

CLEAN AIR · CLEAN WATER · CLEAN EARTH

# GEOTHERMAL<sup>SM</sup> ENERGY SYSTEMS

The Earth is the Lord's, and all its fullness, the world and those that dwell therein. For He has founded it upon the seas, and established it upon the waters. Psalm 24: 1-2

## Economic Impacts of Renewable Energy

10th Annual Southern BioProducts and Renewable Energy Conference

Presented By: Daniel Mallett, Partner – Geothermal Energy Systems, LLC | Loop Tech International, Ltd

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## Topics

- Who We Are | Our Mission | Why We're Here
- Geothermal Heating & Cooling Defined
- Facility Life Cycle Advantages Including Energy Efficiency
- USGBC LEED & Energy Star Relationships
- Financial Incentives & Financing Options
- Project Examples
- Professional & Project Services
- Q&A



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## Who Are We?



- Established in 1984
- Installed over 40,000 loops
- Installed in 17 states and 2 countries
- Complete installation capabilities
- First to offer written warranties
- Pioneers of the industry
- Developed Many Current Standards & Products



In partnership with LoopTech, Geothermal Energy Systems provides comprehensive energy solutions. We provide "best of class" design, installation and services for geothermal systems.



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## Our Mission: Clean Air, Clean Water, Clean Earth





Geothermal Energy Systems is dedicated to environmentally clean, economically sound homes, schools, businesses and recreational environments that promote our clients' health and comfort. Our team is focused on installing products that save money, save energy and provide comfortable, clean, healthy environments year-round.



Clean air, clean water and clean earth are the foundations of our business.

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## Why Are We Here?

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"The *Action Plan* makes energy efficiency improvements the option of first choice in all energy decisions."

"Energy efficiency always should be America's highest-priority energy resource and the energy option of first choice."

"Proper heating, ventilating, and air-conditioning (known in the trade as HVAC) are key to maintaining a comfortable, healthy and productive work environment. Collectively, these systems account for approximately 40 % of the electricity used in commercial buildings. Improved heating and cooling performance along with substantial energy savings can be achieved by implementing energy-efficiency measures."

"Geothermal heat pumps (GHPs) are among the most efficient and comfortable heating and cooling technologies currently available, because they use the earth's natural heat to provide heating, cooling, and often, water heating."

"The geothermal heat pump, also known as the ground source heat pump, is a highly efficient renewable energy technology that is gaining wide acceptance for both residential and commercial buildings."

"Geo exchange systems are the most energy-efficient, environmentally clean and cost-effective space conditioning system available today"

## Why Are We Here?

### 43% of U.S. Carbon Emissions

Category	MMTC	Percentage
Industry	377	26%
Buildings	656	43%
Transportation	482	32%

### 39% of U.S. Primary Energy Consumption

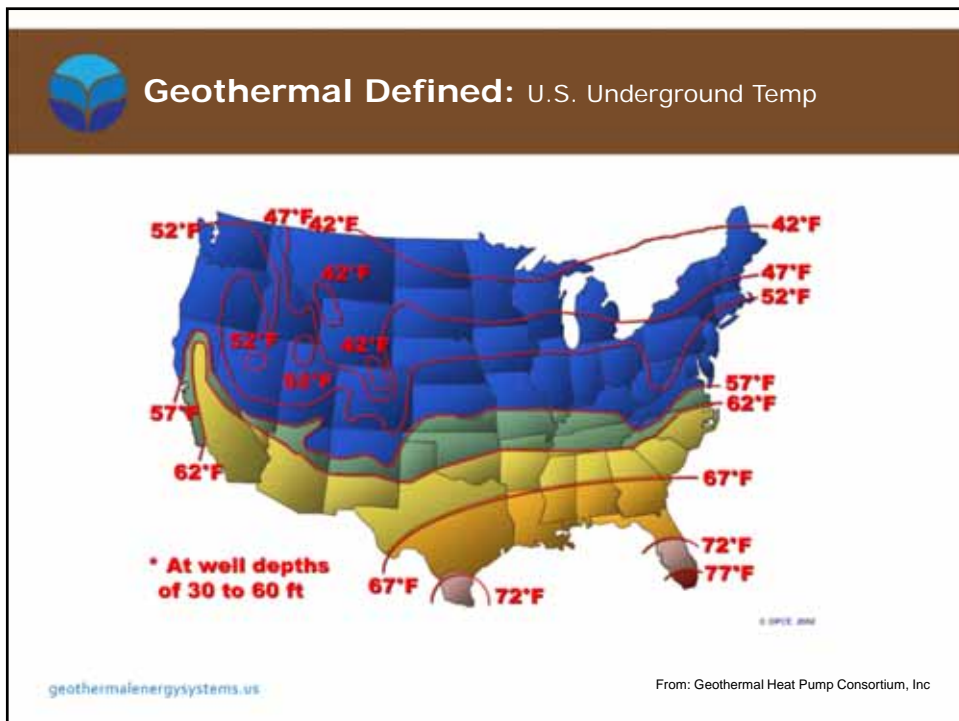
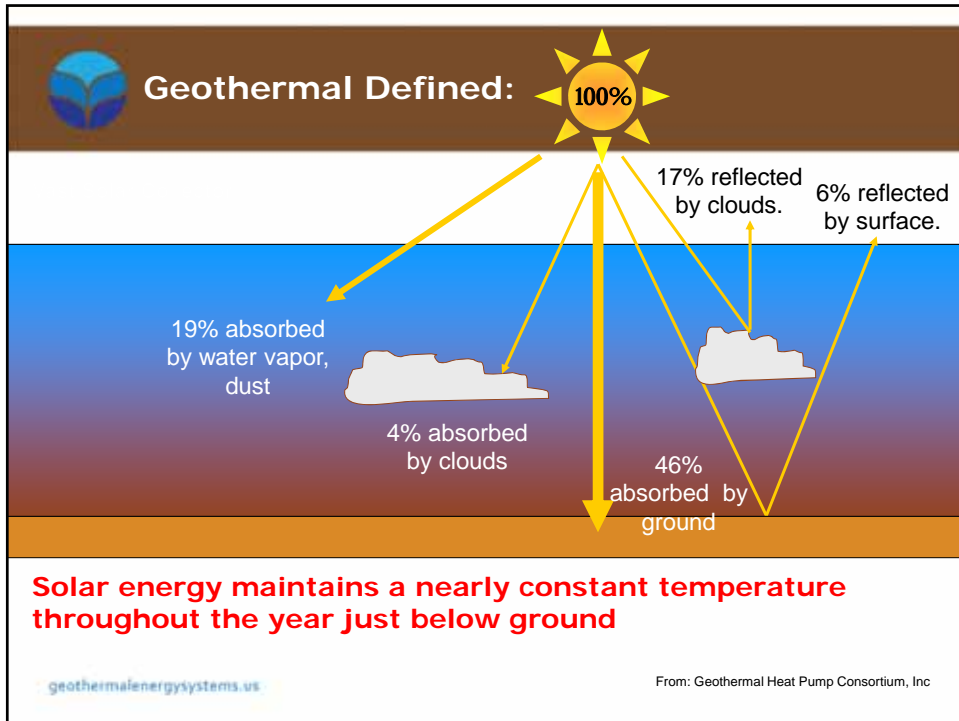
Category	Percentage
Industry	11%
Buildings	28%
Transportation	28%
Residential	21%
Commercial	18%

### 71% of U.S. Electricity

### 53% of U.S. Natural Gas

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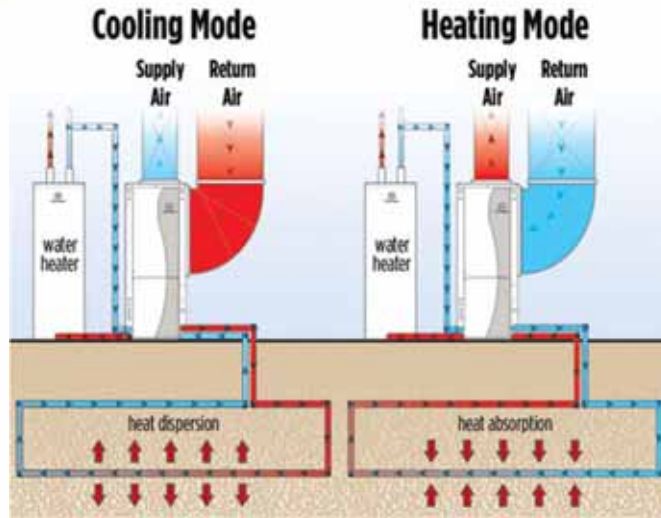
From: Geothermal Heat Pump Consortium, Inc





### Geothermal Defined: System Illustration

Geothermal Heat Pumps Circulate Water Through a Sealed, Underground Piping Loop Field Where The Water Is Naturally Warmed or Cooled By The Earth



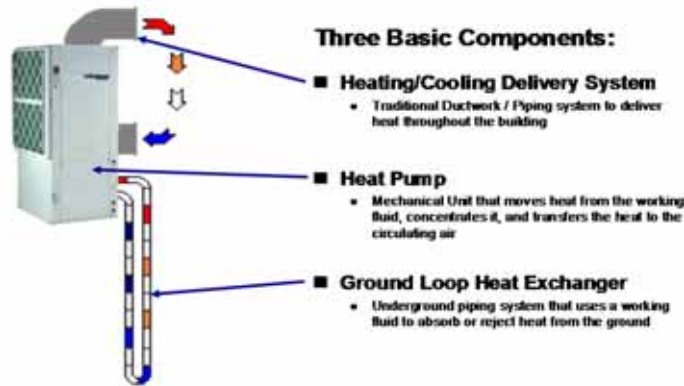
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From: WaterFurnace International, Inc.



### Geothermal Defined: Geothermal Heat Pump

#### Geothermal Heat Pump System



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From: WaterFurnace International, Inc.

 **Geothermal Defined:** Example GSHP Manufacturers

 **CLIMATEMASTER**  
Geothermal Heating & Cooling Systems

 **WaterFurnace**  
Smarter from the Ground Up™

 **FHP**  
Bosch Group


 **Carrier**

 **AAON**

 **TRANE**

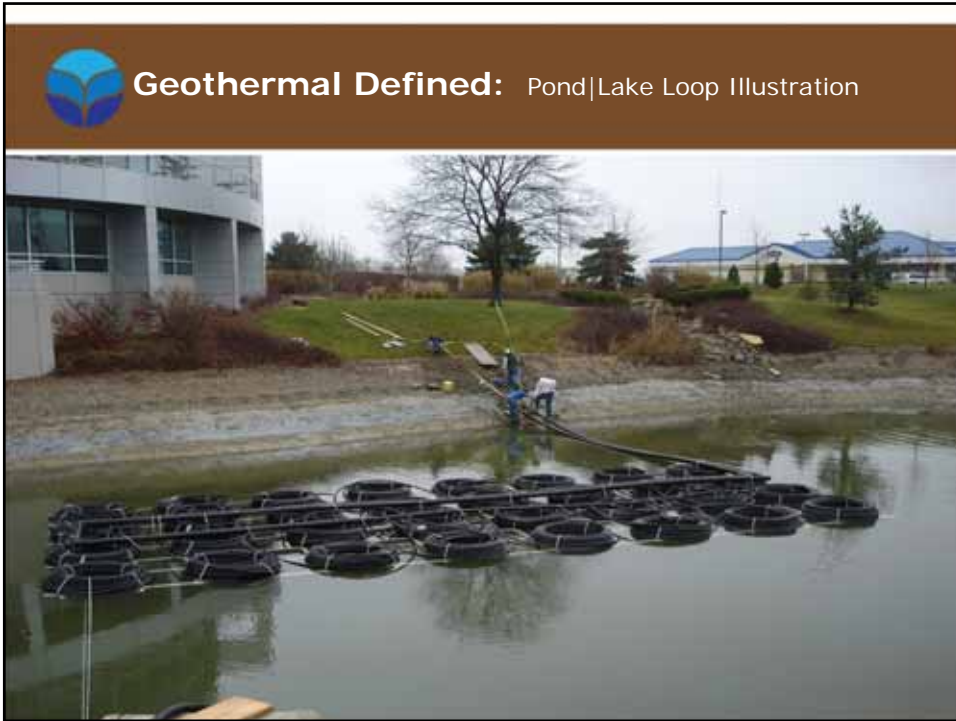
 **Johnson Controls**

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 **Geothermal Defined:** Typical Southern Loops

- Pond / Lake Closed Loop
  - Primarily Used When Cooling Only (Data Center)
    - Requires Adequate Water Volume & Depth
- Vertical Closed Loop
  - Advantages
    - Requires less land than horizontal options
    - Less total piping than horizontal options
    - Least Amount of Pumping Energy
    - More Consistent Ground Temperature

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## Architectural & Life Cycle Advantages

- Saves Energy and Operational Costs – 40% to 70% vs conventional
- Highest Efficiency Ratings
- Low Maintenance Expense
- No Chemical Inhibitors Needed With HDPE In The Building
- Free Hot Water Generation Options
- Longer Equipment Life Cycles & Loop Field Life of 50+ Years
- Increased Humidity and Indoor Air Quality Control
- Elimination of Roof-Top Units, Towers, Boilers, Strip Heat, Dual Fuel
- Eliminates Exterior Noise & Vandalism By Eliminating Outside Units
- One Unit Failure Does Not Down The Entire HVAC System

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## Architectural & Life Cycle Advantages

- Superior Architectural Design Flexibility
- Clean Roof Design Options By Elimination of Roof-Top Units
- Landscape Level Design Flexibility – No Towers | No Chillers
- Storm | Hurricane Considerations – No Outside Equipment
- Heat & Cool Facility Areas Simultaneously = Client Comfort
- Equipment Protection | Concealment Requirements Not Needed
- HDPE Interior Piping & Distributed Pumping = Mechanical Flexibility
- Control & Monitoring System Integration
- Facility Expansion & Multi-Facility Planning Options
- Exterior HVAC Field Exchanger Renovations Begin While Clients Are In The Office or Students Are In The Classroom

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## Geothermal – Federal Commercial Incentives

### Current Commercial Federal Tax Incentives -

WaterFurnace Federal Tax Incentives Publication

- Tax Credit:
  - 10% of total system cost with no limit
  - Use credit to offset AMT tax
  - Use credit over multiple years
  - 10% grant available in lieu of tax credit
  - Combine with solar and wind tax credits
  - Combine with energy-efficient building deduction
- Accelerated Depreciation:
  - 5 year MACR depreciation on entire system
- Eligibility:
  - Building located in U.S.
  - Original use begins with taxpayer
  - Installed between 10/3/2008 and 12/31/2016

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## Geothermal – State Incentives

### Current State Commercial and Residential Incentives

- 37 States have Financial Incentives for GHPs
  - Many are new
  - Sales tax and property tax exemptions, income tax credits, grants
  - 17 States have tax credits or grants
- 28 States have Regulatory Incentives for GHPs
  - Green public building requirements
- 36 States have Utility Incentives for GHPs
  - Voluntary DSM
  - Mandated RES and EES
  - loans and rebates

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From: Geothermal Heat Pump Consortium, Inc



## Geothermal – Finance Option Examples

- Performance Contracting - New Construction & Facility Renovations:
    - Accomplished Through Guaranteed Energy SavingsKeys To Success:
    - Owner, Architect & Engineer Driven
    - ESCO Involved In Evaluation, Finance & Follow Up Data CollectionExample ESCO's – Ameresco, Johnson Controls, Siemens, Schneider Electric
  - Field Exchanger Energy Sales
    - Example - L Vestus Energy GeoTPA<sup>tm</sup> [www.LVestus.com](http://www.LVestus.com)L Vestus Energy Provides Ground Source Heat Exchange Loop Fields (L vestus Owns The Field Initially & "Sells" It To The Client Over Time)
- L vestus Contracts to provide the energy from the field on a long term fixed price per BTU basis, while selling the field to the user.

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## Geothermal – Field Exchanger Efficiency

**Purchased:**  
1 kWh of energy from the grid to operate the system

**Yields:**  
4-6 kWh of energy for the building

**Free:**  
3-5 kWh of energy absorbed from the earth

**400-600% Efficient**

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From: Geothermal Heat Pump Consortium, Inc



## Geothermal – Installation Cost Evaluation

INVOLVE ENGINEERING EARLY TO INCORPORATE GEOTHERMAL HVAC IN DESIGN TO MINIMIZE INSTALLATION EXPENSE AND PROJECTED MAINTENANCE EXPENSE BY EQUIPMENT SELECTION & LOCATION  
FRISCO ISD SCHOOLS MECHANICAL COST COMPARISON - DALLAS | FORT WORTH TEXAS

Campus	System Type	Year Bid	Sq Ft	Mechanical Cost	
				Total	Per SqFt
Bright Elementary	Conventional	2001	71,860	968,922.00	13.40
Spears Elementary	Conventional	2002	71,555	970,621.00	13.50
Riddle Elementary	Geothermal	2003	72,848	981,284.00	13.40
Pink Elementary	Geothermal	2004	76,000	1,054,261.00	13.80
Pioneer Middle	Conventional	2001	137,245	1,676,435.00	12.20
Wester Middle	Conventional	2001	137,245	1,676,435.00	12.20
Griffin Middle	Geothermal	2002	138,651	1,679,000.00	12.10
Roach Middle	Geothermal	2004	138,650	1,709,000.00	12.30

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From: Image Engineering Group, Ltd



## Geothermal – Life Cycle Cost Evaluation

FACILITY LIFE CYCLE EXPENSE SHOULD BE THE PRIMARY COMPARISON

FRISCO ISD - ACTUAL HVAC LIFE CYCLE COST FOR MIDDLE SCHOOL PROJECTS						
IMAGE ENGINEERING GROUP, LTD				GRAPEVINE, TEXAS		
SYSTEM TYPE	TOTAL SYSTEM COST**	ANNUAL MAINT COSTS	ANNUAL ENERGY COSTS **	SIMPLE PAYBACK (YEARS)*	30 YEAR LIFE CYCLE	REMARKS
<b>CAMPUS - 138,000 SQ FT</b>						
<b>FOUR PIPE SYSTEM (GAS BOILER AND AIR COOLED CHILLER (BUILT IN 2001))</b>						
GAS / ELECTRIC BOILER / CHILLER	\$1,676,435.00	\$43,700.00	\$213,091.13	8.0	\$5,135,822.60	
<b>GEOTHERMAL HEAT PUMPS (BUILT IN 2004)</b>						
HEO UNITS AND WELL FIELD	\$1,709,000.00	\$27,600.00	\$143,657.38	6.4	\$3,425,027.60	
<b>LIFE CYCLE COST SAVINGS</b>					<b>\$1,710,795.00</b>	

\* PAYBACK BASED ON ENERGY AND MAINTENANCE SAVINGS ONLY  
\*\* COSTS ARE ACTUAL, NOT ADJUSTED FOR INFLATION OR ESCALATION AND INCLUDE CONTROLS

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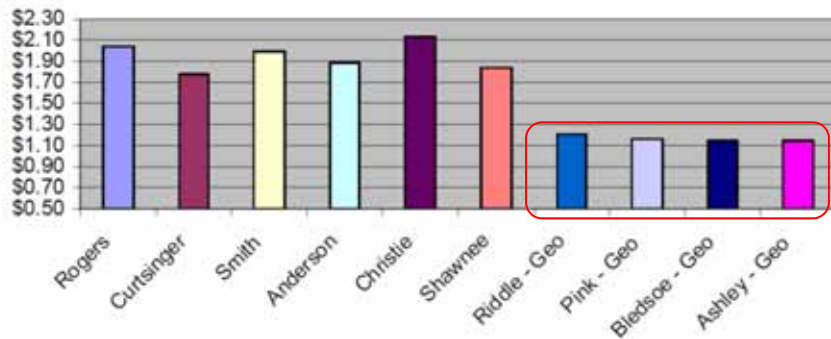
From: Image Engineering Group, Ltd



### Example: Frisco, TX ISD Utility Cost Comparison

- Frisco ISD 2005-2006

#### ELEMENTARY SCHOOL ANNUAL UTILITY COST COMPARISON - \$ / SQ FT



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From: Image Engineering Group, Ltd



### Geothermal – Energy Simulation Results

#### Simulation Results



Note: The percentage displayed for the "Proposed" Base % column of the base case is actually the percentage of the total energy consumption.

\* Denotes the base alternative for the ECR study.

		* Alt-1 4-Pipe System			Alt-2		
		Energy	Proposed	Peak	Energy	Proposed	Peak
		10 <sup>6</sup> Btu/yr	/Base %	MBtu/h	10 <sup>6</sup> Btu/yr	/Base %	MBtu/h
Lighting - Conditioned	Electricity	1,009.5	28	809	1,009.5	100	809
Space Heating	Electricity	35.8	1	9	52.3	142	72
	Gas	311.5	8	1,000	0.0	0	0
Space Cooling	Electricity	1,015.9	28	1,304	442.5	44	912
Pumps	Electricity	47.8	1	94	48.1	97	8
Heat Rejection	Electricity	111.2	3	148	0.0	0	0
Fans - Conditioned	Electricity	322.3	9	283	204.9	64	68
Receptacles - Conditioned	Electricity	555.8	16	328	555.8	100	328
Stand-alone Base Utilities	Gas	149.1	4	100	149.1	100	100
<b>Total Building Consumption</b>		<b>3,569.4</b>			<b>2,459.3</b>		

31% Energy Savings

		* Alt-1 4-Pipe System	Alt-2
Total	Number of hours heating load not met	162	10
Total	Number of hours cooling load not met	0	104

29% Energy Cost Savings

		* Alt-1 4-Pipe System		Alt-2	
		Energy	Cost/yr	Energy	Cost/yr
		10 <sup>6</sup> Btu/yr	\$/yr	10 <sup>6</sup> Btu/yr	\$/yr
Electricity		3,000.7	55,565	2,310.6	42,182
Gas		499.8	8,087	149.1	1,040
<b>Total</b>		<b>3,500.5</b>	<b>63,652</b>	<b>2,459.7</b>	<b>43,222</b>

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## Geothermal – ROI Evaluation - ERG

Year	Cash Flow Difference	Cumulative Cash Flow Difference	Present Value of Flow Difference	Net Present Value
0	-400,000.00	-400,000.00	-400,000.00	-400,000.00
1	30,329.59	-369,670.41	27,572.35	-372,427.65
2	30,329.59	-339,340.83	25,065.77	-347,361.88
3	30,329.59	-309,011.24	22,787.06	-324,574.81
4	30,329.59	-278,681.66	20,715.51	-303,859.30
5	30,329.59	-248,352.07	18,832.29	-285,027.01
6	30,329.59	-218,022.49	17,120.26	-267,906.76
7	30,329.59	-187,692.90	15,563.87	-252,342.88
8	30,329.59	-157,363.32	14,148.97	-238,193.91
9	30,329.59	-127,033.73	12,862.70	-225,331.21
10	30,329.59	-96,704.14	11,693.37	-213,637.84
11	30,329.59	-66,374.56	10,630.33	-203,007.51
12	30,329.59	-36,044.97	9,663.94	-193,343.58
13	30,329.59	-5,715.39	<del>8,785.40</del>	-184,658.18
14	30,329.59	24,614.20	7,986.73	-176,971.45
15	30,329.59	54,943.78	7,260.66	-169,310.79
16	30,329.59	85,273.37	6,600.60	-162,710.19
17	30,329.59	115,602.95	6,000.54	-156,709.65
18	30,329.59	145,932.54	5,455.04	-151,254.61
19	30,329.59	176,262.13	4,959.13	-146,295.48
20	30,329.59	206,591.71	4,508.30	-141,787.18

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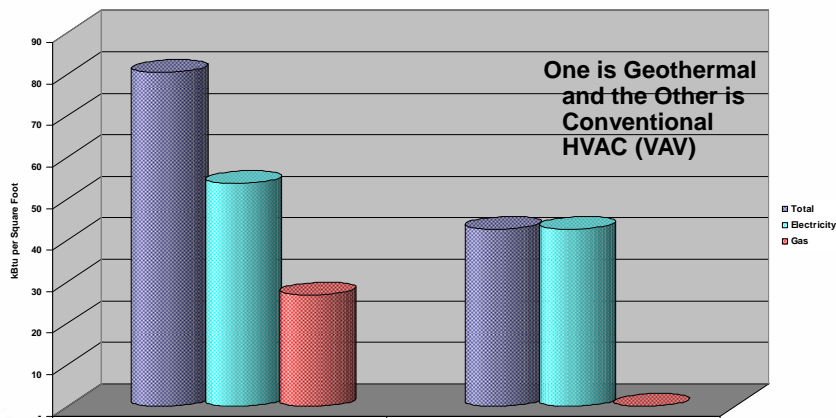
← 8,785.40 13.2 Yr Return



## Geothermal – Energy Evaluation Results

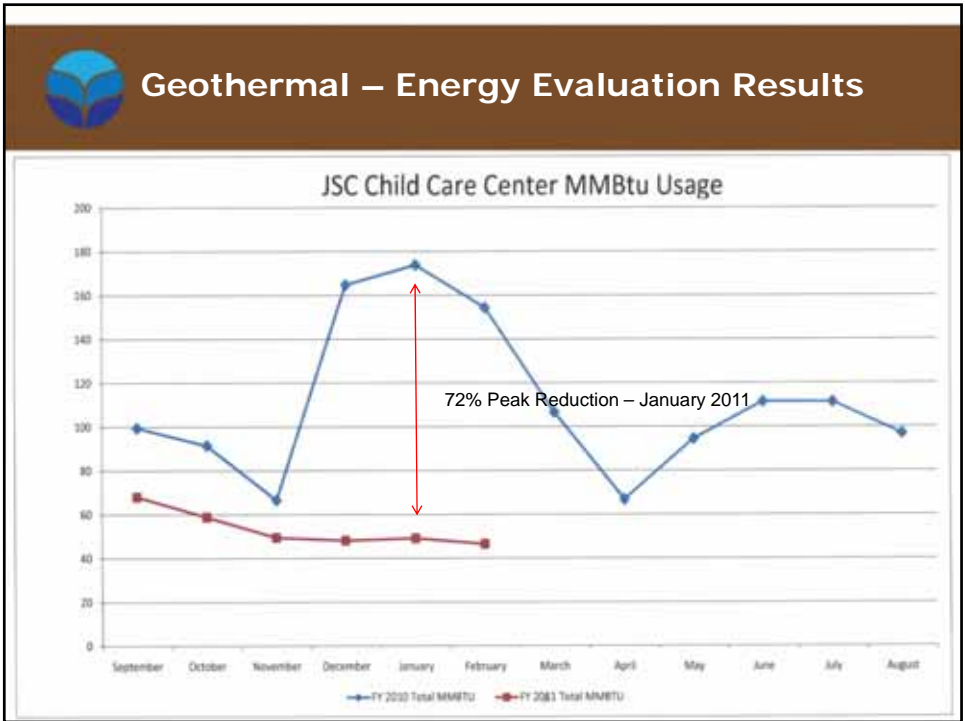
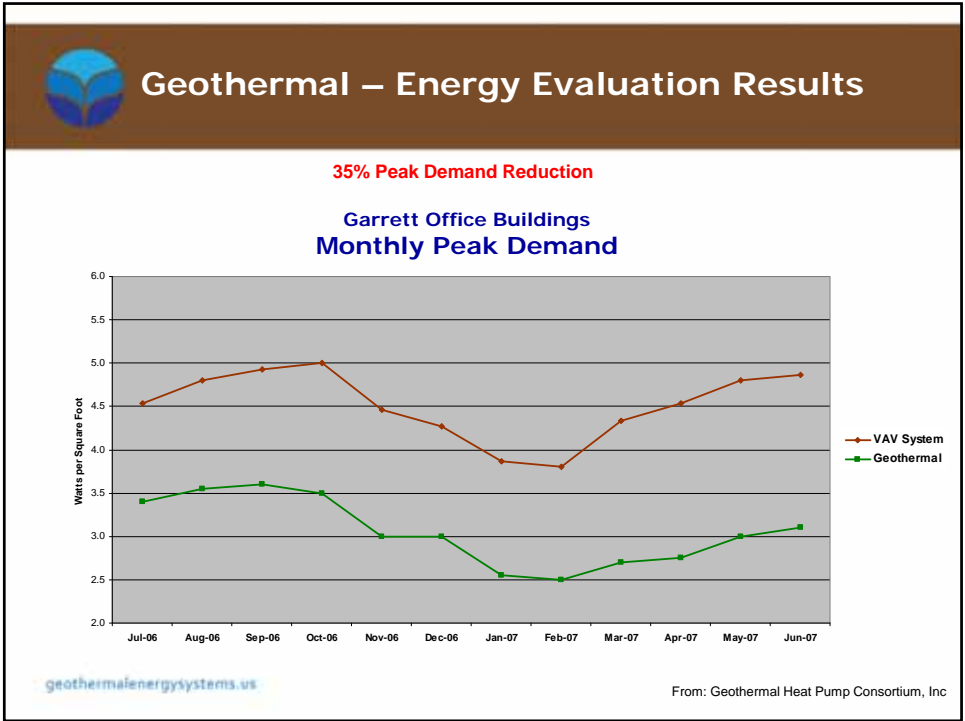
47% Site Energy Savings

Garrett Office Buildings, Edmond, OK  
Actual Metered Annual Energy Use 2006-2007



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From: Geothermal Heat Pump Consortium, Inc





## USGBC LEED Relationship

- **Geothermal HVAC Efficiency =**
  - Energy & Atmosphere Prerequisite 2 Accomplishment
  - Energy & Atmosphere Credit 1 Maximization (Up To 21 Pts)
  - Client Return On LEED Investment

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## USDOE | USEPA Energy Star Relationship


- Recently Realized Facility Energy Star Ratings
  - Geothermal Schools - Leander, Texas K-12
    - Avg 97%
    - Up To 100%
    - Top 10% High Performing Schools Nationwide



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 **Example:** ASHRAE Headquarters – Atlanta, GA

Architect: Richard Wittschiebe Hand  
General Contractor: Gay Construction  
Mechanical Engineer: Johnson, Spellman and Associates



**Level 2 Conditioned Using:**  
 Two-stage, 27 EER Variable Speed Ground Source Heat Pumps  
 Geothermal Field – Vertical Closed Loop


- 12 Wells
- 400 ft deep each


Estimated Annual Energy Reduction - > 31.5%

Reduced Through:

- Dedicated Outdoor Air System (DOAS) with Energy Recovery
- Ground-source Heat Pumps
- Mini-split Systems with Heat Recovery

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 **Example:** SMEPA – Hattiesburg, MS



<http://www.smepa.coop/consumer/GreenPower/Geothermalhandout.pdf>

172 Geothermal Wells – 270 ft Deep Each  
 Purchase Cost – 14% > Conventional  
 Expected ROI – 5 Years  
 (Based on 2008 Energy Costs)

What is all the digging about? South Mississippi Electric is in the process of installing a geothermal heating, cooling and water heating system. “With prices rising on all forms of energy, we feel it’s our responsibility to demonstrate energy efficient solutions on a corporate level as well as to promote energy efficient home products,” said Jim Compton, CEO and General Manager of SME.

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### Example: Fort Polk, Louisiana - 1996

- 4,000 Military housing units converted from air-source heat pumps to Geothermal (Ground Sourced) Heat Pumps
- A total of 6,600 tons of cooling were installed to supply the 4,000 units..
- **Savings:**
  - Electrical Savings – 33% (26 million kWh per year)
  - Natural Gas Savings – 260,000 therms per year
  - Peak electricity was reduced by 43% (7.5 MW).
  - The total value of all energy and maintenance savings is approximately \$3,000,000 per year.
- **Cleaner Air:**
  - Fort Polk CO2 emissions were reduced by 22,400 tons per year

<http://www.tess-inc.com/site-com/assets/filedownloads/Fort%20Polk%20Project%20Summary.pdf>

[http://www.ornl.gov/sci/engineering\\_science\\_technology/eere\\_research\\_reports/electrically\\_driven\\_heat\\_pumps/geothermal\\_heat\\_pumps/fort\\_polk/fort\\_polk.html](http://www.ornl.gov/sci/engineering_science_technology/eere_research_reports/electrically_driven_heat_pumps/geothermal_heat_pumps/fort_polk/fort_polk.html)

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### Example: Innovation Center – Insight Park – UM

#### Innovation Center at University of Mississippi's Insight Park

Architect: Cooke Douglass Farr Lemons Architects & Engineers PA  
Jackson MS

General Contractor: Montgomery Martin  
Memphis TN

Owner: University of Mississippi

Features:

- 30 Class A Offices & Meeting Space
- 2-story - 60,000 square feet
- Lab Space
- Support facilities

Expected to achieve LEED certification

Includes several energy efficient building features:

- Solar Shading
- Geothermal Heating and Cooling



<http://www.montgomerymartin.com/progress.php?project=214&catpos=0&imgpos=0&image=0#>

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**Example:** Gloria Marshall Elementary – Spring, TX ISD



- Began as a "repeat" school design
- Resulted in one of the greenest elementary schools in Texas
- No additional costs to the district's capital budget
- Teaching Tool – Environment Focused, Project-based Curriculum
  - Example – Student Interactive Building Systems
    - Geothermal Well Field Temp Monitoring

Completion Date  
August 2010

Size  
105,000 square feet

LEED  
LEED Gold certification

CHPS  
Designed to meet criteria for Collaborative for High Performance High Schools

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**Example:** City of Espanola, New Mexico City Hall

*"During this natural gas emergency, City Hall was the only government building in the valley that had heat. This geothermal system has proven itself beyond beneficial."*

**"During Record Cold State of Emergency, Española City Hall Stays Warm with New Geothermal Energy System"**



*"System strengthens energy security, cuts energy bills, and improves employee comfort and productivity"*

**COMPLETION DATE:** November 2010  
**COST/BENEFIT:**  
**COST:** \$597,670 (including the city's supplemental contribution)  
**BENEFIT:**

- Estimated annual city operating cost savings of \$42,000
- Estimated cost recovery in 14 years
- Estimated total savings of \$1,260,000 over the 30 year life of the system
- Substantially improved employee productivity due to improved office environment
- Improved energy security for city government
- Estimated 680,000 lbs of CO<sub>2</sub> emissions avoided annually

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## Example: Texas Governor's Mansion Restoration



WHITE CONSTRUCTION COMPANY

integrity at every level.

Mississippi  
613 Crescent Circle Ste. 100  
Ridgeland, Mississippi 39157  
P. 601-898-5180  
F. 601-898-5190

Texas  
2705 Bee Cave Road, Ste. 250  
Austin, Texas 78746  
P. 512-302-1177  
F. 512-302-3009




Texas  
2928 SH 19  
Huntsville, Texas 77320  
P. (936) 295-7038




- Constructed in 1856
- Fourth oldest governor's residence continuously occupied in the United States
- Oldest governor's mansion west of the Mississippi River
- June 8, 2008 - Severely damaged by arson
- Incorporating Geothermal Heating & Cooling in Restoration Project

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## Geothermal – Project Success Tips

1. Mechanical Engineer Selection
  - a) Owner Contracted & Managed For Owner's Desired Results
  - b) Should design the entire system - Interior HVAC, Field Exchanger, and Controls
  - c) Require Cost of Installation Per Sqft For Previous Projects From Engineer
    1. Variations from \$22 and \$25 per sq. ft. to \$40 / sq. ft. and lower Energy Star scores because of poorly chosen engineers.
  - d) Require Energy Star Results From Previous Projects
  - e) Hiring a good engineering firm that works with good mechanical and geothermal contractors yields superior economics and owner satisfaction.
2. Collaborative Efforts of Architect and Engineer Should Begin Early In Project
  - a) Architect Design Flexibility Significantly Increased For Cost Savings Measures
  - b) Exterior Design Greatly Impacted For Cost Saving Alternatives
3. Geothermal Field Exchanger Contractor
  - a) Require capability of completing entire project – Do Not Subdivide Project
  - b) Require References From Similar Sized Projects
  - c) Should Be Capable of Design & Specification Assistance
  - d) Regarding Written & Published Quality Control Practices & Procedures
  - e) Require Materials, Workmanship, and Performance-As-Designed Warranty
  - f) Require Flushing & Purging Procedures & Specifications

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## Contractor Services: Professional Services

Professional Services from Contractors Should Include Turn-key, Comprehensive Solutions for Your Project Including:

- Design Assistance
- Client Consulting
- Project Planning
- Project Estimating
- Complete Execution
- Quality Control, Purging & Testing
- Commissioning
- Field Exchanger Warranty



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## Contractor Services: Project Services

Project Services from Contractors Should Include:

- [Design Input & Feedback](#)
- [Drilling](#) - Exploration & Loop Field To 500' holes & up to 1-1/4" loops
- [Trenching](#) - Environmentally Friendly Machinery & Trained Operators
- [Loop Installation](#) - Specialize in Vertical Loops | Pond Loops
- [Thermal Conductive Grouting](#) - Seals Holes, Conductive Path
- [Exterior Manifolds](#) - Reverse Return, Short Headers, Straight Connect
- [Poly Vaults](#) - Custom Designs for Superior Performance
- [Supply & Return Lines](#) - HDPE lines - Any Size Required
- [Interior Piping & Loop Field Hook-up](#) - Design, Install, Connect
- [Flushing & Purging](#) – 4 to 6 GPM To Remove Debris
- [Loop Field Service & Repair](#) – Peace of Mind Support

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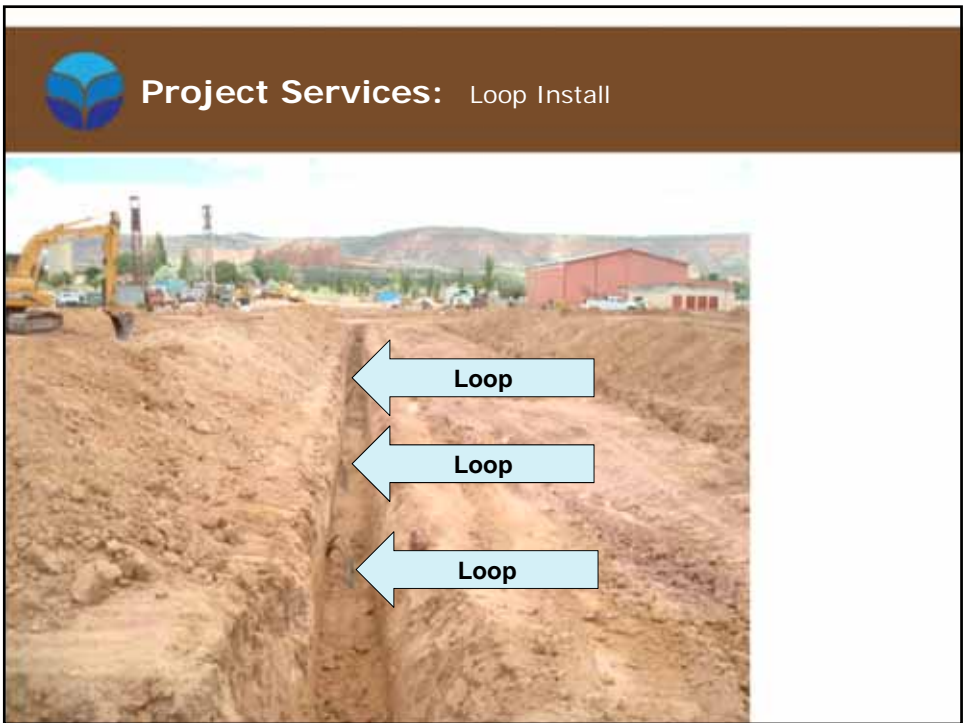
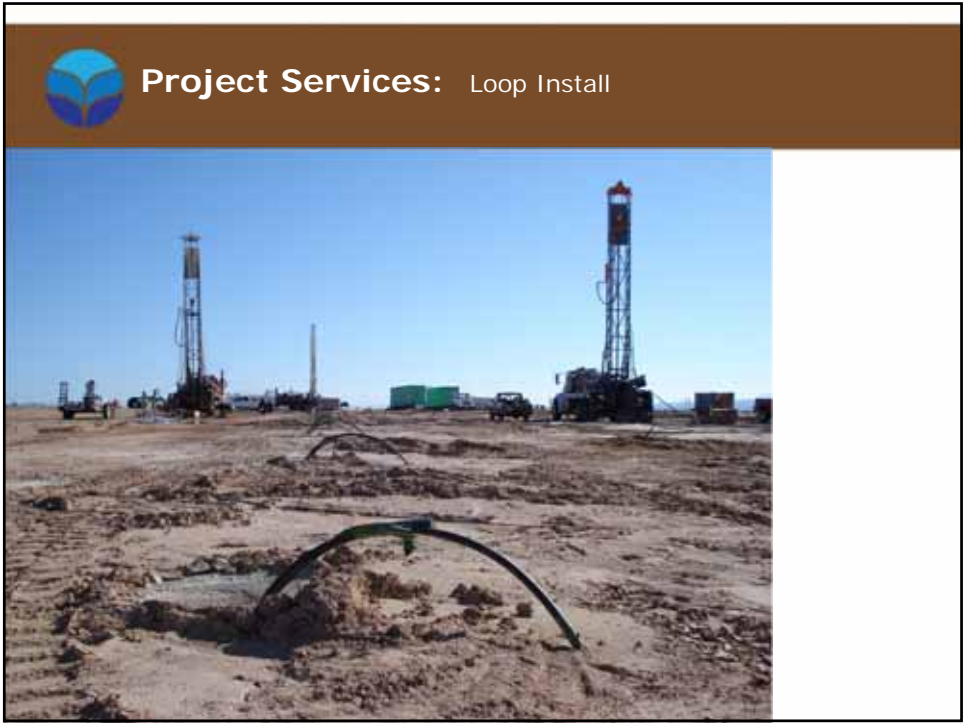


**Project Services:** Drilling



**Project Services:** High Density Polyethylene Loops









**Project Services:** Poly Vault



- Poly Vault Underground
- Traffic Rated
- Aggregates Loop Field



**Project Services:** Supply & Return Lines





**Project Services:** Interior Piping

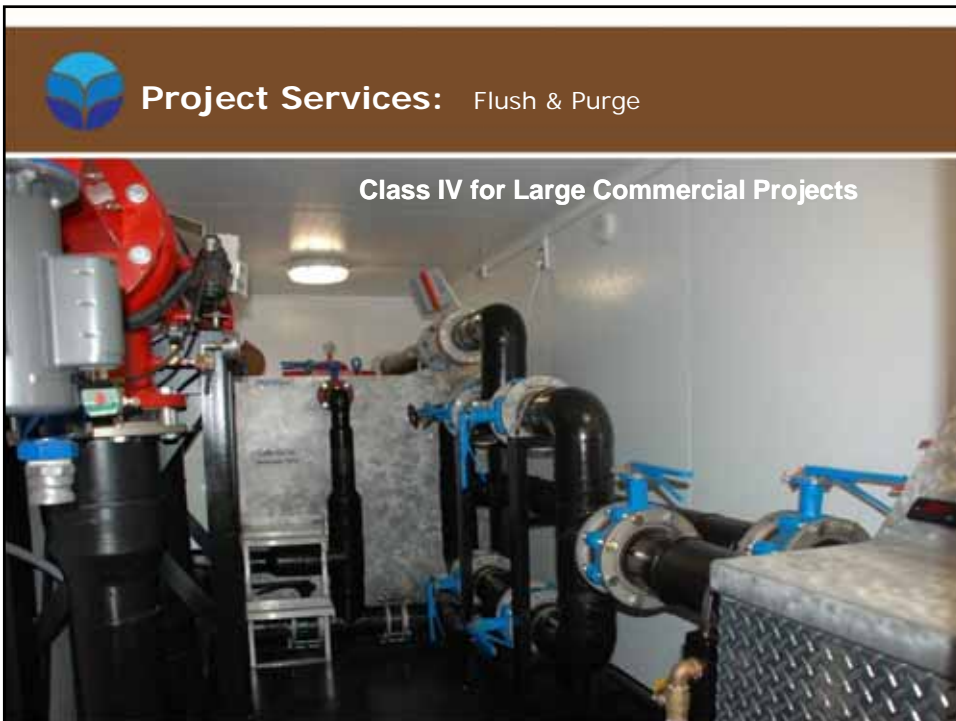
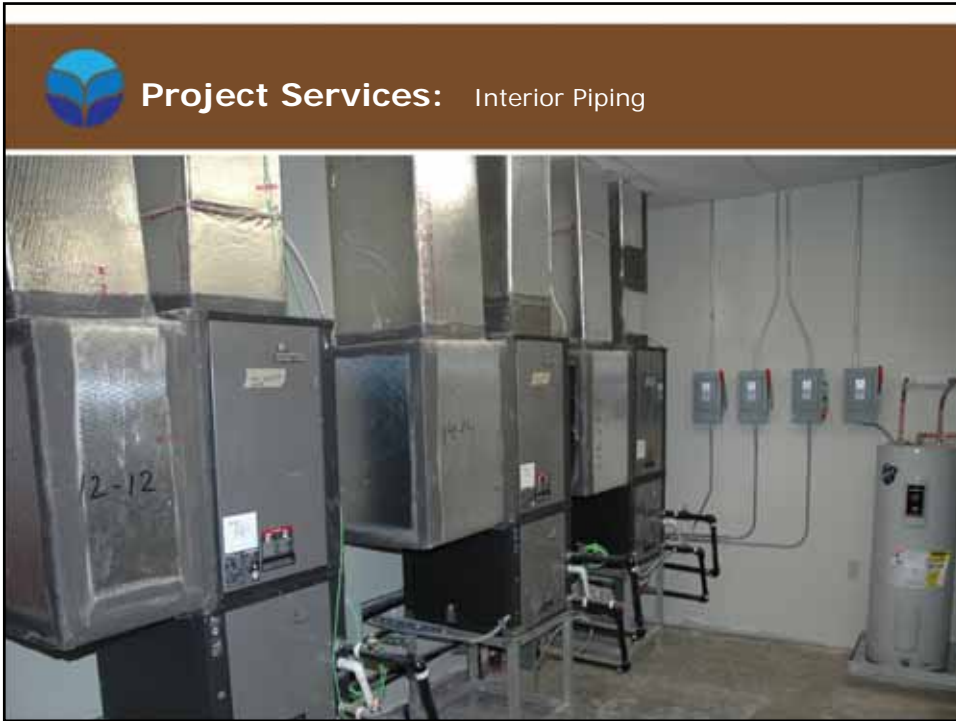


**Project Services:** Interior Piping

Circulation Pumps for Water

- Simple
- Little to no maintenance
- Energy efficient







## Q & A



Questions, Answers, Comments?

[geothermalenergysystems.us](http://geothermalenergysystems.us)



## Conclusion: Who We Are.....

Environmental stewardship and preservation is of the utmost priority in our design assistance, installation services and Company operation. Geothermal Energy Systems is committed to a culture of honesty, integrity, accountability and excellence.



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