BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Identify Disadvantaged Communities in the San Joaquin Valley and Analyze Economically Feasible Options to Increase Access to Affordable Energy in those Disadvantaged Communities.	Rulemaking 15-03-010 (Filed March 26, 2015)

CERTIFICATE OF SERVICE

I hereby certify that I have this day served a copy of the document:

"COMMENTS ON UTILITIES' PROPOSED PILOT PROJECTS
FOR CPUC RULEMAKING 15-03-010"
BY CALIFORNIA GEO / THE GREY EDGE GROUP

on all known parties to R.15-03-010 by transmitting an electronic mail message with the document attached to each person named in the official service list with an electronic mail address.

Executed on March 2, 2018 at Quincy, California.

/s/ Bill Martin

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COMMENTS ON UTILITIES' PROPOSED PILOT PROJECTS FOR CPUC RULEMAKING 15-03-010

CaliforniaGeo / The Grey Edge Group

March 2, 2018.

From its passage in September of 2014, Assembly Bill 2672 (Perea) identified three potential paths to relieve disadvantage in personal finances, safety, and air quality for residents of what became a total of 170 qualifying communities in the San Joaquin Valley. Twelve of those 170 have been identified as pilot projects for the entire sample to demonstrate results among three approaches:

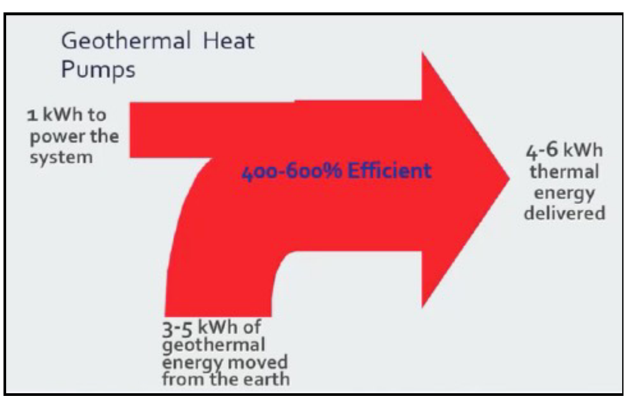
1. Extension of off-site natural gas lines to replace propane and wood heating
2. Boosted financial subsidies through investor-owned utility rate systems
3. Conversion to all-electric energy service and new household appliances

Geothermal heat pumps (GHPs) are applicable to this proceeding because:

1. They can be part of a residential all-electric conversion within the pilots.
2. They eliminate ALL local emissions and provide renewable thermal energy.
3. They can reduce year-round KW demand in ANY all-electric conversion.
4. They provide both heating and cooling from one equipment system.
5. They deliver the lowest life-cycle cost with least maintenance of any system.
6. They reduce evaporative water consumption locally and at the power plant.
7. They help stabilize the grid in that they have a winter kW consumption profile.
8. Geo Heat Pump (ground source) **District Systems**:

A. Boost efficiency by recovering normally wasted energy to the environment. This supports California's policy goals.

B. They are proven energy systems in many campus and city-scape projects in the U.S. and Canada.



California Geothermal Heat Pump Association, Inc.

www.CaliforniaGeo.org

DBA CaliforniaGeo is a nonprofit, 501c6 organization, incorporated in California. We work to craft a blend of advocacy, education, and workforce training that will make market development a certainty for geothermal heat pump technology throughout California.

GreyEdge Group

https://www.thegreyedge.com

The The GreyEdge team consists of people who have worked in the ground source heat pump industry for most of their career. They have been involved in almost every aspect of the industry...including professional engineers and geologists, drilling contractors, project managers, mechanical contractors and certified commissioning agents and system financial experts. They have worked in the industry a combined total of over 250 years, are heavily involved with the International Ground Source Heat Pump Association (IGSHPA), the American Society for Heating, Refrigeration and Air-conditioning Engineers (ASHRAE), Association of Energy Engineers (AEE) and the National Ground Water Association (NGWA). Members are located throughout the U.S., Canada and the U.K. and have experience across North America, the EU and Australia, New Zealand and Asia.

Contents

of this comment by CaliforniaGeo / The Grey Edge Group

1. CURRENT STATUS OF THE PROCEEDING-

Three investor-owned utilities (IOUs) have produced their choice of where to deploy pilot projects among the 12 communities identified in this proceeding. They are Southern California Gas, Southern California Edison, and Pacific Gas and Electric (SoCG, SCE, and PG&E). As might be expected, each IOU has produced a proposal that is anchored largely within their historic business model; the proceeding did not demand otherwise.

CaliforniaGeo / The Grey Edge Group is fully supportive of utilities as regulated territorial monopolies whose existence offers the best chance for service at the lowest cost. Proper regulation includes an assumed priority that utilities must remain solvent in order to attract private capital, to never fail in providing their energy product to ratepayers, and to maintain a fair and predictable rate mechanism for charges to their customers.

In this context, it is reasonable that the IOUs have proposed answering AB 2672's goals within their regular scope of operations. At this point, their cost estimates for treatments among the 12 pilot communities are the "only ones on the table." That suggests that their proposals might likely become the default path forward, then carried to the remainder of the 170 disadvantaged communities identified by this proceeding. AB 2672 and the subject residents desire an improvement in their energy provision without cost increase, and the IOUs have suggested a roadmap that might accomplish this.

CaliforniaGeo / The Grey Edge Group wishes to share a different perspective that incorporates the needs of AB 2672, that moves toward Beneficial Electrification, and that offers the potential to eliminate site emissions in these communities.

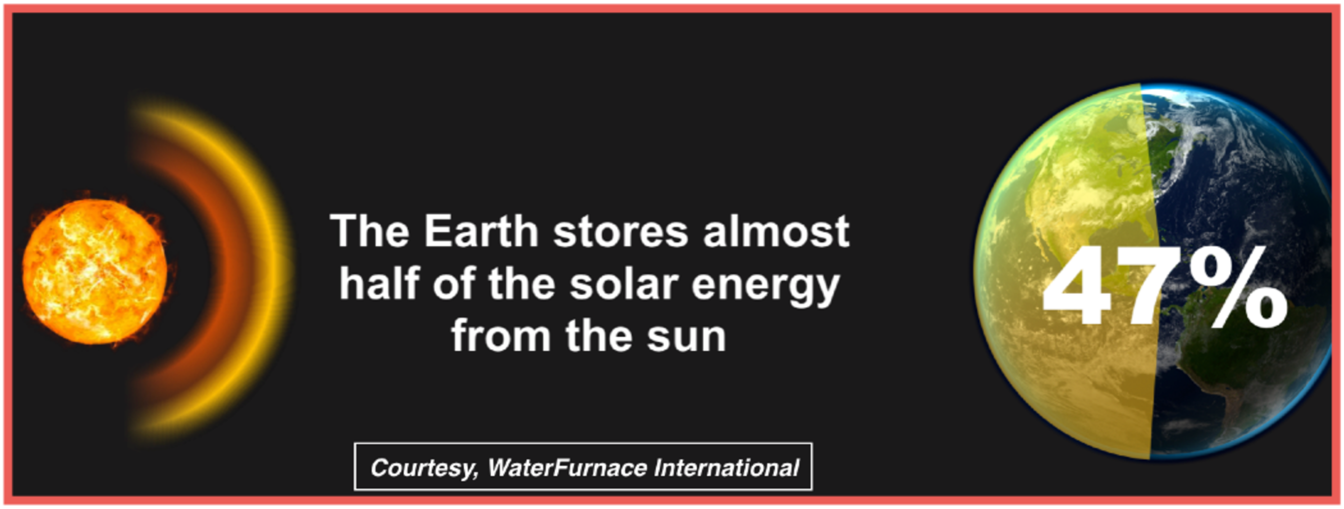
The renewable geothermal resource we use is located everywhere in near-equal measure. *[Note: The earth's thermal battery we connect to has absolutely nothing to do with hot rock and steam systems at random sites that generate grid electricity.]* We can improve the rate of California's progress on AB 32's policy targets by a shift to renewable energy for heating, cooling, and hot water that ought to be tested in these pilot projects. Residential conversion to all-electric energy delivery via geothermal heat pumps (GHPs) is the best technology to accomplish these goals and is deserving of a place in the pilot projects.

CaliforniaGeo / The Grey Edge Group is ready to partner with any other party (especially the IOUs, or as directed by the Commission) to see that a valid experiment is developed and built into one or more of the 12 pilot communities. We recommend that such a pilot ought to include geothermal heat pump deployment in at least two communities among the 12, where individual residential ground loop systems would comprise one approach and a district-based common loop system would be used in a separate community.

It is worth mentioning that community-aggregated solar PV was proposed for some of the all-electric pilot projects by electric IOUs. An off-site geothermal district loop's borefield could effectively reside underneath that ground-mounted PV installation, reducing land acquisition costs, and combining ancillary buildings for this dual-purpose site for even greater savings. Depending on local community development, it is not impossible that a commercial or industrial facility's large parking area could be retrofitted with *elevated* solar PV for shade, and the geo borefield underground for a kind of *triple-whammy* of combined purpose for greater overall savings.

2. ACCUMULATING UNDERGROUND-BASED RENEWABLE THERMAL ENERGY-

Aside from the earth's interior molten core, whose magma reaches toward the outer mantle in a few spots (of the earth's crust) producing geysers, steam, and other evidence of very high heat—all other thermal energy residing in the upper 1,000 feet of the surface derives its energy stability in another way.



Short wavelength solar *radiation* strikes the earth's surface and is converted to heat we know as long wavelength energy. Some of that heat rises to mix with ambient air (giving us higher air temperatures during daytime). The rest travels downward through *conduction*, slowly increasing the temperature of underground layers of soil or rock. That transit, and its storage there, represents the 47% figure illustrated above. This results in *stratification*, meaning the underground formation displays horizontal layers with differing temperatures.

In the case of the three-fifths of the earth's surface covered by oceans, the wavelength conversion to heat is dissipated into water by *convection*, which takes place with all freshwater bodies as well. Particularly in smaller lakes, which lack tidal mixing and/or ocean currents, we often see a *thermocline*. This is a horizontal dividing line where deeper water is not influenced by the near-homogenous temperature of convectively-mixed water above it for much or most of a year.

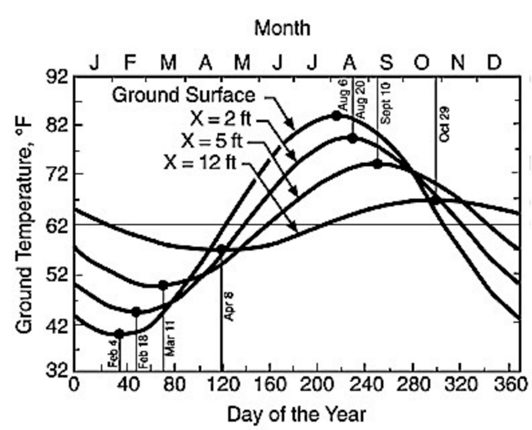


Figure 4. Seasonal soil temperature change as a function of depth below ground surface for an average moist soil.

Terrestrially, the deeper a heat exchanger is placed, the more unchanging is the temperature of the formation it occupies. Below 25 feet of depth, the temperature never changes. That is why vertical drilling, with grouted geothermal boreholes as heat exchangers, has great advantages for the most stable thermal capacity, while also saving land space. [This is about the *heat source* we want to access. More later on the dissipation of unwanted thermal energy resulting from using the earth as a *heat sink*.]

3. ARGUMENTS FOR CONNECTING RESIDENTIAL HOUSING TO THIS RESOURCE-

Connecting residential housing to the earth's thermal battery has long been recognized as a viable technology that remains a mystery for too many citizens. If the only people you talk to about HVAC (heating, ventilation and air conditioning) are "cookie-cutter" building contractors or those representing self-interested businesses, you may end up with purely conventional approaches not representing *your own self-interest*.

Xiaobing Liu, Ph.D., CGD, LEED AP
Oak Ridge National Laboratory's Building Technologies Research & Integration Center
HIDDEN TREASURE
Potential Benefits of Residential [Ground Source Heat Pump] Retrofits
for The California Energy Commission, March 21, 2013

Page 6—

"Increase awareness of public, especially the policy makers, about the potential benefits of GSHP retrofits in residential buildings:

- Savings in primary energy
- Reduced carbon dioxide (CO2) emissions
- Reduced summer electrical peak demand
- Savings in consumer energy expenditures

Inform potential investors about the economics of residential GSHP retrofits
Facilitate the development of a roadmap for the GSHP industry"

Dennis Murphy, GroundSource Geo, Inc. July, 2011
PROJECT NEGATHERM
Prepared for: The California Energy Commission
Publication Number: CEC-500-2011-025 Contract Number: GEO-07-007

From the Preface, Paragraph 1—

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

From the Abstract, Paragraphs 2 & 3—

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

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

4. HEAT PUMPS & AND HOW GEOTHERMAL HEAT PUMPS (GHPs) OPERATE-

Modern, electrically-driven HVAC equipment uses refrigerant-compression technology that does not create heat, but rather concentrates it and transfers it to a location we want. Compressors and other devices perform that work without any involvement from electrical resistance. An appropriate analogy might express it thusly. *"A heat pump is to an electrical resistance-powered radiant heater as an LED (light-emitting diode) lamp is to a (now rare) incandescent bulb."*

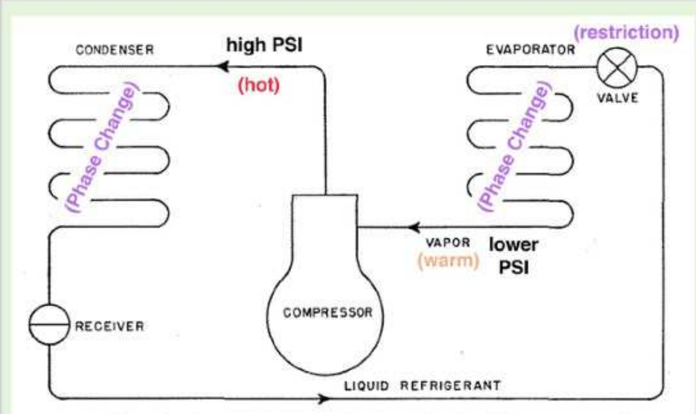
What is refrigerant-compression?

Multiple devices in our lives demonstrate where and how refrigerant-compression equipment provides leveraged thermal benefit. Let's start with two common examples. Most of us have a refrigerator-freezer in our home. If that insulated box stays 38° in the refrigerator section and 0° in the freezer section, this was accomplished even though the refrigerator is surrounded by 70° household air.

If you're driving your air-conditioned auto during summer, you might turn on the A/C as you start to experience an interior temperature above 75°. But if it's 95° outside and 135-150° under your hood, how can you possibly receive 50° air that's cooler than everything else that surrounds you?

The answer lies in the science of physics, more specifically the phenomenon of Phase Change that takes place in some chemical compounds. These are boundaries between a substance's existence as a gas, a liquid, or a solid. H2O works this way, and you know it as steam, water, and ice. The boundary between each of these states of existence requires adding or subtracting large amounts of thermal energy to enable the conversion.

All "refrigerants" are synthetic, man-made compounds with custom-designed phase change temperatures for their two desired states of liquid and vapor. They work in a closed refrigerant loop under great pressure with help from four devices present within that loop. One is an *evaporator* (where liquid refrigerant is warmed into becoming a gas). Two is a *condenser* (where a gas is returned to a liquid state). Three is a *compressor*, which pushes gas into a very small space (and therefore super-heats it). Four is a *thermal expansion valve* that restricts the flow of liquid refrigerant. Evaporation, compression, condensation and back to evaporation is a continuous cycle for the refrigerant—but in the process, it concentrates thermal energy from one location to another, endlessly.



Basis for the heat pump is the standard refrigerant cycle.
(Bill Holladay from Engineering & Science Weekly October 1948, Page 8)

Heat Pumps-

Heat pumps can concentrate and deliver thermal energy where desired from a heat "source" (for the heating function), and can concentrate and reject unwanted interior thermal energy to a heat "sink" (to provide cooling). This dual function is possible because of a *reversing valve* that can change the flow direction of the refrigerant when commanded by a thermostat. There is also a reversal of function between what formerly served as an evaporator and what would now serve as a condenser.

When any heat pump provides **heating**, it uses thermal energy from a heat *source* (which exists at a temperature far below what your thermostat is set for), takes it to the *evaporator*, and changes refrigerant from a liquid to a gas. Once this happens, the compressor squeezes that gas and dramatically raises its temperature. The hot refrigerant moves to the *condenser*, where it returns to a liquid state, but only after lots of thermal energy was transferred from that condenser into your home.

When any heat pump provides **cooling**, your home's excess thermal energy is used to power the *evaporator* (that initially contained liquid refrigerant), sending that gas to the compressor where it's made very hot. The hot gas travels to the *condenser*, where that load of unwanted thermal energy is transferred to the *heat sink*. In either heating or cooling function, the electricity consumed by the heat pump is used only for concentration and transfer of thermal energy. Before heat pumps were common, *electrical heating* meant "resistance," or electric friction as seen in your kitchen's toaster. In that case, it was the electricity (by friction) that made the heat—but at exceptionally high cost to you and a greater grid load for your utility.

Efficiency-

Starting with **heating**, the means of comparing efficiency among heat pumps is a value called Coefficient of Performance **(COP)**. All heat pumps are tested under controlled conditions and are not labeled for performance until these tests are certified by a third party. The COP is a comparison of the thermal energy a heat pump can transfer, compared to the electrical resistance heat output gained from one Kilowatt hour (KWH) of electricity. Resistance output per KWH is a constant of 3,413 British thermal units (Btus). If a heat pump was capable of producing 6,826 Btus for heating with one KWH, it would possess a COP of 2.0, because 6,826 ÷ 3,413 = 2. Put another way, it performs twice as much thermal work with the same amount of electricity consumed.

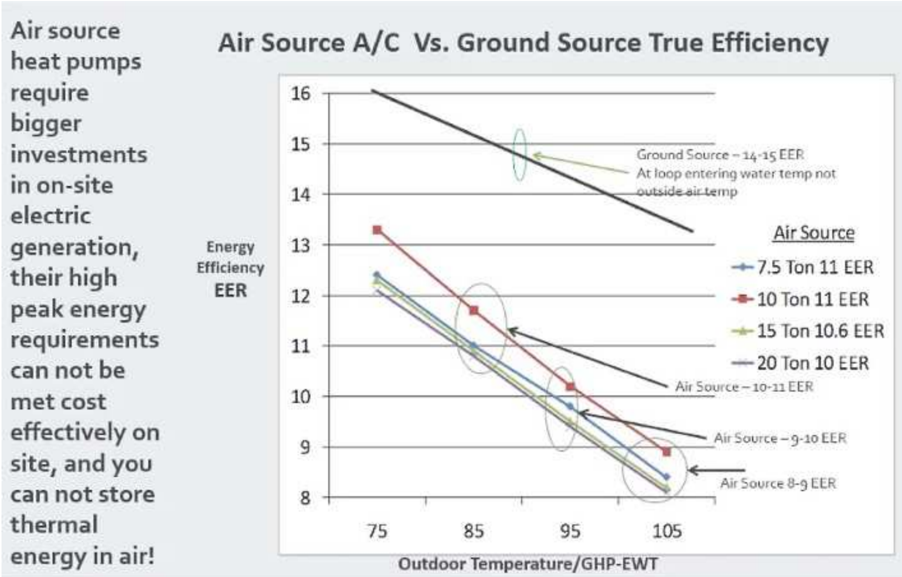
In **cooling** efficiency measurement, electrical resistance does not enter the calculation. The original term for cooling efficiency was Energy Efficiency Ratio **(EER)**, where output in Btus per hour was divided by electricity consumption in watts. If a heat pump (or air conditioner) could provide 19,000 Btus/hour of cooling while consuming 1,900 watts (1.9 KW) it would have an EER of 10, because 19,000 ÷ 1,900 = 10. The Outdoor Air Temperature **(OAT)** for EER calculations was originally pegged at a fixed 95°. It represents the heat "sink" into which the equipment is attempting to push unwanted heat.

In the last two decades, the air conditioning industry has preferred a rating called the *Seasonal Energy Efficiency Ratio* (SEER). Here, the performance of cooling equipment is evaluated based on average temperatures in a particular climate zone against which equipment would have to work over an entire cooling season. This rating is not popular with all mechanical engineers, as it provides less precise information to consumers.

For example, two identically-rated air conditioners (or air-source heat pumps) would not perform identically if one was located in Sacramento, California, and the other in Las Vegas, Nevada. Cooling loads in the latter are far greater, and the equipment's efficiency would suffer (thus rendering the SEER rating number less predictive for a Las Vegas consumer).

Geothermal (or ground source) Heat Pumps (GHPs)-

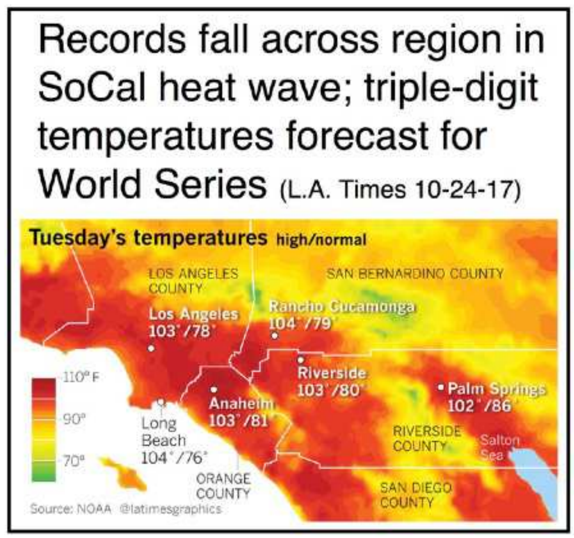
GHPs are the best performing cooling equipment, partially for reasons related to the SEER dilemma above. This is because their heat sink and ground loop design operates independently from 95° air, (or something even hotter, as in the south San Joaquin Valley).



They also skip the operational efficiency penalty suffered by every kind of air-based equipment.

On hot days, when interior space demands cooling for comfort, the air-sourced equipment is asked to provide it against what is much closer to the highest outside temperature of the day. In addition, the medium used to reach the heat sink is hot air itself, via *convection*. There is no way to store morning air temperatures to displace the more challenging heat sink of the afternoon.

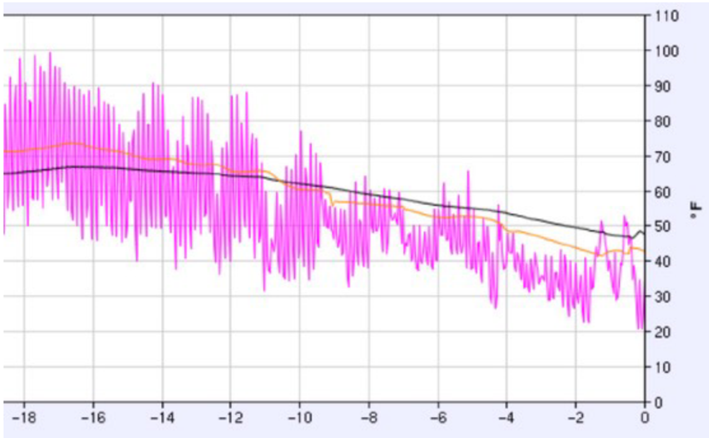
During cooling, geothermal heat pumps use a *heat sink* with a temperature likely under 75°, and they do it with water, or treated water, as the transfer medium, which is over 3,000 times as dense as air. This makes for improved heat transfer via *conduction*. And in nearly all cases of residential application, GHPs are equipped with de-superheaters to pre-heat hot water. This is a second (smaller) liquid-to-liquid heat exchanger inside the GHP using its post-compressor gas to pre-heat hot water for free in the cooling cycle. The rest of the thermal load is sent through the main liquid-to-liquid heat exchanger and into the ground loop for dissipation. The EERs of such equipment are much higher, and they remain that way, no matter what time of the day or night they operate for cooling.



Greater Efficiency-

To summarize the difference in efficiency between GHPs and air-sourced air conditioning, it should be remembered that greater efficiency also translates to less power consumed. Cooling equipment is rated in "tons" of capacity. That reflects the number of Btus required to melt a ton of 32° ice, turning it to water at 32°. Compared to standard air conditioners or air-sourced heat pumps, the GHP saves between .55 and .7 KW per ton of capacity. That means that if a 4-ton GHP is running in the cooling mode, it might be using 2,800 watts LESS THAN air-sourced equipment, while still producing free hot water.

This efficiency premium is very utility-friendly, particularly on hot afternoons which tax the grid. It's all possible because of the GHPs connection to the earth instead of to hot outdoor air above ground.



Consider the nearby graphic with vertical lines of magenta in color. These represent daily highs and lows of outdoor air temperature over an 18-week period in the summer-to-fall period of 2018. The lateral orange line is the underground temperature at a 3-foot depth and the black line represents underground temperature at a 7-foot depth, where this system's horizontal heat exchange piping resides.

As this 18-week period continues into the winter heating season, notice that the majority of the magenta color shows outdoor air temperature well below the temperature of the black line where the GHP will be working. The result of this is the flip side of the GHP's summer advantage, now present during its winter heating function. Instead of an air-sourced heat pump laboring to pull thermal energy out of ever-colder night time air, the GHP is tapping a richer thermal heat "source," again using less electrical power.

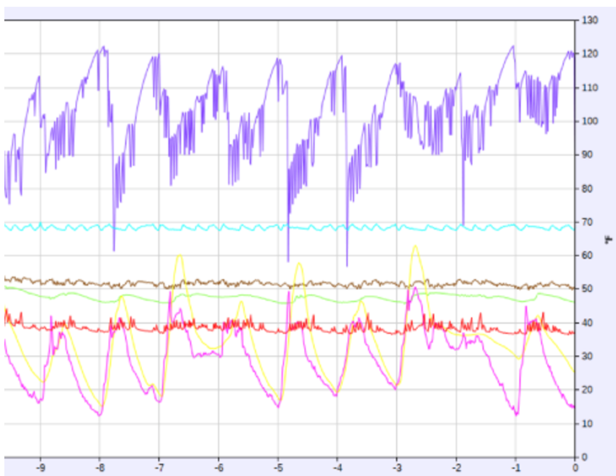
No defrost penalty with GHPs-
As someone who has lived in homes equipped with both air-sourced and ground-sourced heat pumps, this writer can testify to one last penalty experienced with the former. It's called the "defrost cycle," and it can consume significant amounts of energy. Air-sourced heat pumps in the heating mode have to gather heat only from the outside air mass. To accomplish this they will have to convey fan-driven outdoor air past an "evaporator" coil.

Here's the scenario. The thermostat falls below set-point and calls the equipment to produce heating. This is because the structure has been losing heat to the outdoors, and this situation is likely to continue during the night time hours and into the morning. As cooler air passes the colder evaporator, moisture from that air can condense on the evaporator coils. In cold weather, particularly if the air is moist, the continuance of that condensation produced can turn to ice in proximity to that "cold coil." *[You can't achieve heat transfer if you don't have a thermal gradient to initiate it.]* The ice obstructs the former path for air to accomplish its role in evaporating the refrigerant, decreasing the equipment's efficiency. The air-source heat pump is designed to perform a defrost cycle to melt such ice so that optimum airflow across the evaporator can resume.

As can often be the case, a thermostat is not yet satisfied when a defrost cycle is necessary, so here's what happens. Electric resistance coils located in the ductwork's plenum are activated to continue ducted warm air delivery to occupants while the compression cycle reverses into cooling mode, thus sending hot refrigerant to the outdoor coil to melt that ice.

The efficiency penalty here is that thermal energy that might be delivered at a COP of 3 temporarily degrades to a COP of 1, while wasted energy is focused outside to melt ice. This is why the earliest air-sourced heat pumps of the late 1950s (without defrost cycles or resistance boosters) delivered very unpopular cold air to occupants. Such heat pumps were not installed other than in southern states.

A winter performance example-
A 10-day snapshot of this writer's 3-ton dual-speed compressor GHP that serves 3,265 sq. ft. of conditioned space is shown during February, 2018. Temperatures are a bit colder than normal during this period, and this northern Sierra location at 3,500 feet carries an ASHRAE winter design temperature rating of +10°F. I direct your attention to the graphical plots of purple, turquoise, red, (and magenta, once again our outdoor air temperature).



The magenta plot shows the day's highs and lows. The bottom edge of the red shows the temperature of the entering water (EWT) to the heat pump's main heat exchanger (in this heating example, it's serving as the *evaporator*). The measured ground temperature at 7-foot depth during this snapshot was at 41°.

The turquoise plot is the temperature at the Zone 2 thermostat, located in our home office. Notice how steady that temperature is due to regular calls from the thermostat to the heat pump. *[While this set point may seem low, we are comfortable at a setting of 69° because of a central humidifier that keeps us at 40-45% relative humidity during the winter.]* The purple plot is the temperature of potable water exiting the GHP's de-superheater, a small heat exchanger that accepts the compressor's hottest gas. This water loops to and from a 50-gallon hot water storage tank serving as a pre-heat for the main 82-gallon electric water heater and the home interior's hot water circulation loop. Notice the achievement of 120° output that feeds the downstream resistance water heater. The dips in these temperatures represent the effect of household hot water use when lost water volume is replaced by 45° water from the street connection.

[Full disclosure] While summer cooling's de-superheater output is "free," this wintertime production is not. The de-superheater scavenges the hottest compressor gases, putting them into hot water while diminishing the output at the condenser that serves the ductwork. While this causes the GHP to run longer to satisfy a thermostat, this is not a waste. Hot water made by the heat pump is gained at a COP of 4.9 on this unit when running on low compressor (which this GHP does 90+% of the time). The 82-gallon electric resistance water heater consumes electrical power at a COP of 1.0. To put it simply, the de-superheater is providing hot water at a ratio of 1 ÷ 4.9 = .0204. That means this hot water was made for a fifth of the expense of electrical resistance. On low compressor, this GHP consumes just under 1,800 watts, to deliver 21,800 Btus/hr heating plus 3,100 Btus/hr for hot water pre-heat when the EWT is at 40°F. My wife's hairdryer consumes more than that. This building has a heat load of 17,500 Btu/hr @ 10°F.

5. GEO HEAT PUMPS' CONTRIBUTION TO CALIFORNIA'S ENVIRONMENT & POLICY-

As the outstanding HVAC equipment on the market, GHPs can make progress on a number of fronts in support of California's environmental policy goals. Let's take a look at these.

Water-
California has a definite drought tendency.

In connection with R.15-03-010, residents among 170 disadvantaged communities might now use the least expensive form of cooling (evaporative). GHP retrofits to those dwellings would provide cooling with no water whatsoever, and dramatically limit indoor humidities currently tolerated in order to cope with summer's extreme outdoor heat in the San Joaquin Valley.

As previously mentioned, GHPs operate on significantly less electrical demand (amperage) than their air-sourced cousins or regular central air conditioning. This means less transmission by the electrical utility is required, and if supply power originated with a thermal power plant, less water would be consumed by evaporation in the plant's steam-condensing loop. As more of the grid is powered by sources other than steam-turbines (particularly by renewables), water savings would diminish. However, the compensating factor is that as the grid becomes greener, renewable power is supplying all GHPs, whose thermal extraction becomes a 100% sustainable, renewable operation. <u>That</u> is a virtuous loop.

Heat "Islands"-
Air-sourced cooling equipment dumps its unwanted heat into ambient air. If there is no wind to disperse it, neighborhoods with air-sourced cooling rise in temperature, resulting in greater challenges to cooling equipment. While it's true that this is more likely in city scapes with high residential density, it is still possible in suburbs under low-wind conditions, where fences and trees slow the dispersion of unwanted heat.

Anything that causes HVAC cooling equipment to run longer to achieve results, or to operate less efficiently, is a challenge to preserving quality of life (with silence) for humans and other animals. If they are de-superheater equipped, GHPs help occupants re-purpose thermal energy into hot water, and partially displace conventional water heating needs.

Raw Materials-
Once installed, GHP equipment performs all necessary heating AND cooling in a single unit. They last longer than conventional equipment, therefore requiring less frequent replacement and disposal. A geo heat pump is good for 25-to-30 years and its ground heat exchanger for 200+. One 1970s model worked for 35 years in Stillwater, OK, with only minor maintenance before it was replaced with more modern and efficient equipment—but it was still performing after more than 400,000 hours of use. Part of this longevity is due to operation against benign underground temperatures approaching the heat exchanger, not the extremes of summer and winter temperatures that act negatively on air-sourced equipment.

Conventional heating equipment operates a combustion flame of nearly 3,000 degrees Fahrenheit in order to heat a building to 75°. Why do we still do that? The firebox temperature wears out its walls more frequently, in part because of this difference. This discrepancy highlights GHP's ability to feature LCC superiority (lowest life cycle cost).

Grid Friendly-
Electric utilities in California struggle most with meeting summer peak generation needs brought about by hot weather and/or lengthy heat waves. The KW reduction metrics of GHPs

have already been shared here. They mean less challenge for the utilities, but a reduction in what might otherwise be thought of as "prime time revenue."

Both geo and air-source heat pumps help balance that seasonal revenue discrepancy. All-electric residences consume electricity throughout the cooler months, particularly for water heating during shoulder seasons when less heating or cooling is required. Conventional heating with gas cannot help in this way. With the exception of year-round water heating, its revenue profile for utilities is upside down—who needs to burn lots of gas in summer?

Electric hot water is stored energy. It can be incentivized by Time-of-Use rate systems and also coupled with Demand Response programs and self-programmed timers. GHPs with larger buffer tanks can also extend balancing for the grid (although not a desirable expense in these project retrofits).

Renewability, Emissions, and Zero Net Energy-

Because of the technology afforded by GHPs, every square foot of terrestrial land surface in California can deliver thermal energy in perpetuity for the benefit of occupants without harming the natural environment. Once a ground heat exchanger is deployed, there is a permanent, free heat source and heat sink available at no cost and near-zero maintenance expense. NASA performed simulated long-term testing on the kind of HDPE (high density polyethylene) pipe used in heat exchangers and stopped testing when it reached 200 years.

This kind of pipe was pioneered by the gas industry in the 1950s. The lack of unnecessary underground mechanical joints, connectors, and metallic fittings from the heat fusion process of connection ensures trouble-free delivery. HDPE is tough, flexible, chemically inert (corrosion-proof, inside and out), and since it carries only low pressure water, there is no wear.

As already explained, GHPs operate by thermal *conduction*, not by thermal *combustion* (like conventional heating does with gas). This results in a zero emissions platform that yields an environmental improvement from every GHP retrofit completed. It further avoids emissions in the construction of all new building stock. This path supports AB 32's 2020 emissions target, while reaping all possible air quality improvements for the pilot communities' residents in support of their respiratory health.

California has a policy that all new residential construction by 2020 must become Zero Net Energy. Unfortunately, this goal is for "code-defined ZNE." It doesn't mean what ZNE means across the rest of the nation because California uses a complicated definition using the phantom term TDV (time dependent valuation). This is a construct that preserves carbon combustion in new buildings by virtue of the phrase "cost effective," which pits the current cost of electricity for all-electric buildings with heat pumps against cheap natural gas.

This fig leaf to preserve the installation of gas furnaces, boilers, and hot water heaters through Title-24's regulations is disingenuous because the price of electricity incorporating more (free) renewable sources will fall with greater deployment of those resources—while buildings equipped with gas will belch emissions for decades-to-millennia. These regulations provide no accommodation for a builder inside gas distribution territory who wants to offset any fraction of their building's expected electricity use with renewables. That sounds more like a protected business model than a path to efficiency with lowered emissions.

Efficiency and GHPs-

The following page contains a study on behalf of the California Energy Commission by UC Davis' William Glassley that saw GHPs very favorably, yet the CEC does not adequately support them. Please review 2012's AB 2339 to further understand why this policy is a dis-connect from California's stated environmental goals.

Glassley, Asquith, et al for the California Energy Commission, April, 2012
ASSESSMENT OF CALIFORNIA'S LOW TEMPERATURE GEOTHERMAL RESOURCES: GEOTHERMAL HEAT PUMP EFFICIENCIES BY REGION
Contract Number : 500-08-017

(entire) ABSTRACT

California has a broad inventory of geothermal resources. High temperature geothermal systems are well recognized and have been an important part of California's renewable energy portfolio for many years. The low temperature resource, however, has remained inadequately characterized and developed, especially the technology that can be used for heating and cooling homes. This project evaluated the potential impacts of using geothermal heat pump systems in residential buildings. This study developed a residential building standard, based on United States census data, and used this standard to compute heating and cooling loads in the state's 16 distinct climate zones. Commercially available software was then used to design geothermal heat pump systems for each climate zone based on the electricity load calculations. The impacts on energy use by climate zone and on emissions of carbon dioxide, nitrogen oxides and sulfur dioxides were evaluated as well as natural gas displacement. The results showed that significant reductions in energy and natural gas demand and emissions would occur with geothermal heat pumps in 15 of the 16 climate zones. The energy use savings and emissions reductions (between about 20 and 70 percent) indicated that deploying these highly efficient systems could dramatically reduce energy consumption and atmospheric emissions statewide.

(excerpt from) Conclusions

"Deploying geothermal heat pump systems in California has lagged behind many other states. The reasons are many including a lack of information regarding the potential benefits of such systems. Additionally, the performance of these systems is sensitive to many variables, including local climate patterns and geological properties. This variability has made it difficult to provide general guidance to prospective users. Without clear information regarding the benefits for various regions, and lack of financial incentives that exist for other energy efficient and renewable energy technologies, there has been little incentive to pursue their use. This report provides an initial evaluation of the impacts geothermal heat pump systems may have on energy use and emissions of CO2, NOx and SO2.

This analysis show that energy use would be reduced in fifteen of California's sixteen climate zones and virtually unmodified in the remaining climate zone. Energy savings ranged between 22 percent and 77 percent, with an average savings of 44 percent by climate zone. Taking into account variation in population across climate zones, the potential energy savings in the state could be as high as 35 percent of the energy used for HVAC. The climate zones for which the greatest reductions were achieved were those zones dominated by heating demand. Climate zones for which cooling load dominates energy use saw smaller reductions in energy consumption, but were still within the 20 percent to 40 percent range, which is significant.

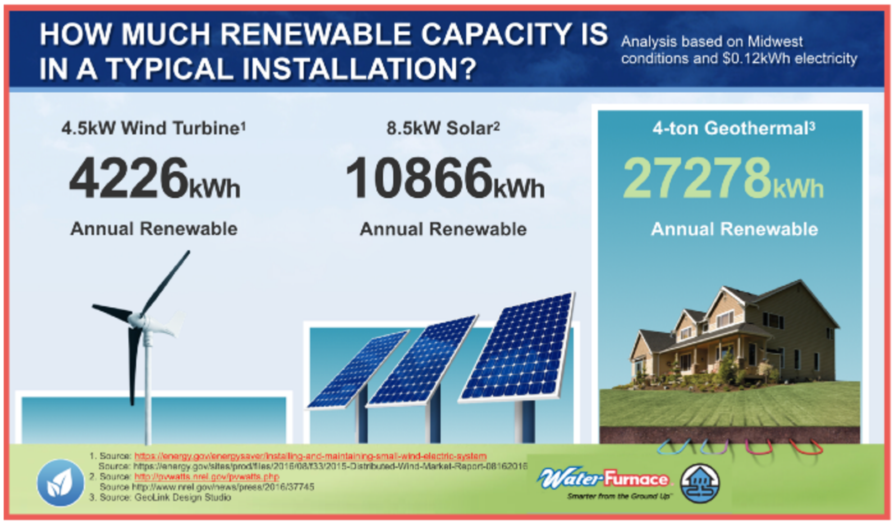
Reduction of CO2 and NOx emissions closely followed those of energy use (on a percentage basis). The SO2 emissions generally increased, reflecting the difference in energy sources in heating and cooling cycles, and the lower efficiency of geothermal heat pump systems in their cooling cycles relative to their heating cycles. Even so, the total emission of atmospheric pollutants was reduced by percentages closely following those observed for reductions in energy use.

These results provide striking evidence that deployment of geothermal heat pump systems on a large scale could significantly contribute to the ability of California to meet its emissions goals, as outlined in Assembly Bill 32 (2006; Global Warming Solutions Act of 2006). In addition, since California uses approximately 35 percent to 40 percent of its energy on building heating and cooling, wide spread deployment of geothermal heat pump systems could significantly contribute to lower energy demand."

Efficiency and GHPs (continued)-

The geothermal heat pump industry has suffered from little support by regulatory agencies in California. For a proven technology, it is certainly less understood than any other heating and cooling system. Nearly half the people I have new discussions with about this technology nod in agreement for 1-to-3 minutes. Then, they ask that devastating question: “How did you become lucky enough to buy land for your recent home’s construction that was directly above geyser-like steam deposits?” They assume I’ve been talking about hot-rock geo-thermal technology.

There are other facts about GHPs of which few are aware. Here are some marketing approaches from one of our organization’s members to correct the “invisibility” of GHPs:



Hopefully the above message is not lost on the observer—that wind is intermittent and solar radiation can only happen in the best of daytime hours without occlusion by clouds. A GHP can displace a much higher quantity of what would otherwise be less efficient heating and cooling by conventional means. GHPs improve progress on emissions reduction.

6. SAMPLES OF GHP DEPLOYMENT IN CALIFORNIA AND OTHER JURISDICTIONS-

What follows is a series of technical narrative excerpts and images that depict geothermal heat pump installations in a variety of locations. Some are very large installations. A couple of points should be emphasized. Many are public, non-profit facilities, yet the decision was made to seek and install this technology, even without any useful tax credit. That strongly suggests that these entities felt that long-term renewable energy provision via a thermal connection to the earth was worth the effort on a public-financed basis.

For municipal, tax-funded facilities, this strategy committed current financial resources whose long-term savings will exceed utility bills over the useful life of the building. This choice was an alternative to seeking lowest first costs for HVAC operations. For jurisdictions looking to minimize taxpayer expense, this can be seen as an improved fiscal strategy.

Private developers of office and commercial space act on long-term financial strategy as well, but make an additional bet that by green reputation and enhanced indoor occupant comfort, they will enjoy lower vacancy rates and more satisfied clients.

As greater numbers of buildings are equipped with geothermal heat pumps using either individual heat exchangers or district-loop heat exchangers, we will see a larger specialty labor force and a reduction in per-unit equipment and infrastructure costs. This will magnify reduced first costs for projects and provide significant improvement in both grid security and reduced emissions.

———————————————————————-

A sample of geothermal heat pump-equipped projects/facilities in California:

Feather River Community College, Quincy
San Francisco City College
Ohlone Community College, Fremont
The Buck Institute for Aging, Novato
Delta-Americas Headquarters, Fremont
Walter Annenberg Center, Rancho Mirage
Sonoma County Water District, Santa Rosa
Fuel Processing Laboratory, Edwards AFB
Fort Hunter-Liggett Army Base
NASA-Ames Center Office, Mountain View
Indian Valley College, Novato
Mission Community College, Santa Clara
Santa Rosa Junior College
The Embarcadero Center, San Francisco
Rancho Los Alamitos, Long Beach
Mendota State Prison, Mendota
Bardessono Hotel & Spa, Yountville
Fort Irwin Army housing, Mojave Desert
Ash Meadows Nature Center, Mojave Desert
Lucas' Big Rock Ranch, Marin County

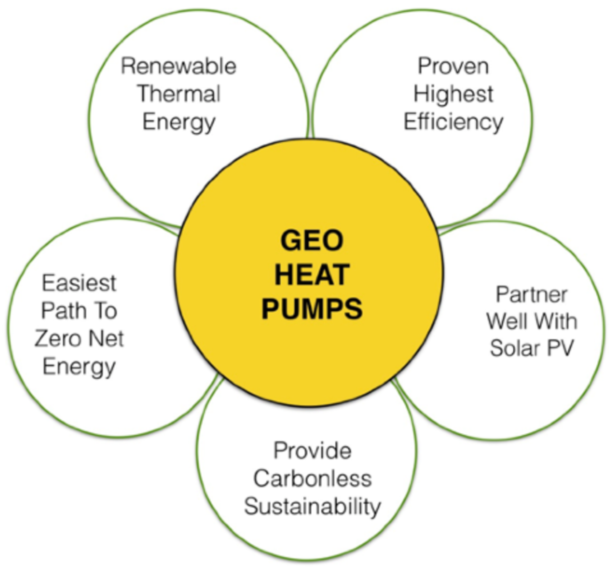
Under Construction (or future)

George Lucas Museum, Los Angeles
Google Headquarters, Mountain View
San Francisco Shipyard Project

A sample of geothermal heat pump-equipped projects/facilities (outside) California:

State of Washington Department of Environment Headquarters, Olympia, WA
Montana State University (retrofit of central campus buildings), Bozeman, MT
Ball State University (total conversion to Geo and abandon central coal) Muncie, IN
Weber State University (stepped abandonment of central fossil plant) Ogden, UT
ASHRAE National Headquarters (geo vs air-source in same building) Atlanta, GA
IKEA retail centers in Merriam, KS, Dallas, TX, and Centennial, CO
Pinellas County Emergency Operations Center, Florida
Nashville County International Airport, Nashville, TN

William L. Buck Elementary School (retrofit of 1940s facility) Valley Stream, NY
Lady Bird Johnson Middle School (ZeroNet Energy facility) Irving, TX
Colorado Mesa University, Grand Junction, CO
City of Fort Collins Municipal Center (retrofit), Fort Collins, CO
Multiple Fire Departments (new and retrofits) Issaquah, WA and (Denver area), CO
Whisper Valley mixed use development on district loop for 7,500 units, NE Austin, TX
Gibsons, B.C. (Canada) 750 unit central geo loop system
Uinta Basin Medical Center Distributed Energy System, Roosevelt, UT
Adams Crossing, a 750 acre mixed-use development, Brighton, CO
Cashman Equipment Headquarters, 500,000 sf, Las Vegas, NV
State of Oklahoma Capitol Complex, Oklahoma City, OK
State of Massachusetts Capitol Complex, Boston, MA
Port of Portland Office Complex, Portland, OR
The Bullitt Center Office Building (ZNE, and LEED Platinum) Seattle, WA
Josephine Commons (senior and affordable) housing project, Lafayette, CO
U.S. Army housing at Fort Bliss, TX Fort Sill, OK Fort Rucker, AL, Fort Mead, MD
Fort Leavenworth Federal Prison, Leavenworth, KS



The "blossom" of Sustainability

From Governor Brown's Website (circa 2015):

"Investments in clean energy produce two to three times as many jobs per dollar as gas, oil or coal. And dollars invested in clean energy tend to stay in California, instead of going to other states or other countries. Clean energy jobs and businesses have grown much faster than the economy as a whole in the past fifteen years, and have continued to grow even during the economic downturn."

First EcoSmart, ZeroEnergy Community
Whisper Valley in Austin, Texas

(a Public Improvement [utility] District)

The votes are in— Whisper Valley in Austin, Texas has won the Green Home Builder magazine award for Community of the Year 2017.

2,000 Acres 1,429 Acres as Developed Property
2,848 detached single family residences
2,668 multi-family units, 217 acres of commercial development
38 acres of mixed use development
All buildings served by a "district-style" heat exchanger

Discussion of the Design Principles and Construction Features of “District” Geothermal Heat Exchanger (GHEX) Systems

Cary Smith, CGD CEM CEA CGI
Owner, Sound Geothermal Corporation and Principal of The Grey Edge Group

(These design excerpts come from a district loop proposal for Adams Crossing, a 750 acre mixed use development in Brighton, Colorado.)

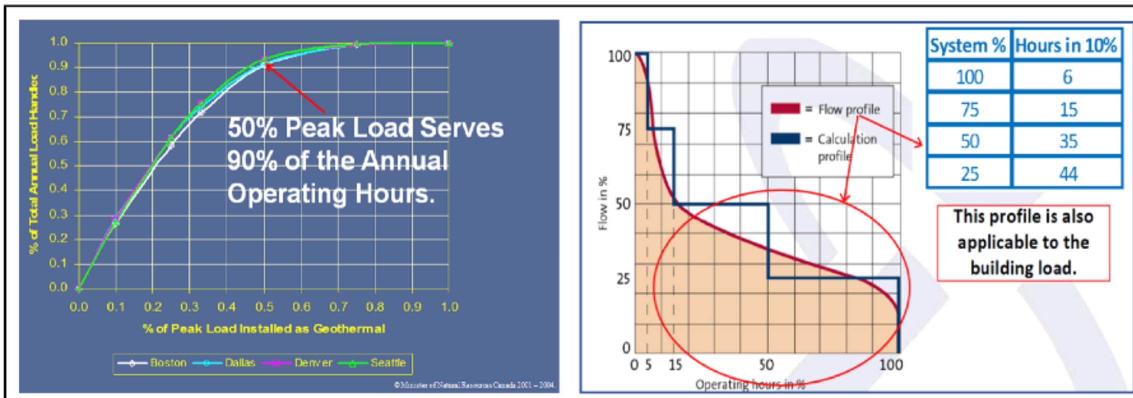
The system concept is to provide a hybrid, ground coupled heat pump (GLHP) system for the full Adams Crossing project. The central feature will be a series of connected loops, similar to a domestic water distribution system, which will connect to all buildings on the project. These loops will be designed to be added in phases as the project moves towards completion. The sizing will be flexible and designed to enable changes to the development plan. We will call this the Central Loop (CL) or, yielding to conventional system nomenclature, the condenser loop. All buildings on the system, for the most part, will heat and cool using extended range ground source heat pumps (GSHP). The Central Loop is the “Energy Highway”.

Example 1: A building in heating, using the GSHPs, will reject the energy from the building to the CL which will move the warmer fluid to a building that needs some form of space or water heating. Pulling energy out of the fluid will cool the fluid. In turn the now cooled fluid will circulate back to the first building. The net result will be to make both sets of heat pumps work more efficiently.

The starting point for the design will be to size the various components, conventional and renewable, such that the primary energy source/rejection of all buildings on the system will be the shared energy between the buildings. This is the “least energy path”.

We have access to significant depth, earth temperature data, and thermal conductivity data in this area. All current data indicate advantageous conditions for ground loop placement and drillability. Although testing is mandatory because of the range of thermal conductivity values in off-set sites, we anticipate that we may be able to drill boreholes in the neighborhood of 600 feet thus conserving surface area. In addition, a horizontal loop component may be attractive, reducing installed cost of the Central Loop’s associated ground coupling.

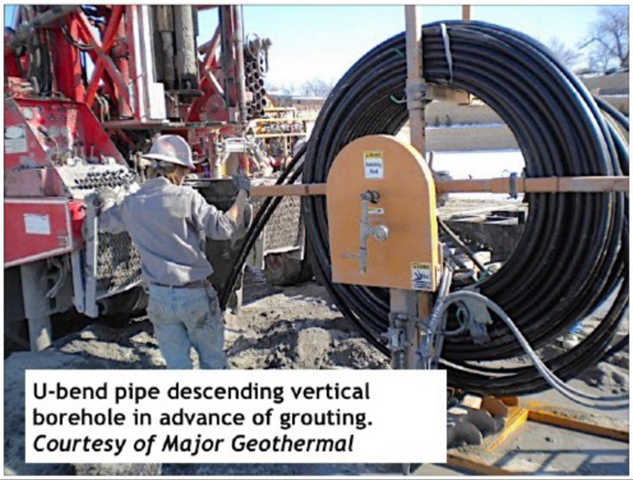
We are able to help regulate energy consumption or shift the whole project’s energy demand profile. This provides significant economic advantage for the system. The whole process of moving and storing energy is called Waste Energy Recovery. In a figurative manner of speech, using and reusing the same energy over and over and, in short, makes the system an energy utility. This unique concept permits charging for the energy both in and out of the building. The key points are: recover, store, and reuse.



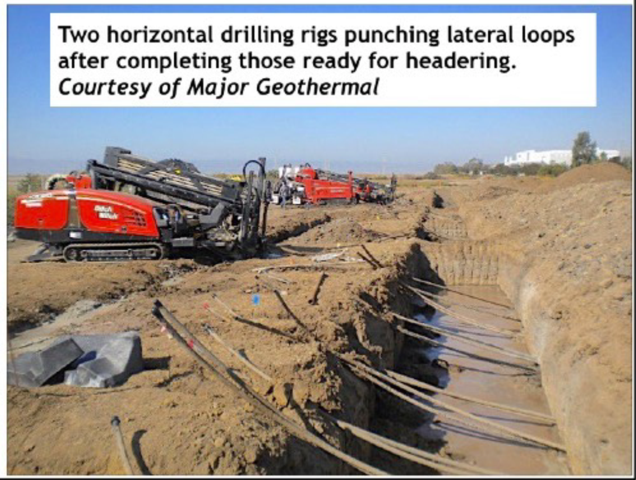
Experience with Central Loop Systems over the past 15 years has lead us to the point in our Central Loop design that we start with a goal of building the ground loop to handle 40% to 60% of the total load with the conventional component taking up the balance of the load. The reason for this is continued proof that an HVAC system will operate at or below 60% capacity for over 90% of the conditioning hours of the year. The conventional equipment is only required to operate during the hottest or coldest part of the year.

Sample Drilling Techniques, District Loops and Circulation along the “Energy Highway”

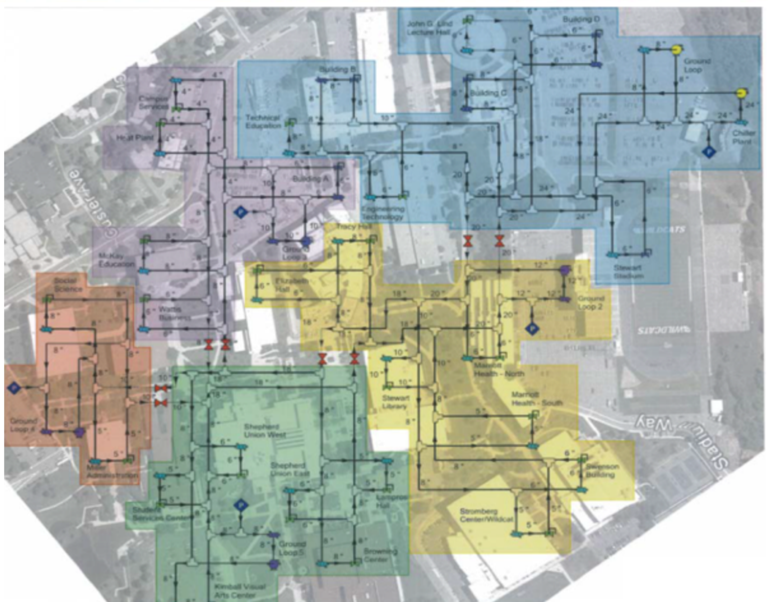
Examples of drilling rigs used for horizontal borehole closed loop installation and loading of u-bend ground loop assembly (Delta Americas headquarters, Fremont, CA).



U-bend pipe descending vertical borehole in advance of grouting. *Courtesy of Major Geothermal*



Two horizontal drilling rigs punching lateral loops after completing those ready for headering. *Courtesy of Major Geothermal*



Planned build-out of Weber State University’s district loop to abandon a previous central fossil boiler system

Central mechanical room for district loop circulation at Ball State University (the nation’s largest system)

Central mechanical room for district loop circulation at Colorado Mesa University

Fire Station #10
West Metro Fire Protection District
3535 South Kipling Street, Lakewood, CO 80226

Facility = Municipal Fire Station
Completion = 2009
Distributed water-to-air packaged heat pumps

Conditioned Space = 14,000 sf
Closed loop ground heat exchanger
Capacity = 29.5 tons

Configuration-

The distributed water-to-air packaged heat pump system conditions the living and administration areas, using seven heat pumps of 1.5 to 8.0 nominal tons. The Ground Heat Exchanger (GHX) consists of 35 Slinky® circuits of 800’ x 3/4” high density polyethylene (HDPE) pipe, with a net operating length of 85’ for a nominal slinky pitch of 9.4:1. Five header pairs service seven Slinky® circuits each. The dimensions of the slinky pit measure 90’ long by 200’ wide, with an installation depth of 7’ below grade and was constructed below an on-site storm retention pond. Circulation pumping between the GHX and heat pumps is redundant for reliability.

Major Geothermal — Major Heating
6285 West 48th Avenue, Wheat Ridge, CO
800-707-9479 www.gomajornow.com

7. SUMMARY-

CaliforniaGeo / The Grey Edge Group possesses the capacity to make the most out of the portion of the 12-community Pilot Projects which deal with conversion to all-electric energy provision. This is a comparative experiment in which we would like to participate.

The heating, cooling, and hot water equipment we advocate for and work with is the most efficient known, while remaining emission-free. This means that for Proceeding R.15-03-010 (not considering added pilot community solar projects), local air quality can improve, electric utility peak generation needs can be reduced, and the electric utilities' load profile can be improved, with more winter off-peak rate revenue to fund infrastructure maintenance and improvement.

We also hope to interest the gas utilities in the paths adopted by the state of New York and the Canadian Province of Ontario, where natural gas lines will not be extended further. Individual geo ground heat exchangers (GHEXs) and district loops will replace them.

These policies are generating programs for utility participation, where support for geothermal ground loops can result in financing opportunities through on-bill financing, thermal tariffs, renewable energy credits, and the chance for perpetual cash flow that compensates for reducing former gas revenue (all in ratepayers' interest).

The public is slowly moving away from fossil-based paradigms, showing strong interest in renewable energy. Financial and investment interests have accelerated their embrace of renewables while souring on carbon. This makes for problems in the fossil industry's business model, but it also provides opportunity for those nimble utilities who follow the trends of migrating investment cash, keeping their shares "desirable" in the eyes of the public, and to earn a public relations "dividend" that can offset unfortunate accidents and/or management errors. It might be a stretch, but we'll say it.

"Paying out cash for a positive PR message to appear green could be less effective than genuinely becoming more and more green over time."

We hope to be contacted in the future by the Commission, the three IOUs involved in this proceeding, or both. We think we have something you can benefit from. Thank you.

RESPECTFULLY SUBMITTED,

/s/ Bill Martin

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Dated: March 2, 2018