issue for each state if you attended one and paid the fees in other states that would lower cost. As having to go to 8 states that I am licensed in takes away from my time on job sites and drives my cost as I am

going back for the same classes 8 different times and not on the jobsite. Also if the government would fund the green energy projects and not give the stimulus money away to people that do not deserve it that would blow this industry wide open and make our country one of the true green leaders in the world.

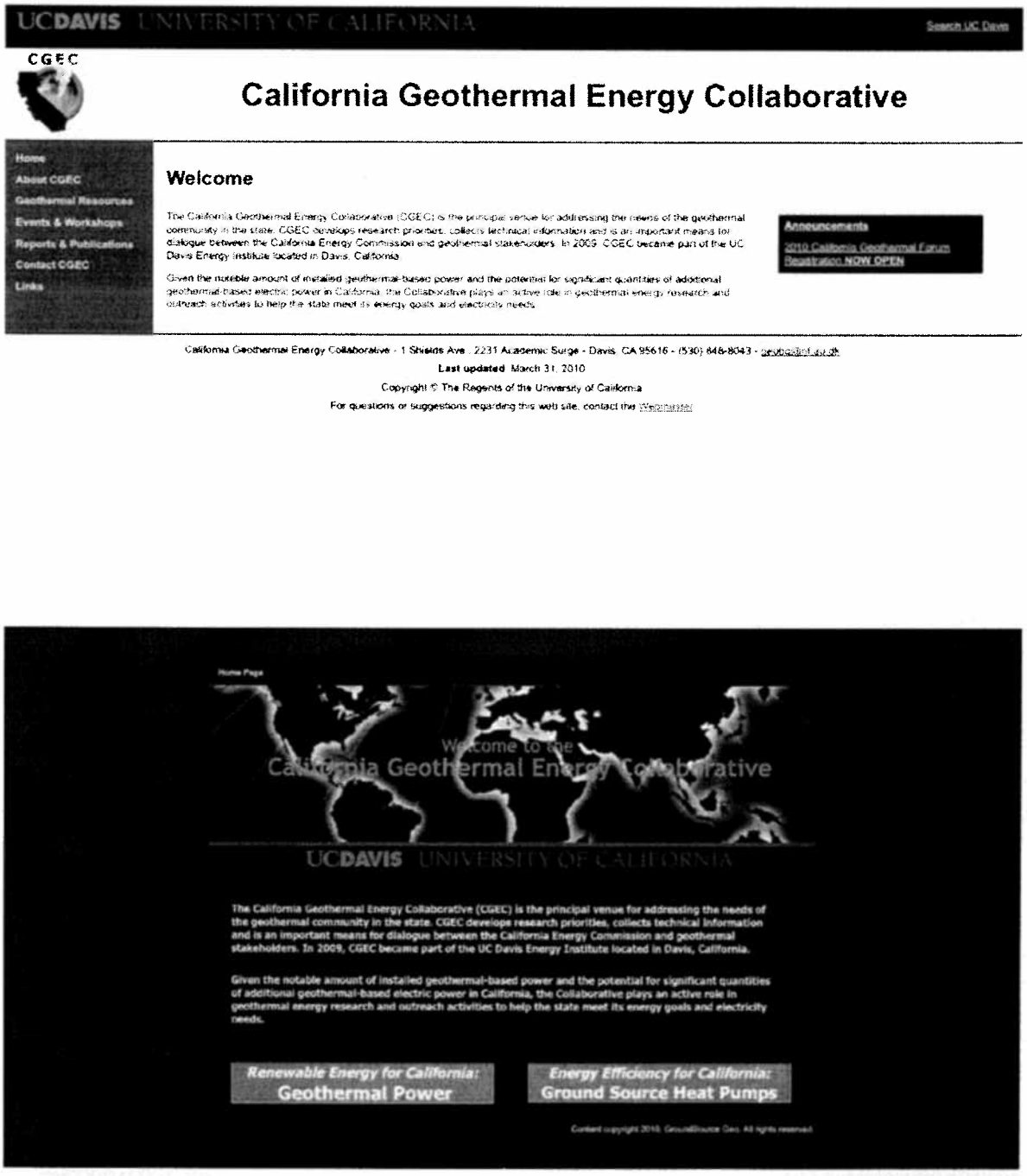
CHAPTER 11:
Consumer/Drilling Web Portal

The development of the Project Negatherm website encompassed three goals:

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

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

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



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

For the foreseeable future, both ProjectNegatherm.org and CaliforniaGeo.org will be hosted by Web Synergetics, the key project web developer and administrator of GHPC's Geoexchange.org site. The sites are constructed on the award-winning open-source Joomla portal engine and

content management system which, unlike a more static HTML structure, keeps track of every piece of content (text, photos, music, video, documents) on the site and stores them in a logical, flexible fashion. Joomla is built upon the PHP scripting language and the MySQL database.

Sitemaps

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

ProjectNegatherm.org Sitemap

Home

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

Tabs

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

b) Interviews (derived from Tasks 2.6 and 2.7)

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

CaliforniaGeo.org Sitemap

Home

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

Tabs

- Consumer Tools

a) Benefits

b) Technology Explained

c) Costs and Calculators

d) Financial Information

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

a) Regulatory links

b) Permitting information

c) Soil maps

d) Technical info

e) California Geo Forum

- Project Negatherm

a) About

b) GSHP Library

c) Blog

Data Collection

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

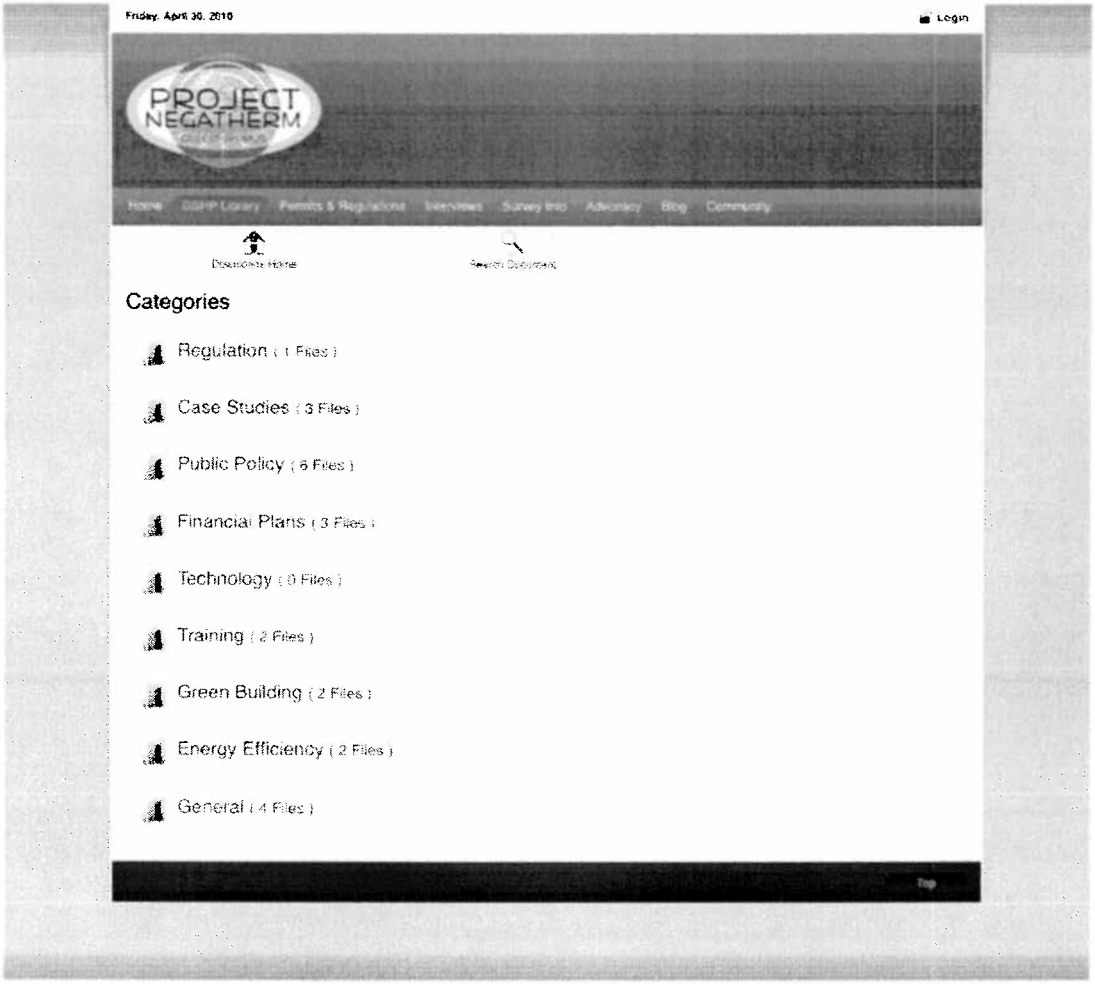


Figure 3: A view of the Project Negatherm library.

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

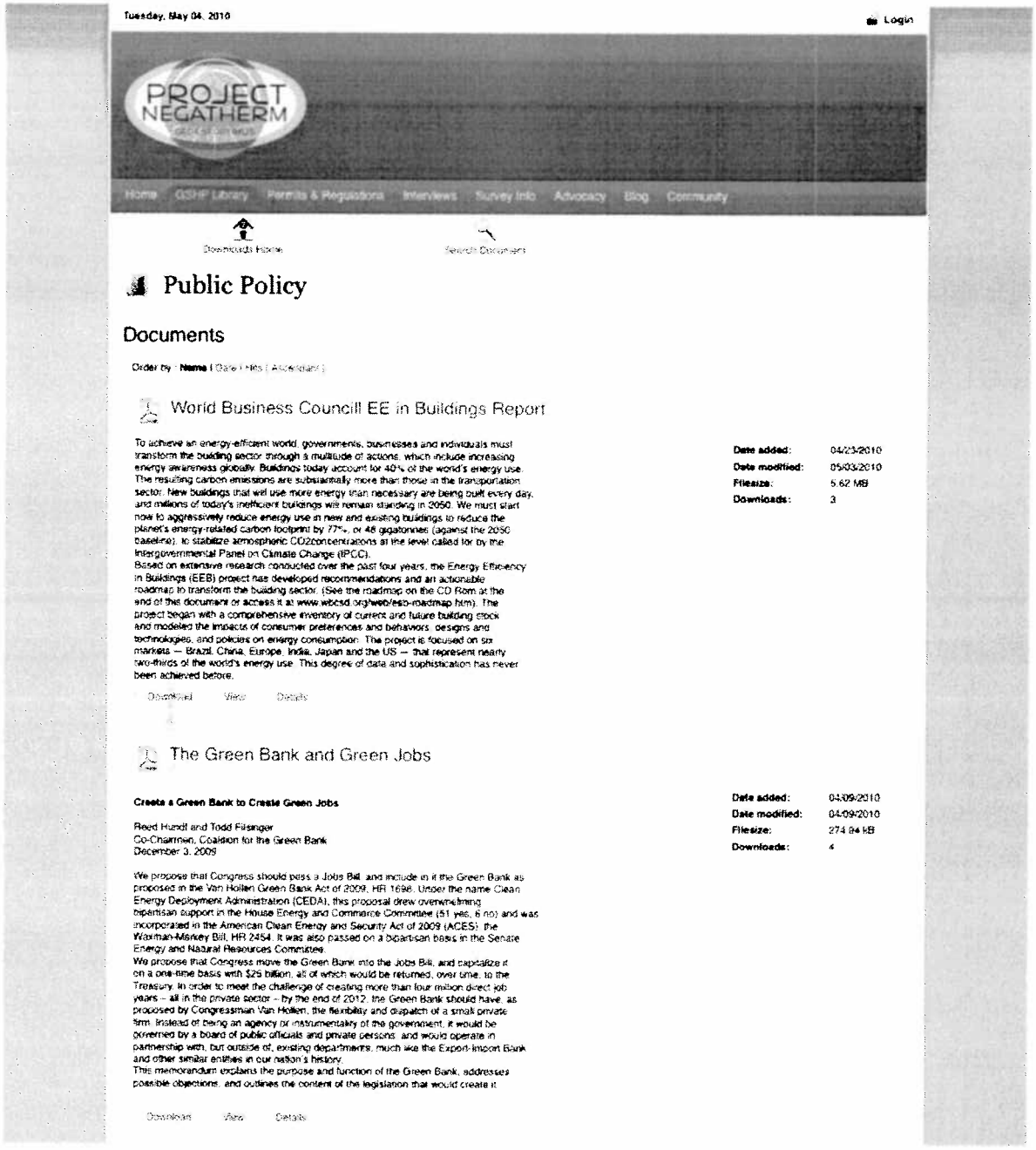


Figure: 4: Document listing within "Categories" folder provides file summary information.

Web Portal Page Design and Production

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

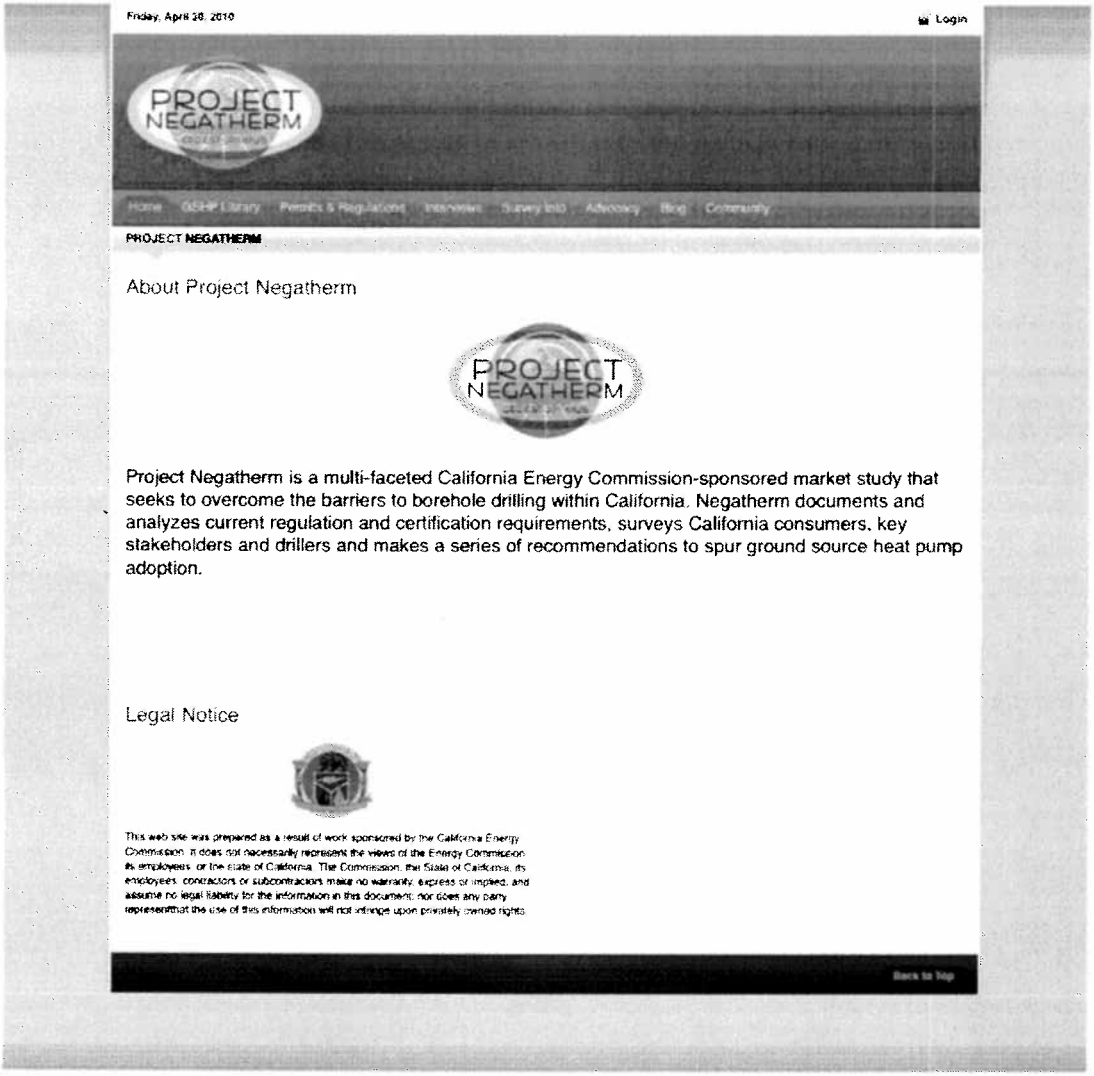


Figure 5: ProjectNegatherm.org main page.

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

Figure 6: ProjectNegtherm.org blog

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

industry material. With some search optimization and industry referral support, CaliforniaGeo.org can quickly become an engaging, honest broker of heat pump information.

Figure 7: CaliforniaGeo.org main page

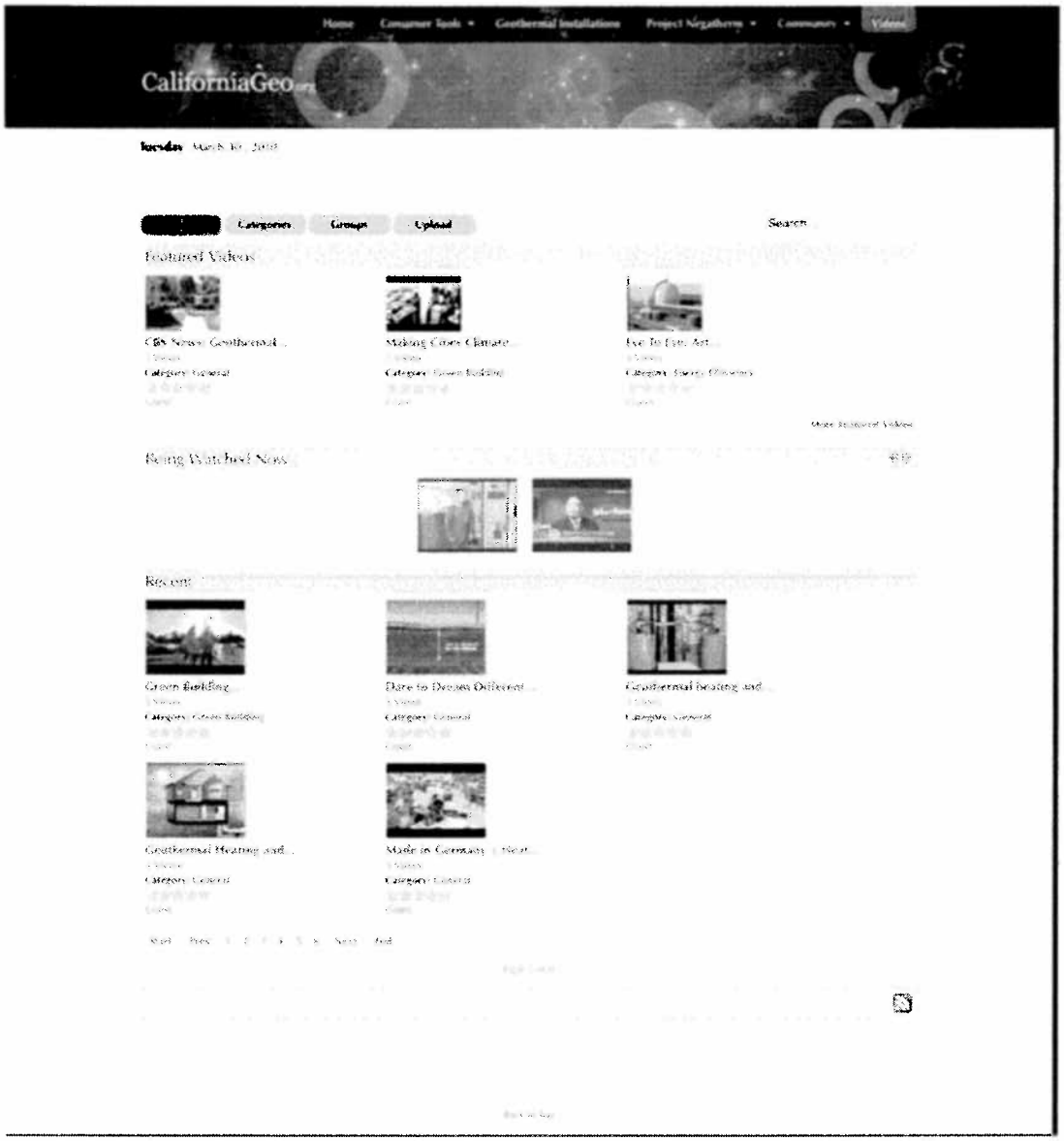


Figure 8: CaliforniaGeo.org video page.

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

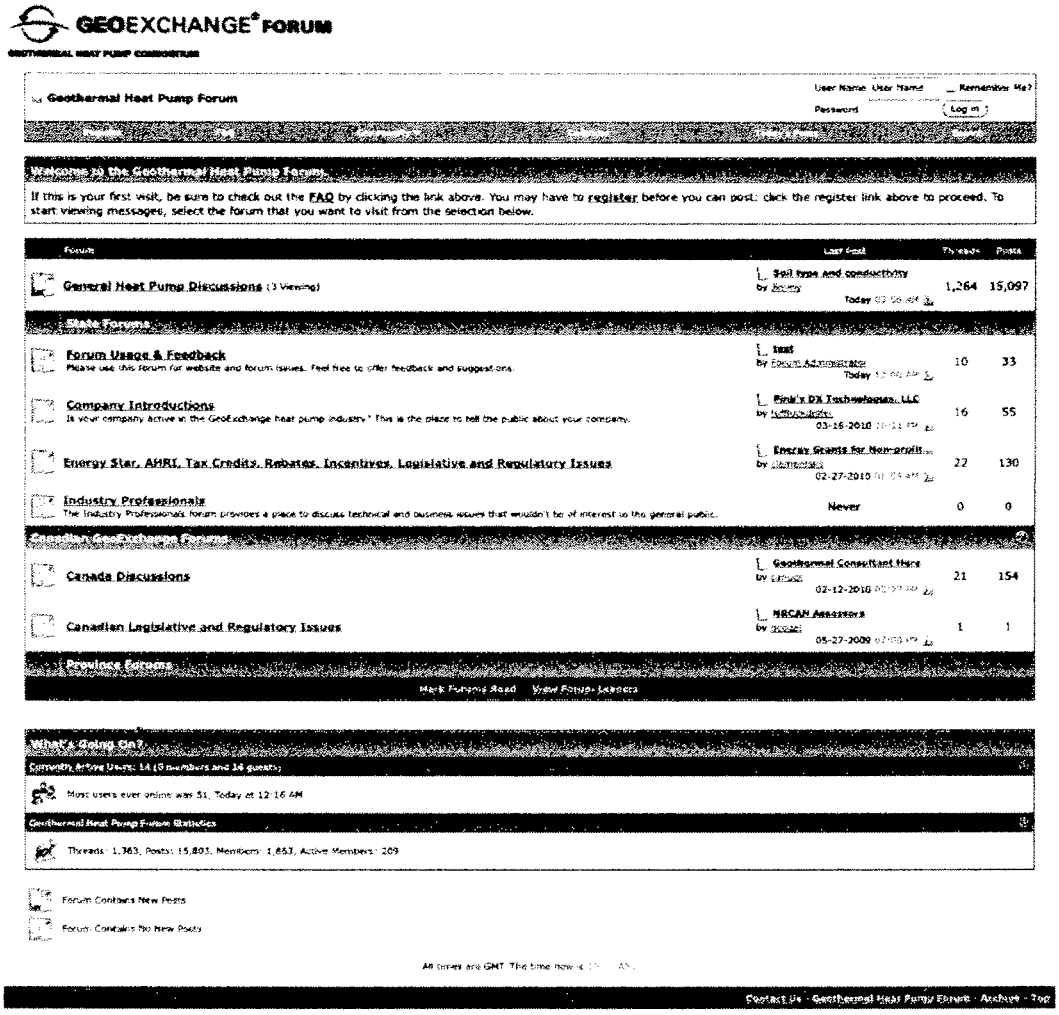


Figure 9: CaliforniaGeo.org's industry section integrates with GHPC's Geoexchange.org's California Discussion Forum.

Web Portal Review and Quality Assurance

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

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

Delivery of Finished Portal

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

CHAPTER 12:
Financial Overview

Summary

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

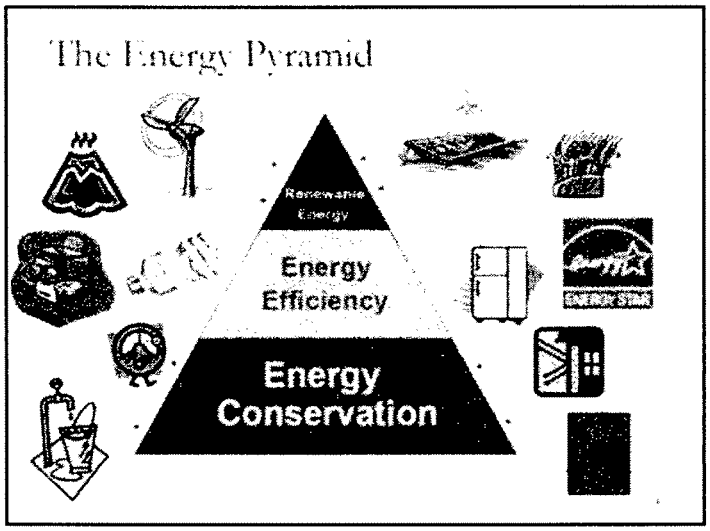


Figure 1: The classic energy industry version of "reduce, reuse, recycle."

Credit: U.S. Department of Energy

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

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

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

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

Property Assessed Clean Energy (PACE) Financing

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

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

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

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

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

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

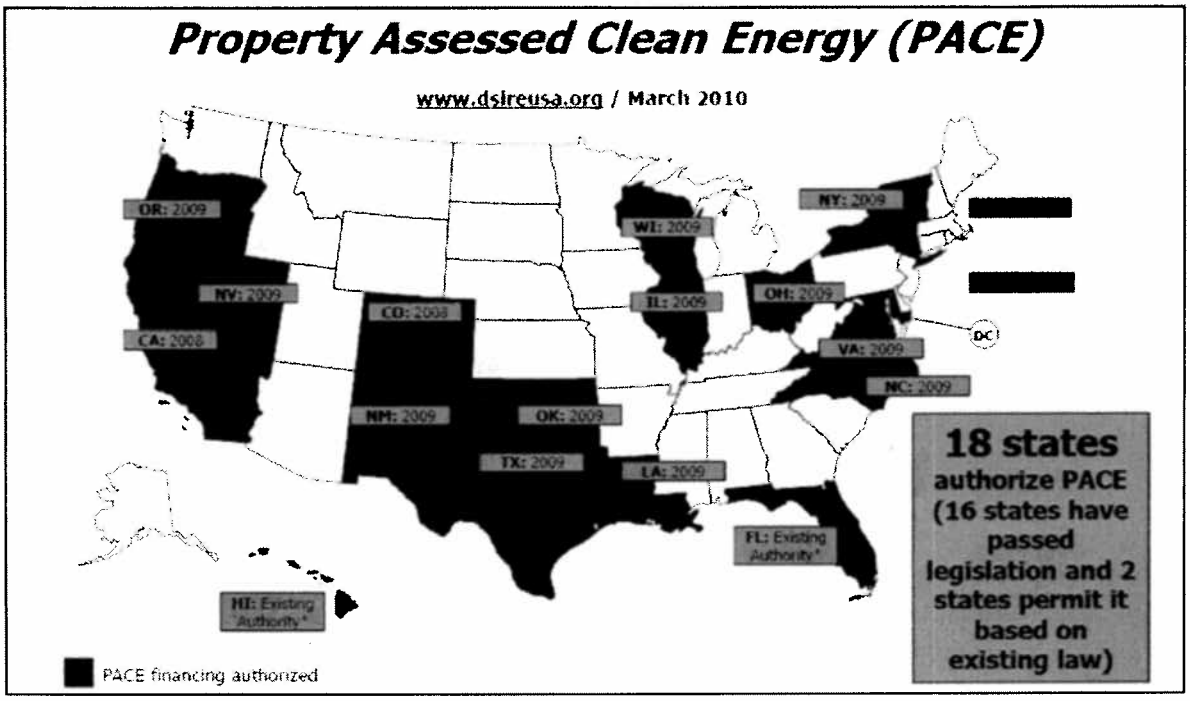


Figure 2: The PACE funding concept has spread quickly over the last year.

Credit: DSIRE.org

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

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

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

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

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

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

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

CaliforniaFIRST[83]

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

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

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

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

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

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

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

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

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

Utility Loop-Lease Programs

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

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

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

Plumas-Sierra Rural Electric Cooperative

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

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

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

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

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

[88] Market Development Group Case Study, 2007.

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

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

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

Delta-Montrose Electric Association

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

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

Green Bank Proposal

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

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

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

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

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

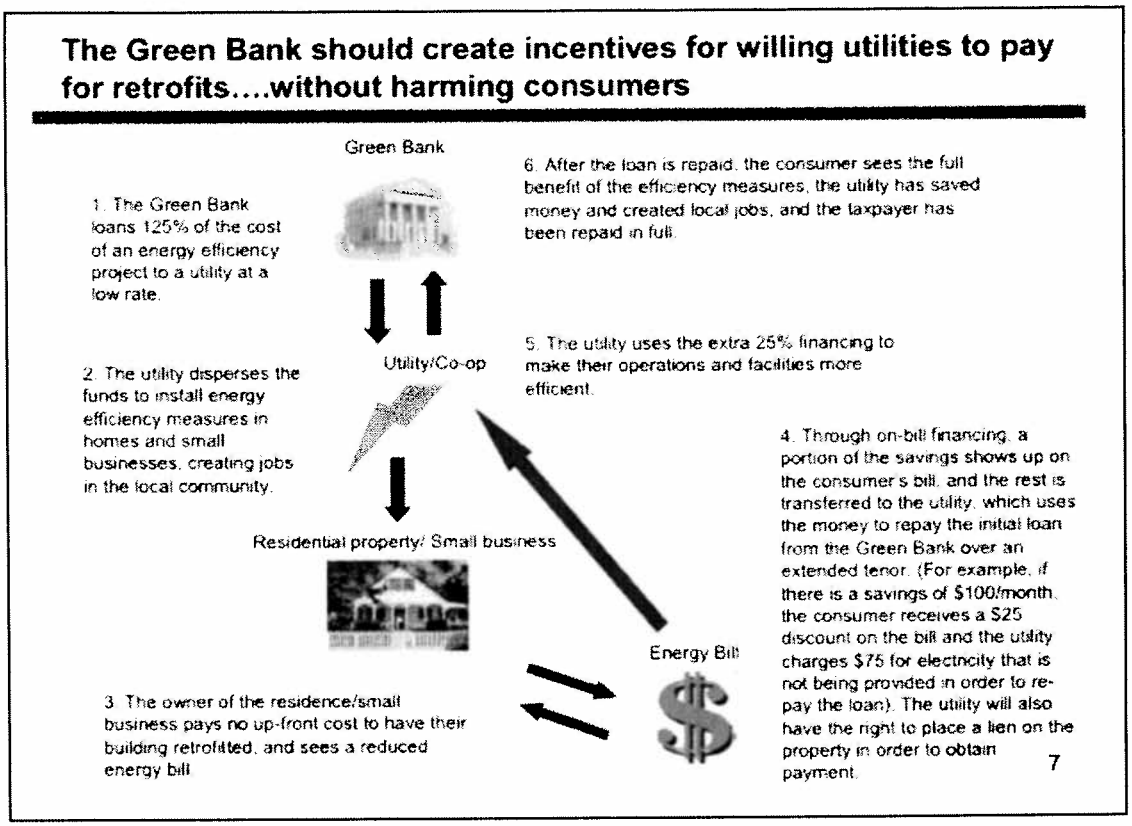

Figure 4: Green Bank utility incentive concept.[93]

Credit: Washington Post

92

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

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

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

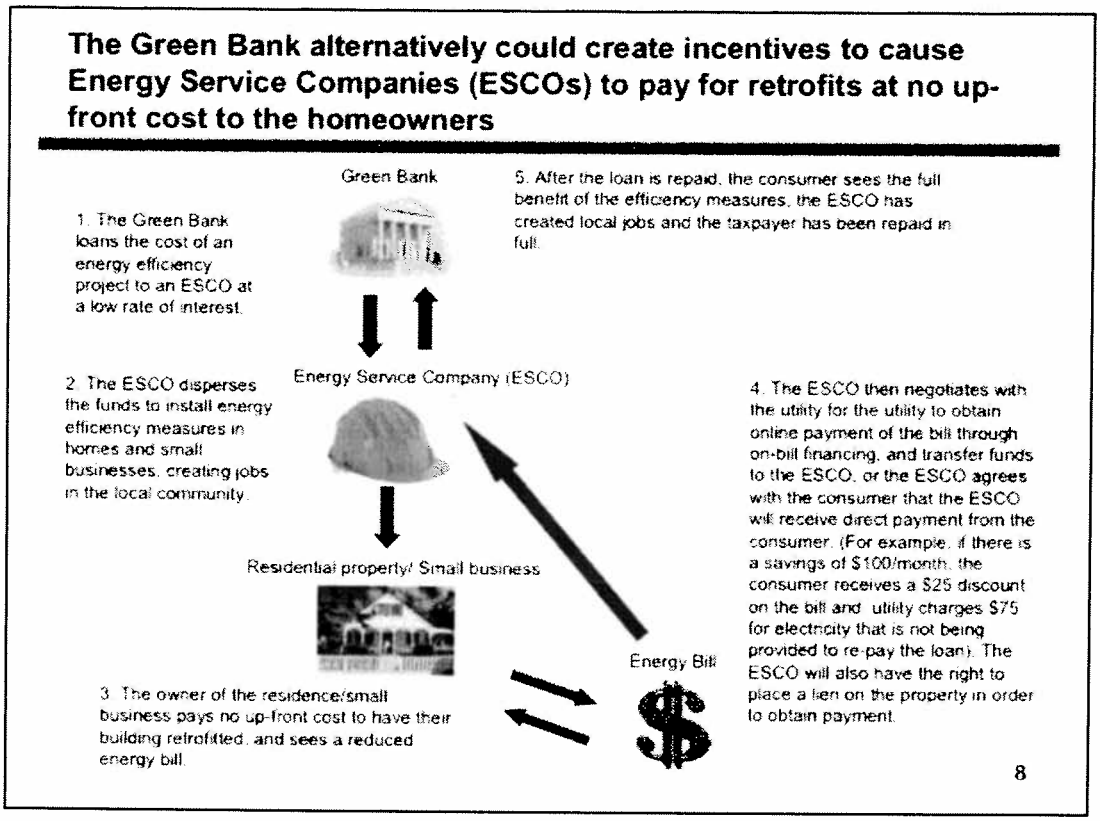

Figure 5: Green Bank ESCO incentive model.[95]

Credit: Washington Post

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

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

CHAPTER 13:
Technology Transfer Plan

Summary

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

Web Portal

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

ProjectNegatherm.org

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

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

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

CaliforniaGeo.org

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

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

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

Schedule of Presentations

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

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

Publicity

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

APPENDIX A: The Literature Reviewed

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

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

Key findings included:

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

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

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

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

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

The study's findings included:

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

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

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

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

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

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

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

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

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

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

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

This report had the following findings:

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

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

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

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

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

Key findings from the evaluation efforts include:

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

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

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

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

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

Overview of GSHP in the United States:

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

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

Overview of GSHP in Europe:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

- Ground Source Heat Pumps

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

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

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

Findings:

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

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

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

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

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

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

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

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

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

The report findings include:

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

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

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

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

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

The report had the following findings:

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

The report had the following recommendations:

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

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

Annex 29 outlined its work plan at a workshop in Zurich in May 2008. Their first task is to conduct a Ground Source Heat Pump (GSHP) market analysis that examines: the number of installed systems in different sectors such as single-family and multi-family homes, commercial buildings, and data on the operation modes such as heating-only vs. cooling only systems. From

this data, Annex 29 is developing a matrix of ground source heat pumps to help identify systems designs for particular climatic conditions, soil temperatures, soil properties, heat source/heat sink systems as well as different types of buildings with different distribution systems. Task 4 for Annex 29 is overcoming legal barriers, which include using fluids without any toxic components. Economic barriers that must be overcome include enacting subsidies to support the industry and reducing first costs for the customer. Finally, Annex 29 intends on increasing the acceptance of GSHP technology by information, training and advertisement to policy makers, planners, installers, drilling companies and users.

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

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

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

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

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

- High First Cost of GSHP systems to consumers

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

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

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

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

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

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

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

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

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

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

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

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