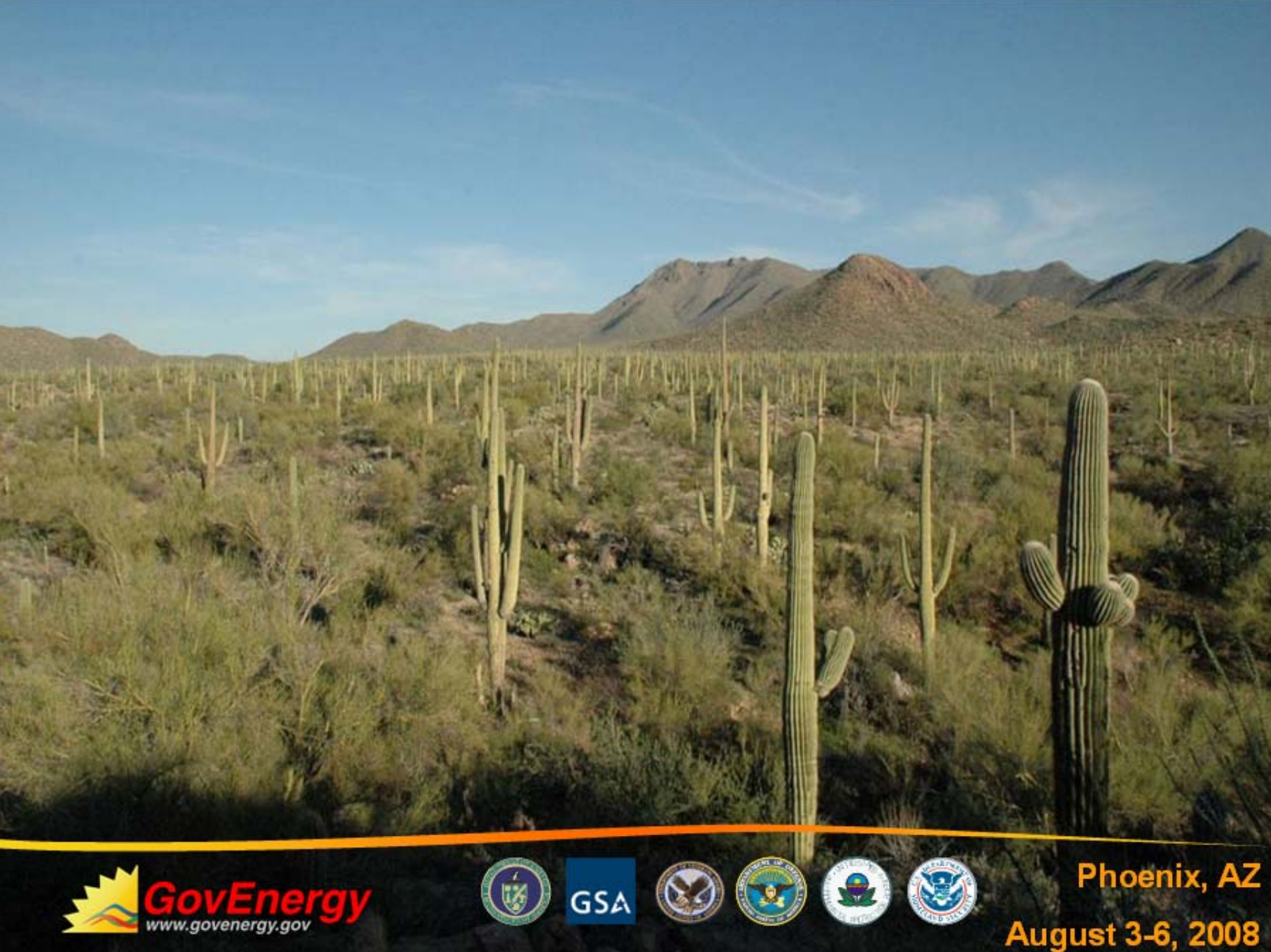
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GSA
Phoenix, AZ
August 3-6, 2008

Geothermal Heat Pump Installations: Prospects For Growth

Presented By:
Phil Rawlings, CGD
Director of Geothermal Services
TRC Energy Solutions - Geothermal

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For More Information

- Would you like to know more about this session?
- Speaker Name: Phil Rawlings, CGD
- Company: TRC Energy Services - Geothermal
- Address: P. O. Box 1255, Greenville, TX 75403
- E-mail Address: geoman@geusnet.com
- Booth Number: 330

Don’t forget to fill out and drop off your session evaluations!

Geothermal Heat Pump Systems Are: Simply the Best…

Per the EPA 1993 report titled Space Conditioning, The Next Frontier (Report 430-R-93-004), Geothermal Heat Pumps are:

"The most energy efficient, environmentally clean and cost effective space conditioning system available today."

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Geothermal Heat Pump Systems Are: Simple and Flexible

- Able to serve from the smallest facility up to commercial and industrial facilities.
- Can provide heating, cooling, hot water, ventilation, etc.
- Available in forced air or hydronic models
- Primarily use Vertical applications for the ground heat exchanger

Geothermal Heat Pump Systems are: A RENEWABLE Resource

Earth energy is available:

- Day or night, rain or shine, windy or calm
- Not high temperature geothermal (50°C+)
- Renewed by heat from the earth's core and/or the sun

How Do Geothermal Heat Pump Systems Exchange Heat With The Earth?

- In heating, heat is absorbed from the earth, intensified by the geothermal heat pump's refrigeration cycle, and delivered into the structure.
- In cooling, heat is absorbed from the structure and rejected into the earth
- Water or a water and anti-freeze solution is the conveyor that carries heat from place to place

Geothermal Heat Pump Ground Heat Exchanger Methods

Closed Loop Systems circulate water or a water and antifreeze solution through a buried or submerged piping grid to exchange heat with the earth.

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Closed Loop Systems

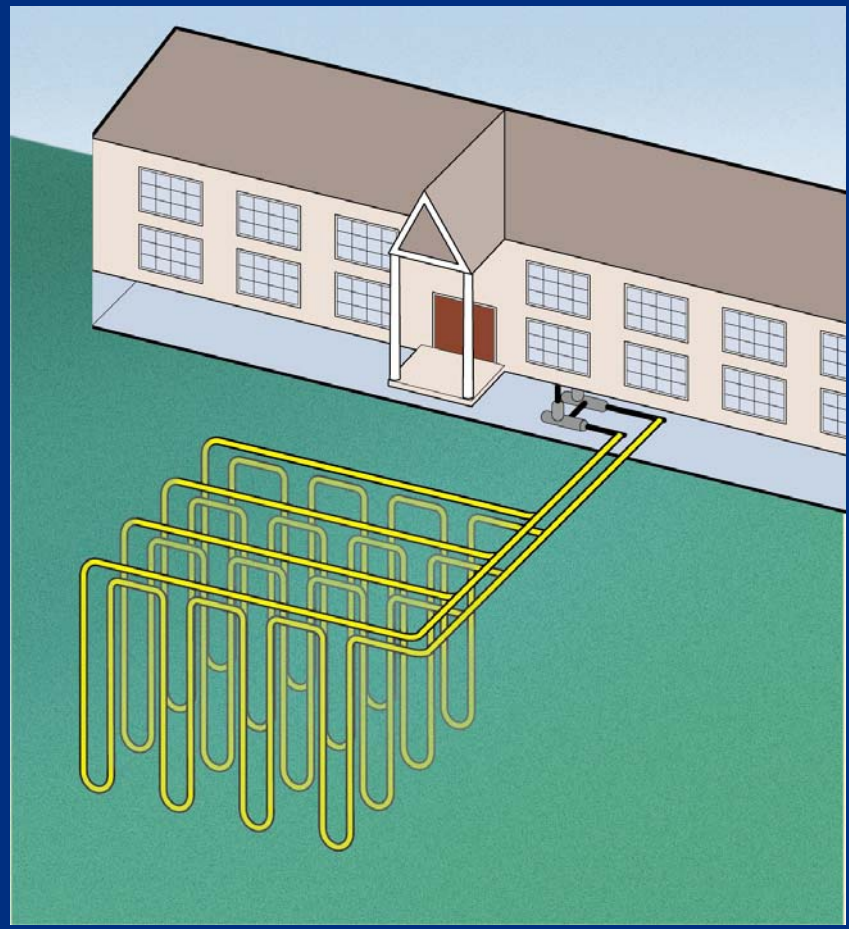
Vertical ground heat exchangers use pipes set in the earth in vertical boreholes. The heat exchanger is a sealed piping grid, the fluid within the pipe is not in communication with the ground in which the pipe is buried.

Vertical Ground Heat Exchangers

- Require approximately 400 square feet of surface area per borehole (boreholes are typically located on 20’ centers).
- Depending on conditions and depth, a borehole can accommodate less than one nominal ton (12,000 BTU) up to several tons of heat exchange capacity.
- Typically installed under yards, playgrounds, parks, athletic fields, parking lots, etc.
- Typically no impediment to ground coverings or landscaping

Vertical Ground Heat Exchanger Installation Considerations

- Installed anywhere as long as sufficient surface area available.
- Dry soil ground areas typically not feasible
- Used world wide on commercial facilities – from inside the Arctic Circle to Riyadh, Saudi Arabia
- Drilling technologies used (conditions based):
  - Mud or wet rotary
  - Air rotary or air hammer



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Geothermal Heat Pump System Regulatory and Construction Special Requirements

- NONE – the interior of the building is basically the same as a boiler/cooling tower water source heat pump system with no specialty components or permits required.
- GHP systems require no make up-water
- GHP systems sometimes require no water side chemical treatment

Ground Heat Exchanger Governing Codes

- Vertical closed loop ground heat exchangers, ground water wells, and standing column wells are typically within the jurisdiction of ground water quality or public health code sets, and are constructed according to water well construction codes*.
- Some government facilities are independent of local codes (but follow the codes anyway!!).

Trenching Construction Codes

- Some misinterpret trench construction code areas when considering horizontal ground heat exchanger trenches and use the same requirements as utility trenches.

  - Trenches for ground heat exchanger piping do not require trench bottom grading or load bearing trench bottoms.

  - High Density Polyethylene is flexible, and expands and contracts throughout an annual cycle, causing the pipe to move.

Large Commercial Facility Ground Heat Exchanger Design Criteria

- Typically vertical closed loop technology used because of space availablity.
- Commercial facilities typically cooling dominant because of building core loads
- On vertical closed loop:
  - Perform thermal conductivity test
  - Evaluate ground loads for seasonal imbalance
  - Design ground heat exchanger to accommodate effects of seasonal imbalance

Thermal Conductivity Test?

- Test borehole drilled to depth expected for project.
- Heat soak test run for 40-48 hours – dumping heat into hole continually.
- Data recorded every 15 seconds throughout testing time frame
- Test deliverables:
  - Well log
  - Ground thermal conductivity
  - Ground thermal diffusivity
  - Deep earth temperature

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Geothermal Heat Pump System Economics

- First cost is typically about the same as a 4-pipe boiler/chiller system
- No outdoor equipment and related safety, theft, and/or vandalism issues
- Maintenance costs typically reduced 30% or more
- Unsurpassed energy savings – 30-70% based on system of comparison
- Unbeatable life cycle costs – its like having a boiler and chiller that never need maintenance or replacement.

The Loop Field Never Needs Replacing?

- Correct – unless it is damaged by excavation that ignored warning tape, “as-built” drawings and locator wire system.
- All loop field pipe is high density polyethylene – guaranteed by the manufacturer for 50 years with a useful life well in excess of that duration.

Environmental Installation Considerations

- Vertical boreholes/wells installed according to code.
- Vertical closed loop boreholes grouted from bottom to top with Thermally Enhanced Bentonite grout.
- Thermal enhancement material is natural silica sand of engineered particle size
- Minor temperature change in the water when it returns to the earth.

Environmental Installation Considerations Continued

- The system water is in a sealed piping loop, not exposed to the atmosphere or refrigerants.
- On closed loop systems, if an antifreeze is used, it is a biodegradable material.

Environmental Operational Considerations

- No point of use combustion of fossil fuels, so no greenhouse gases discharged to the environment.
- Reduced electricity consumption, so reduced power plant emissions
- As stated in the beginning, per the EPA, “The most energy efficient, environmentally clean and cost effective space conditioning system available today.”

What About A Real Track Record Of Large Projects?

The following are some of the projects TRC has done over the last 15 years or so. Several are Energy Savings Performance Contract (ESPC) or Utility Energy Savings Performance Contracts (UESPC) projects that must pay for themselves with energy and maintenance savings – all have succeeded.

Beaufort Marine Corps Air Station

- Facility: *1,235 Housing units*
- Function: F*amily housing*
- Customer: *SCANA and U.S. Marine Corps*
- Technologies: *Ground source heat pumps with heat recovery units to generate domestic hot water*
- Type of Financing: *Project Funded By SCANA*
- Type of Contract: *Utility Subcontract*
- Term of Contract: *10 Years*
- Projected Savings: *$783,000*
- Actual Savings: *$783,000*

Beaufort Marine Corps Air Station

Department of the Navy

NAVY / MARINE CORPS ENERGY EFFICIENCY

The Secretary of the Navy
is pleased to present this

Energy Conservation Award
to

Marine Corps Air Station
Beaufort, SC

for superior achievement in energy conservation through innovative energy management, successful use of energy efficient equipment, and outstanding awareness and application of energy conservation principles, setting a worthy example for the entire naval community.

October 22, 2002
Date

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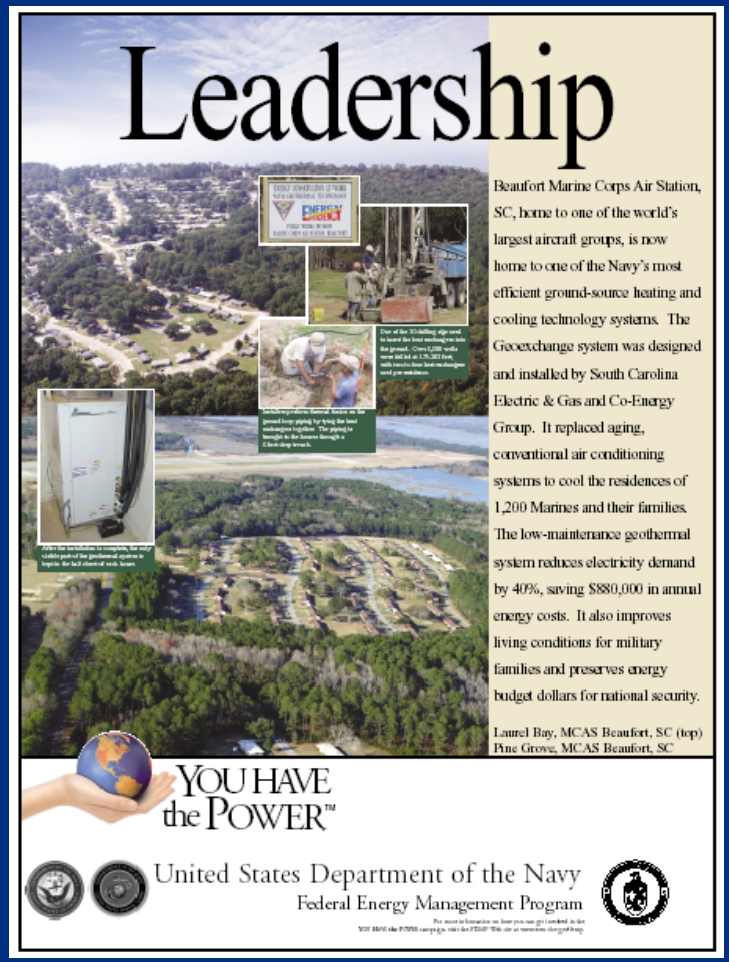
Beaufort Marine Corps Air Station



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Parris Island BOQ

- **Facility:** *2-Story Bachelor Officer's Quarters*
- **Function:** *Multi-Family Housing*
- **Customer:** *SCANA and U.S. Marines*
- **Technologies:** *Variable speed pumps and 70-ton ground source heat exchanger for 64 units*
- **Type of Financing:** *Project funded by SCANA*
- **Type of Contract:** *Utility Subcontract*
- **Term of Contract:** *1 year*
- **Projected Savings:** *N/A*
- **Actual Savings:** *N/A*

Carlisle Barracks
Army War College

- **Facility:** *Administrative, housing, laboratories, museum, bowling alley, club house, health, warehouse and post office*
- **Function:** *Military Administration, Commercial, Housing and Laboratory*
- **Customer:** *U.S. Army*
- **Technologies:** *Ground source heat pumps and controls, natural gas boilers, infrared heaters, and lighting.*
- **Type of Financing:** *Project Financing*
- **Type of Contract:** *GSHP IDIQ Super ESPC*
- **Term of Contract:** *17 Years*
- **Projected Savings:** *$828,606 per year*
- **Actual Savings:** *$828,606+ per year*

National Marketing

- All energy related industries have benefited from our 3 year national energy awareness program - $4.00+ per gallon gas and diesel!!
- We as a nation are finally beginning to believe energy matters.

What Does TRC Energy Services Think The Future Holds For This Technology

- At the current time, our backlog for geothermal installations is high, working on multiple projects on several sites
- If current negotiations are successful, it will almost double within the next year.
- We believe!!

Please Hold Questions Until the End of the Session

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