

(Completed) CaliforniaGeo's **UNDERGROUND** January 17, 2024.

Contractors Roundtable - The Value of Past Experience

With geo veterans Jeff Brower, Mark Morelli, and Kent Penning

This session was designed for both the consumer who wanted more detail about what and how geo projects were designed and constructed, and the existing mechanical contractor who might want to know what would be needed to expand into geo heat pump contracting.

Take-aways from this *tight* Hour

- **Baseline costs for GSHP specific tools**
- **Ideal skill sets for GSHP contracting**
- **Mistakes and lessons learned**

We were fortunate to have three experienced geo contractors who answered a prepared list of questions from our Education/Training standing committee, and others submitted during the session via a Chat option. Our panel shared the origins of their entry into the business as well as their most (and least) favorite projects. This helped to emphasize cautions for the rest of us and the kind of learning that comes from analyzing and correcting past mistakes.



Jeff Brower

Retired Mechanical
Contractor, Rocklin,
California



Mark Morelli

Air Connection Inc.,
Santa Rosa, California



Kent Penning

Retired from Cold
Craft, Campbell,
California

This was a very effective session with plenty of interaction to benefit our audience. However, a number of the pre-session questions we constructed were not addressed due to time running out. Therefore, a possibility exists that we will build and offer a follow-up contractors roundtable in one of our monthly Undergrounds at a later date.

Geothermal Systems - Case Studies and Lessons Learned

With Clark Bisel, PE, a mechanical engineer with LEED experience

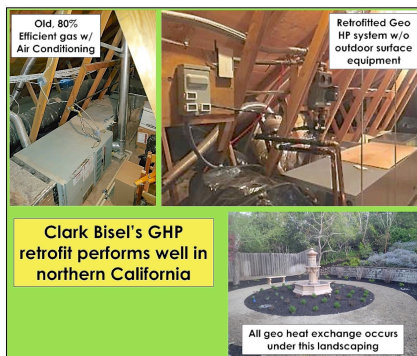
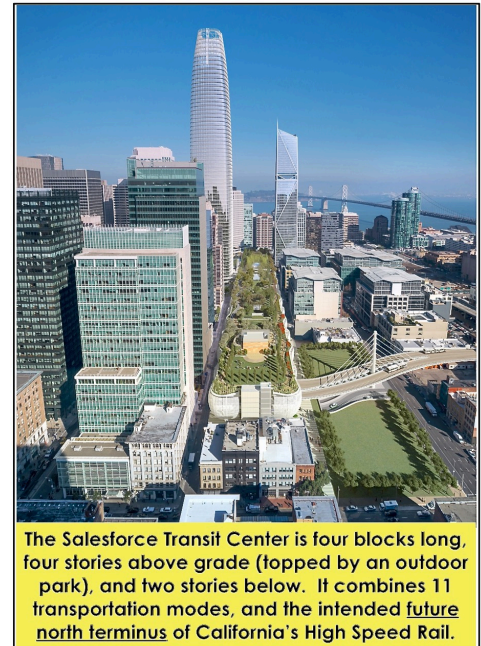


After being part of the formation of the USGBC (United States Green Building Counsel, Clark added this dimension to his design work for a major architectural firm. In today's program, you saw and heard his description of the planning and design work on one of northern California's largest geo projects—the Sales Force Transbay Terminal. It's a building that acts like a central hub for rail,

bus and trolley systems that stretches 50 feet underground with a park-topped facility resting two stories above.

BART (Bay Area Rapid Transit) trains are a short walk away and the future northern terminus of the state's high speed rail system will be accommodated in this carbon-free facility.

There were a number of design considerations that had to be considered, including a future expansion of the facility. Two high tides of salt water approached daily from San Francisco Bay, and the decision was made to use horizontal heat exchanger boring to stay away from salt water incursion.



Clark reported on his own home's geo retrofit to replace a gas furnace and standard air conditioner. The attic mounted mechanical equipment was replaced by geo in the same location and three front yard bores to 350 feet completed the on-site heat exchanger.

Local permitting for drilling vertically was made difficult by unfinished state regulations and low experience from the building department in Contra Costa County. Eventually, officials understood that this was a closed loop borehole and their worries about

water contamination were overcome. Even with expense and complications, Clark completed this challenging retrofit and is pleased that gas is no longer supplying his home. Utility costs are stable, comfort is better, and Clark explained that he would do it all again.

Take-aways from this *tight* Hour

- The reasons to implement a geothermal heating/cooling system
- General energy efficiency of geothermal heating/cooling
- General lessons learned

(Completed) CaliforniaGeo's **UNDERGROUND** August 16, 2023.

Advanced logistical drilling methods by Dandelion in New York

With Kathy Hannun, Co-Founder of Dandelion Energy



Kathy is President and Co-founder (2017) of Dandelion which began operations in central New York. The company has focused on residential retrofits in a region not served by piped natural gas.

After a couple of years of offering full-packaged geo retrofits and handling long-term financing for customers, Dandelion set out to make their program even more efficient, driving a search for drilling methods that were faster and less expensive. (They found it in Sweden.) The Swedes generously allowed access to their methods and equipment, and Dandelion adapted them for use in New York.

For our **Underground**, Kathy generously shared Dandelion's continuing search for efficiency and lower costs for what is the largest geothermal heat pump market segment in the U.S. and most other places—residential retrofit projects.

We learned that Dandelion is a nimble organization, dedicated to ongoing research and development for better ways to reach and serve more customers. Though not trying to spread across the entire U.S., they have recently begun work in Massachusetts with local contractors willing to utilize these new methods. Moderator Bill Martin observes that Dandelion resembles the Japanese car makers' pursuit of "continuous improvement" since the 1980s when they successfully challenged American car manufacturers on quality.

Kathy shared her hope that the installation cost difference between air-source heat pumps and geo heat pumps can be narrowed, allowing greater focus on geo's other benefits, including longer equipment life and greater efficiency.

Hannun has been recognized as a TED Fellow, one of Fast Company's Most Creative People in Business, in *MIT Technology Review*'s "35 under 35," and as the recipient of a C3E Award from the U.S. Department of Energy. She graduated from Stanford with a BS in Civil Engineering and a MS in Computer Science.

Take-aways from this *tight* Hour

- A high-level understanding of how the Swedes approach residential geothermal drilling
- What has translated to the Northeast US (and what has not)
- Could this method translate to California?
- A perspective on future opportunities to further decrease the cost of residential geothermal drilling

(Completed) CaliforniaGeo's **UNDERGROUND** June 14, 2023.

A Geo Utility Can Simplify Large Geo-equipped Projects

With Chris Coley, ORCA Energy



One of the largest, if not **THE** largest hurdles for mass adoption of geothermal heating and cooling is the upfront cost and complexity of installing the underground heat exchanger in advance.

Because it seems simpler and less costly to use traditional technologies for heating and cooling, geo technology is often ignored. Geothermal utilities can solve these issues. They will pay all of the costs and assume full responsibility for the design, engineering and installation of the exterior ground loops and associated infrastructure.

What Does it Do?

*Design & Construction
Integration with other on-site trades
Ongoing maintenance & servicing
Handles all billing and collections*

Developer Benefits

*Zero up-front capital investment
Renewable energy for heating & cooling
Reduced or eliminated carbon footprint
Eliminate cooling towers & outdoor condensers
Continuing loop maintenance by 3rd party*

Chris Coley has been actively installing geothermal heating and cooling systems for over 13 years. His experience is broad, ranging from field services, estimating, and project

management, to handling these for both Geotility Corp and Orca Energy.

Take-aways from this *tight* Hour

- Geothermal as a utility can be used as a tool for gaining new projects by solving some of the largest issues for developers considering geothermal HVAC.
- Geothermal as a utility can turn a considered geothermal project from a financial negative to a positive.

Chris is responsible for all staff in the Pacific Northwest region and leverages his management experience to maintain the highest quality levels for the companies he serves. His current term as a board member of CaliforniaGeo will end on 12/31/25.

(Completed) CaliforniaGeo's **UNDERGROUND** April 18, 2023.

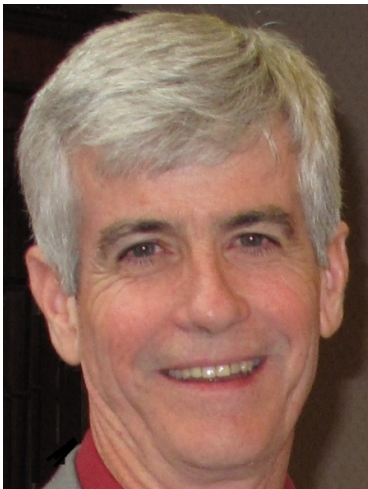
How to Select a Qualified, Experienced GSHP Engineer

With Dr. Steve Kavanaugh, P.E. Dept. of Mechanical Engineering, U. of Alabama (retired)

Owners: Select Your Own Design Engineers

- Architects aren't always the best judge of engineering design quality.
- Often prefer designers who comply with their approach.
- Architect portfolios provide visual appeal, image, function, "greenness", etc.
- Engineer portfolios should provide efficiency, comfort, safety, value, maintainability, etc.
- Negotiation between architects and engineers for owner satisfaction

Steve Kavanaugh is Professor Emeritus (retired), University of Alabama and Owner, Energy Information Services.



Take-Aways-

- Successful firms take responsibility for design of the entire system.
- Successful firms can point to former successes.
- Satisfied owners should participate in satisfaction surveys.

(Completed) CaliforniaGeo's **UNDERGROUND** February 15, 2023.

A Discussion about Geo's Future



The presentation introduced **four “major truths”** that affect the heating and cooling industries for occupied building space.

Terry and Bill followed that with a discussion of FIVE specific questions that are critical for our geothermal industry:

1. Can GSHPs go head-to-head with conventional HVAC?
2. Are there risks with a too rapid an expansion of Geo?
3. Can lower geo system complexity be of help?
4. Are residential design tools reasonably equivalent when properly used?
5. Is geo performance validation a driver of market momentum?

Good equipment, adequate training, better public understanding and strong standards for materials, installation, and commissioning— will help continue the expansion of geothermal heat pump technology. The unifying standard for our industry (at right) will be a big help in accelerating the expansion of GeoExchange®.

Take-Aways-

- Answers from discussion of FIVE questions related to geothermal heat pumps and HVAC.



(Completed) CaliforniaGeo's **UNDERGROUND** December 14, 2022.

Are You Ready for A2L Refrigerants?

Lisa Meline, P.E.



The presentation attempted to 'catch everyone up' on where the HVAC industry is relative to reducing high global warming potential (GWP) refrigerants: the treaties, the policy, and the phase-out schedule.

The effort to phase out CFC's goes back to the Montreal Protocol of 1987 and continues today with concern over greenhouse gas contribution by leakage of common refrigerants used in many applications of heating and cooling. There's a variety of occupational exposure limits, toxicity effects, and flammability concerns. These are described by ANSI/ASHRAE Standard 34-2022, which classifies all refrigerants and mixtures combining them. This provides guidance to the industry for refrigerant choices in various applications.

HVAC equipment's performance potential needs to be matched with its intended refrigerant and tighter GWP standards. The migration to less damaging refrigerants is forcing a re-design of compressors and heat exchangers that will challenge manufacturers to scale-up. This step in the evolution of refrigerants has become one of the steeper ones.

| FLAMMABILITY | SAFETY GROUP | |
|--------------|-----------------------|-----------------|
| | Higher Flammability | A3 B3 |
| | Lower Flammability | A2 B2 |
| | No Flame Propagation | A1 B1 |
| | Lower Toxicity | Higher Toxicity |
| | INCREASING TOXICITY → | |

* A2L and B2L are lower flammability refrigerants with a maximum burning velocity of ≤3.9 in./s (10 cm/s).

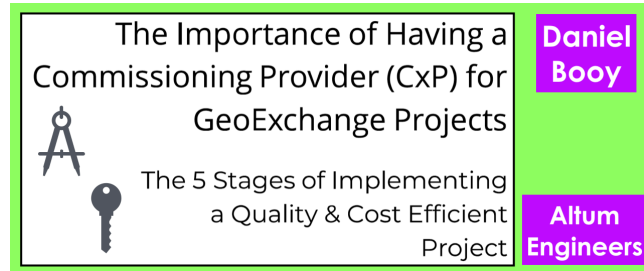
Take-Aways-

- Designers need to be aware of the properties and performance of A2L refrigerants and the impact they will have on mechanical system design: capacity, efficiency, leak detection and mitigation measures
- Everyone in the HVAC industry will need to understand the implications of the UL 60335-2-40 Safety standard and its impact on manufacturing, design, and installation. Spoiler alert: In larger systems there will be requirements for leak detection systems.

(Completed) CaliforniaGeo's **UNDERGROUND** October 19, 2022.

Use of a Commissioning Provider for Geo-exchange Projects

Daniel Booy, P.Eng., Dipl.T., CEA



The presentation will focus on the importance of having a commissioning provider to be the owner's consultant through the entire project with services including but not limited to:

1. Assist with detailing the Owner's Project Requirements (OPR) prior to hiring the design team.
2. Plan monitoring, inspections, and testing – really making an inspection and testing plan (ITP) as early as possible in the process and enforcing hold points listed in the ITP.
3. Obtain signed and stamped forecasted energy consumption calculation results to protect the owner from long-term operation costs far exceeding the forecasted values.
4. Ensure that the sequence of operations is detailed, and that the system works according to the sequence of operations.
5. Get proper sign-off on progress to hold various parties accountable.
6. Catching any problems during the warranty period and clearly identifying if issues are design issues or installation issues, as contractors typically get blamed for issues that are related to design.

Take-Aways-

- Geo-exchange projects are multidisciplinary and require leadership from people who are subject matter experts to ensure the outcomes are congruent with the Owner's Project Requirements and the Basis of Design.
- With many different parts of the system design and construction happening at different stages of the project, it is important to have consistent oversight and an ITP in place to ensure each stage of the project is completed according to plan, and each party is held accountable throughout the process.




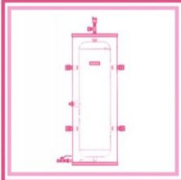
(Completed) CaliforniaGeo's **UNDERGROUND** August 17, 2022.

Free Tools for Designing and Troubleshooting Geothermal Systems



Tom Wyer of Geo-Flo will take us into the design world of the geothermal heat exchange liquid loop and show us how to use a variety of computer-based, iterative tools to design new systems and to troubleshoot existing ones.

(August 17th) Free tools for designing and troubleshooting geothermal systems

[ALL](#) [PRESSURE DROP CALCULATORS](#) [PUMP SIZING CALCULATORS](#) [SERVICE CALCULATORS](#) [GENERAL CALCULATORS](#)



[BUFFER TANK CALCULATOR](#) [EXPANSION TANK SIZING-Geo](#) [EXPANSION TANK SIZING-RADIANT SYSTEM](#) [POND COIL CALCULATOR](#)



Tom Wyer, President, Geo-Flo Corporation

Tom is a trained mechanical engineer, serves on IGSHPA and CSA technical committees, and his company manufactures fittings and equipment for the geo heat exchanger's liquid path. This includes flow centers, HDPE fittings, various valves, hose kits, and socket fusion equipment. If fluid runs through it, Geo-Flo has you covered between the ground loop pipe and the geo heat pump's main heat exchanger.

Take-Aways:

- Free tools exist to help technical personnel in the geothermal industry quickly solve a wide variety of problems.
- Understanding the concepts of pressure drop and pump curves allows one to both design and troubleshoot geothermal systems.

(Completed) CaliforniaGeo's **UNDERGROUND** June 22, 2022.

The Roadmap to Electrification in California: The Need for Thoughtful Design

(A panel discussion led by Lawrence Garber, Building Decarbonization Coalition)

Additional Panelists:

Carrie Rizzo, Burns & McDonnell Sustainability, Kansas City

David Warner, Redhorse Constructors, San Rafael

David Johnson, Sera Design, Oakland

Led by Lawrence Garber of BDC, we will feature three professionals to take on defending our climate through decarbonization. Join this panel for a glimpse of how we might get there. And remember, we don't need to invent a brand new gadget for this challenge—we have everything necessary within our grasp. California policy and regulation already highlight the need to vanquish carbon everywhere we can. This session will focus on that effort for the buildings we retrofit or start anew.



MODERATOR
Lawrence Garber
Building Decarbonization
Coalition



Carrie Rizzo
Burns & McDonnell



David Warner
Redhorse
Constructors



David Johnson
Sera Design

California has a history of leading policy development for energy efficiency and emissions. “Reach” codes are now an expanding tool that tackles advanced efficiency in new construction without using as much (or any) carbon. Recently, the number of jurisdictions with restrictions or bans on gas use reached 58. While significant progress has been made at the local level on new construction codes, numerous challenges and opportunities exist in decarbonizing existing buildings. The central question remains, “What does the decarbonization roadmap look like from this point forward?”

Walking away from an historical focus favoring carbon will be challenging in many states. The right balance of **why** and **how** we do that will come from good design that’s recognized as requiring no major sacrifice. Prevention of utility disruption and concern for social equity will be involved. Any success we can achieve will serve climate defense by avoiding increasing cost and risk from extreme weather-related events.



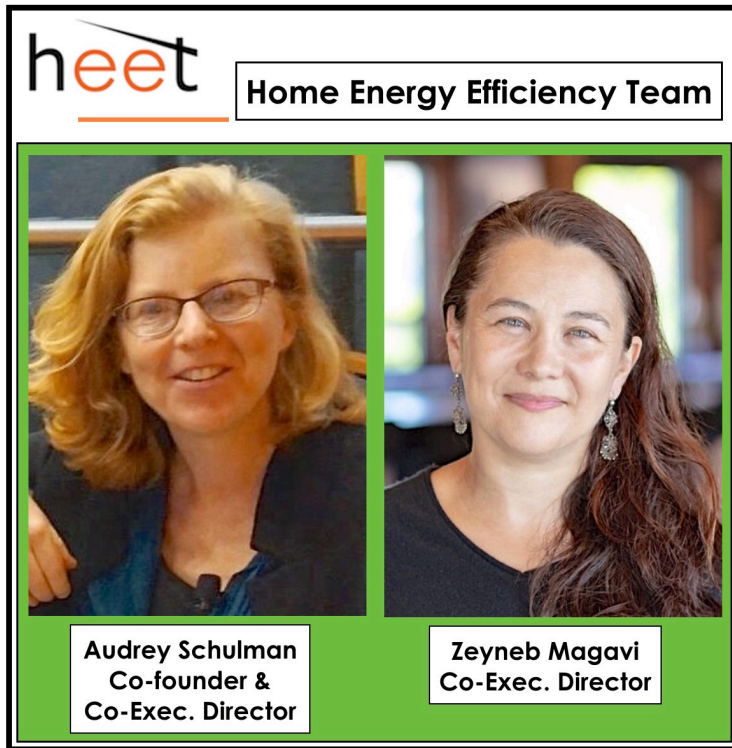
Take-Aways:

- The application of non-carbon substitutes in occupied spaces.
- The must-reach destinations along this road map needed for success.

(Completed) CaliforniaGeo's **UNDERGROUND** April 20, 2022.

From Gas to a GeoGrid

Accelerating a just transition to a non-emitting future



After unifying community groups around Boston to respond to large underground gas leaks, HEET is branching out from their prototype that gained regulatory and utility cooperation to replace failing gas lines with ambient water loops to serve geo heat pumps. [An article by Jay Egg](#) in 2020 highlighted the work of HEET with a Large Volume Leak Study. It also questioned what is estimated to be a \$20 Billion cost over 20 years if leaky gas infrastructure was replaced, taking us into another cycle of future stranded assets if a greener choice was made at a later date.

You'll hear from these two spark plugs who unified community groups, regulators, legislators, and two gas utilities toward diagnosing and quantifying the leaks and built an experimental prototype to install ground loop piping for geo heat pumps rather than lines carrying methane. Demonstration installations have been approved by regulators, and we may be seeing the nation's first thermal utility in the era of beneficial electrification!

HEET is expanding its analysis work to answer the question ***"What if this program was expanded, can it work elsewhere?"***

Take-Aways:

- How a merged geo/gas rate base can avoid stranded assets while transitioning the utility and infrastructure to renewable thermal energy.
- Expansion of the argument for electrification if geo heat pumps are the choice for heating and cooling.

(Completed) CaliforniaGeo's **UNDERGROUND** February 23, 2022.

First Looks At Commercial Geo Projects

Fast, Easy, and Decisive with an Iterative Analysis Tool

Ed Lohrenz, Principal at GeOptimize



Feasibility is a big issue in any building project, particularly in commercial developments. Operating costs last for the life of the building over 100 years. Occupant comfort and future occupancy will influence a developer's bottom line. What usually happens when a project considers a newer, more efficient technology like geothermal heating and cooling?

Architects and Mechanical HVAC contractors are not widely familiar with geo technology and you may experience more than initial discouragement from either or both. You could spend a large sum to contract with a specialist designer who uses elaborate software to establish feasibility and predict operating costs before you decide.

There is a quicker and less expensive way to see if geo is a possibility. With GeoFease® you can get a highly predictive answer at low cost to see if following up with a geo-based design is worth it. Ed Lohrenz is an experienced engineer practitioner who will show you how.

This product has a companion system that can track performance after the commissioning process. It can adjust equipment to maximize performance of both the mechanical and underground heat exchanger.

Take-aways:

- Getting away from Rules-of-Thumb is the best way to pitch Geothermal Heat Pump installations to commercial building customers.
- An iterative computer-based design tool is the best way to balance loads, optimize operation, and reduce the size and complexity of vertically bored heat exchangers—that saves tens of thousands and increases developer interest and commitment to geo.

(Completed) CaliforniaGeo's **UNDERGROUND** December 8, 2021.

Geothermal as a Utility Service

Taking The Worry Out of First Steps and Cost of Commercial GHEXs

Scott Musgrave, Principal at Orca Energy



One of the largest, if not the largest hurdles for mass adoption of geothermal heating and cooling is the upfront cost and complexity of installing the infrastructure. When a developer considers using geothermal for heating and cooling on a new project, this adds costs to their budget, adds a new item that they are unfamiliar with and another piece of infrastructure that they have to manage. The fact is that it is less costly and easier to use traditional technologies for heating and cooling. Geothermal as a utility service solves these issues. A utility company such

as Orca will pay all of the costs and assuming full responsibility for the design, engineering and installation of the exterior ground loops and associated infrastructure. And in some cases Orca will also be responsible for the interior equipment. Orca provides oversight and management of the interior equipment. This is all done at ZERO Cost to the developer. Orca removes the largest barriers for developers to use geothermal energy.

Scott will discuss how geothermal as a utility service works, and the steps and details involved in the business model for companies like Orca that build, own and operate the exterior, and sometimes interior components of a geothermal system.

Take-aways:

- Geothermal as a utility can be used as a tool for gaining new projects by solving some of the largest issues for developers deciding to go geothermal.
- Geothermal as a utility can turn a geothermal from a financial negative to a project to a financial positive.

(Completed) CaliforniaGeo's **UNDERGROUND** October 27, 2021.

Josephine Commons, Lafayette, CO

Practical Net Zero - GSHP as a cornerstone for success

Corey Chinn, P.E., CEM, CxA, LEED AP

The Farnsworth Group, Inc.



This mechanical engineer discussed his experiences, results, and evaluation of a series of projects in Boulder County, CO which culminated with the successful completion of two net zero homes, exceptionally high performance 80,000 sf Multi-Family Senior Housing facility, and the resulting implementation of lessons learned for future high efficiency affordable housing development. The foundational project for these series of projects was studied and reported on extensively by NREL, the approach and results of which have been documented at the following link. (<http://www.nrel.gov/docs/fy12osti/51450.pdf>).

Your take-aways:

1. Be aware of terminology, metrics, and basic expectations for facility energy use and simple tools available for determining the order of magnitude for Energy Conservation opportunities.
2. Be able to discuss the importance of Owner involvement.
3. Be able to discuss the importance of integrated design and setting measurable goals.



(Completed) CaliforniaGeo's **UNDERGROUND** August 18, 2021.

"Geo-Janitorial"

Problematic GSHP Installations; Forensics; Solutions;
& Lessons Learned

- **Terry Proffer, Geothermal Manager for Major Geothermal, Inc.**



Geologist

| | |
|--------------------------------------|---|
| Member | ASHRAE, IGSHPA, NGWA |
| IGSHPA | Accredited Installer #12131-994 |
| IGSHPA/NATE | Certified Installation Instructor #T1063-496 |
| AEE | Certified GeoExchange Designer #16 |
| IGSHPA | CGD Instructor |
| Colorado Division of Water Resources | |
| | Closed Loop Certification #GT-13 |
| | ClimateMaster Certified Installation Instructor |

Terry shared examples of 10 problematic GSHP installations ranging from easily resolved to catastrophic failures. He'll show how his focus on forensics helps reveal the best corrective actions

He frequently serves as a third party design evaluator for geo system designs and sometimes testifies in court actions covering system performance disputes. When he's not busy with this, he's designing simple, effective, and bulletproof geo heat exchange and control systems that won't require a geo janitor.

(Completed) CaliforniaGeo's **FIRST UNDERGROUND** June 16, 2021.

A Geothermal Retrofit At Colorado State University

CSU (Fort Collins) recently geo-retrofitted their athletic complex, encompassing 3 buildings, to eliminate an antiquated, leaky steam heating system and added cooling to their indoor arena and other spaces for competitive sports and summer events.



The large bore field will also serve a future Phase II, adding an interconnection enabling a new residence hall complex to share the same GHEX. This will become a larger “district loop,” further optimizing energy efficiency of the geothermal heat pump systems by sharing loads between buildings and their use schedules. Trey Austin and his company were there.

Take-Aways:

- How to plan for a large/medium scale geothermal bore field for multiple buildings.
- Challenges for retrofitting an existing system with respect to heating and cooling coils.
- Factors to consider for future system tie-ins.

Trey has 26 years of experience with geo systems and is a PE and CGD. His company, Geo-Energy Services, LLC has a 650 project portfolio stretching from the USA to Asia, Central America, and the Caribbean. Beyond design-build projects of all sizes, he brings 3rd party financing to large projects as thermal utility agreements.

*CaliforniaGeo is pleased to bring Trey to launch our **first UNDERGROUND** learning session!*