Geothermal Solutions for Colorado

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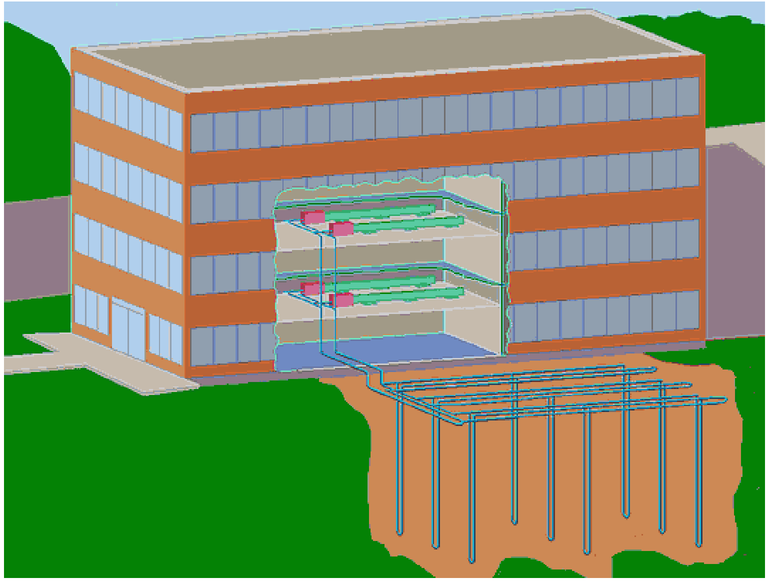
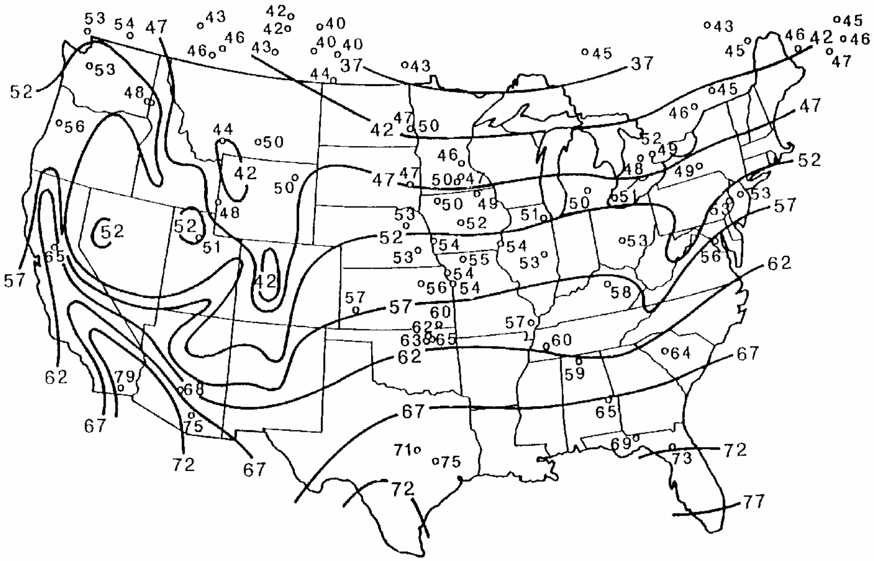
Geothermal Heat Pump Systems





<u>The principle of a Geothermal Heat Pump (GHP) system is to transfer heat.</u>

- In winter, the earth's natural heat is collected through the underground pipes in the Earth Heat Exchanger (EHX). Clean water circulating in the loop carries this heat to the facility.
- In summer, the process is reversed in order to cool the facility; the earth becomes a heat sink.
- The Earth's constant temperature is the key source of utility savings.

Main Benefits of Geothermal Cooling and Heating

Compared to traditional Systems

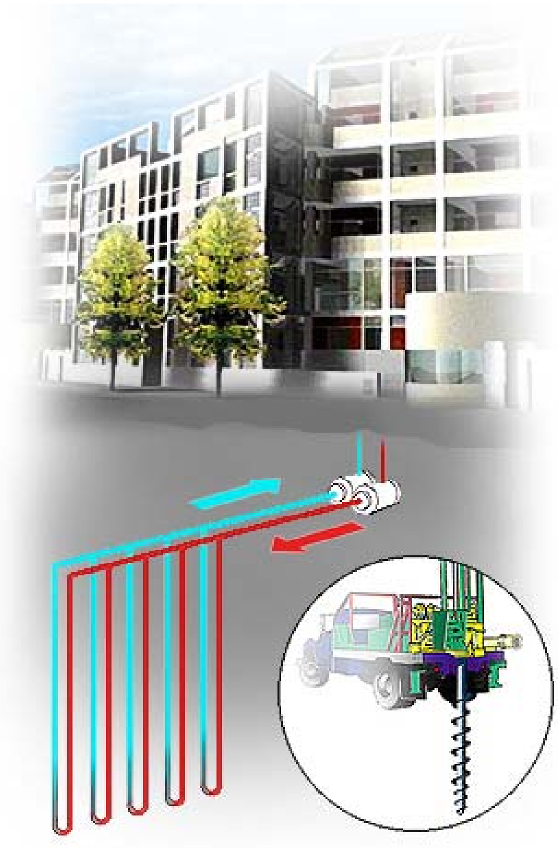
- **Utility Reduction (40% to 60% of the energy consumption of a building is for heating, cooling & hot water)***
  - No water consumption from Cooling Tower
  - No gas consumption for heating
  - GHP dramatically reduces electricity demand (kW) and electricity consumption (KWh) because the system uses the renewable energy stored in the earth.
- **Operation and Maintenance Costs Reductions**
  - GHP system can reduce up to 50% of the Operation & Maintenance costs (vs. chiller & boiler system)*.
- **Return on Investment / Payback**
  - Depending on the financial structure (equity vs. loan) of the investment, the average IRR is between 15% and 50%,
  - The average payback (simple) can be as low as 5 to 7 years.

**according to ASHRAE published reports*

Main Benefits of Geothermal Cooling and Heating (2)

Compared to traditional Systems

- **Eliminate gas boiler**
  - No Mechanical Room: Free up additional space
  - Eliminate gas usage, enhance building safety
- **Eliminate cooling tower**
  - Elimination of unsightly equipment (cooling tower on top of the building roof) and, as a result, reduction in the risk of air-borne diseases
  - Eliminate chemical treatment of water
  - Eliminate water usage
- **More comfortable interior environment**
  - Individual thermostat control to customize comfor

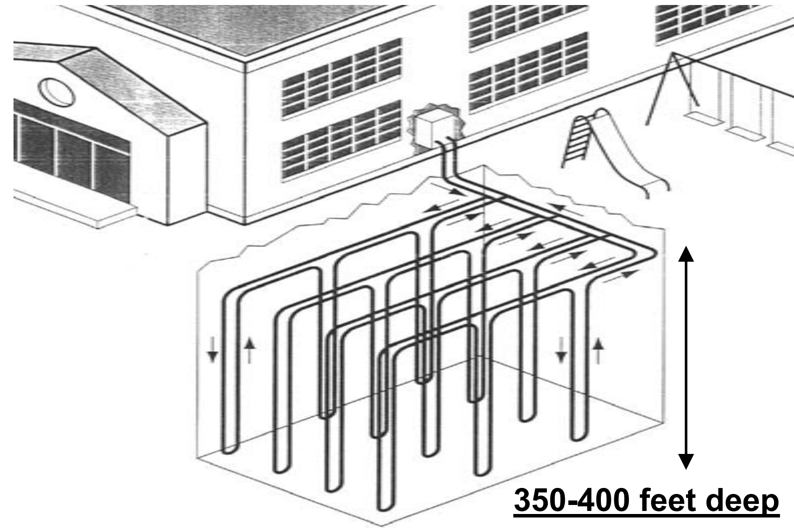


U.S. Department of Energy
Energy Efficiency and Renewable Energy

Main Components of the GHP System

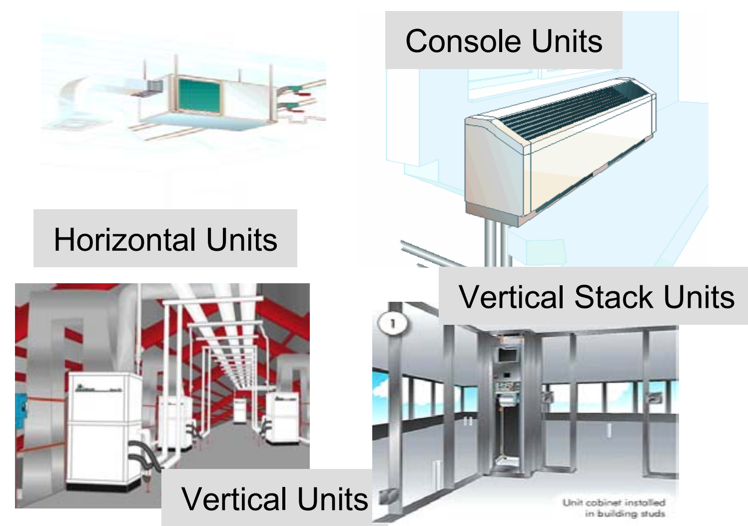
The Earth Heat Exchanger (outside)

- The EHX design is a fundamental issue.
- Integrated processes are critical for the efficiency and the reliability of an installation in the long term:
  - Design Engineering Assistance
  - Drilling, Looping, & Grouting
  - Trenching, Headering & Manifolding
  - Testing, Metering, Verification and Acceptance



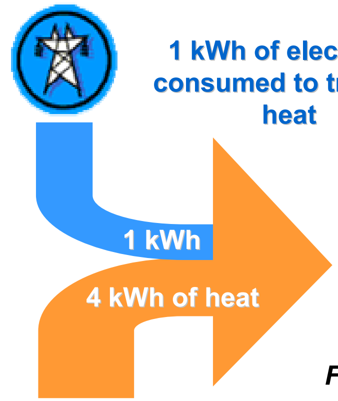
The Water Source Heat Pump (inside)

- The most efficient heating and cooling system
- A decentralized design: each heat pump is installed in close proximity to the zone it serves.
- The water source heat pump is easy to service and does not require specialized training.



Geothermal Solution for Sustainable Development

Renewable Energy for Heating In Winter



1 kWh of electricity consumed to transfer heat

5 kWh of heat produced (17 kBtu)

4 / 5 = 80%
From a renewable source

4 kWh of heat (13.6 kBtu) "free" taken from the earth

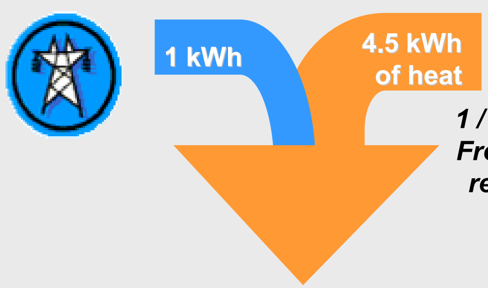
Energy provided to the building for each increment of 5 kWh required for heating (17 kBtu)

Renewable Energy used for the total comfort need of the building: 80%

Renewable Energy for Cooling In Summer

1 kWh of electricity consumed to transfer heat

4.5 kWh of heat (1.3 ton-hour) are taken from the building to cool it



1 / 4.5 = 22%
From a non-renewable source

5.5 kWh of heat (1.4 ton-hour) rejected and "renewed" in the ground

Energy provided to the building for each increment of 4.5 kWh required for cooling (1.3 ton-hour)

Renewable Energy used for the total comfort need of the building: 78%

Benefits for Colorado Schools

- Ideal ground conductivity
- Ideal heating/cooling loads
- Turnkey providers exist in the market
- Ideal for all climates in Colorado
- Can be renovated without disruption to students
- Financing structures allow for zero budget impact

"One Stop Shopping"

- **Analysis of the building thermal needs and design of the Earth Heat Exchanger**

- **Provide a reliable, efficient and sustainable earth heat exchanger**
  - Coiled tubing unit (CTU) for loop insertion and grouting
  - Cementitious Grout with Gel Polymer

- **EnLink Earth Heat Exchanger Meter**
  - Service Aid-monitor EHX status
  - Performance Assurance – monitor entering water temperature
  - Emissions Reduction Report

- **Thermal Conductivity "TC" testing**
  - Proves system design parameters
  - Provides performance benchmark

Feasibility Report, Design, Construction, Commissioning, Warranty

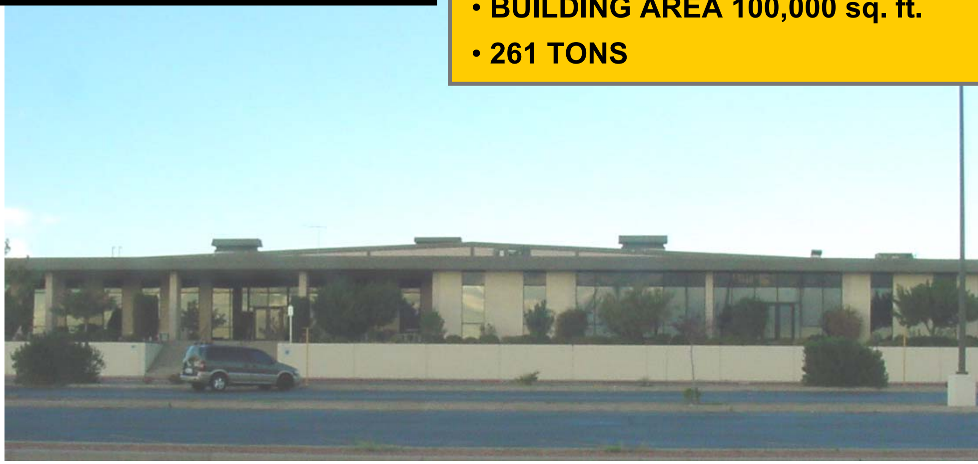
Case Study #1:
El Paso Chamber of Commerce

El Paso Chamber of Commerce

THE GREATER EL PASO
CHAMBER OF COMMERCE
SINCE 1899

PROJECT TYPE : HVAC RETROFIT

- **BUILDING AREA 100,000 sq. ft.**
- **261 TONS**



Existing Equipment Problem

- ✓ Expensive repairs – old cooling tower
- ✓ High water usage
- ✓ Inefficient cooling and heating equipment
- ✓ Inadequate comfort
- ✓ Leaking water pipes
- ✓ Budget problems due to escalating costs

→ **Need for a new HVAC system**

The Chamber's primary concerns for the new heating and cooling system

- ➢ Create a comfortable, even temperature throughout the building
- ➢ Reduce utility bills (water, electricity and gas) and maintenance costs
- ➢ Where applicable, tie into the existing system with no disruption in building operations
- ➢ Become an example to the business community on how to implement renewable energy and water conservation programs.

El Paso Chamber of Commerce

The EnLink Geothermal Heat Pump (GHP) Solution

- ✓ 55 heat pumps, each with its own thermostat installed, for a total need of 261 tons.
- ✓ The Earth Heat Exchanger consists of 128 wells
- ✓ 6 months to complete the installation without disruption in the facility.

THE GREATER EL PASO CHAMBER OF COMMERCE SINCE 1899

Benefits for the El Paso Chamber

- **Comfort**: customized comfort (zoning)
- **Economics**: dramatically reduced utility & maintenance costs (- 45%)
- **Health & safety**: no gas-fired boilers, reduced risks of air-borne diseases, remove unsightly outdoor equipment.
- **Environment**: emissions (CO_2, NO_x, SO_2) saved are equivalent to removing 5,860 vehicles from our roads.

Case Study #2:
Lubbock Christian University

Lubbock Christian University, TX

Lubbock Christian University Project (LCU), TX

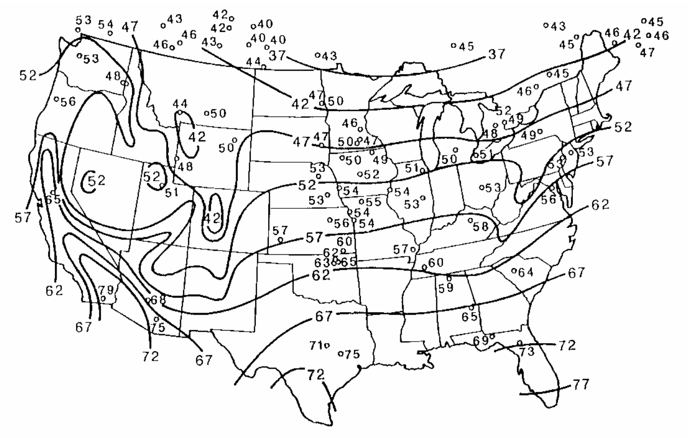
- First 3 buildings (peak cooling 350 tons) of a 20-building retrofit planned over the next 4 years
- 1st Phase contract price - $2.9 million
  - Geothermal 4 buildings
  - Lighting retrofit 20 buildings
- 1st Phase paid through total energy savings
  - Financing capital cost
  - Immediate positive cash flow from project
  - $5.4 million in savings over 20 years
- Construction schedule May 12th – Sept 10th

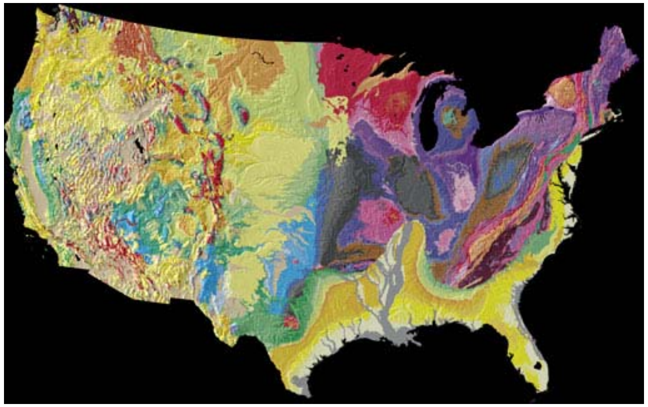
LUBBOCK CHRISTIAN UNIVERSITY

HVAC system before retrofit

Stage 1: Engineering Analysis

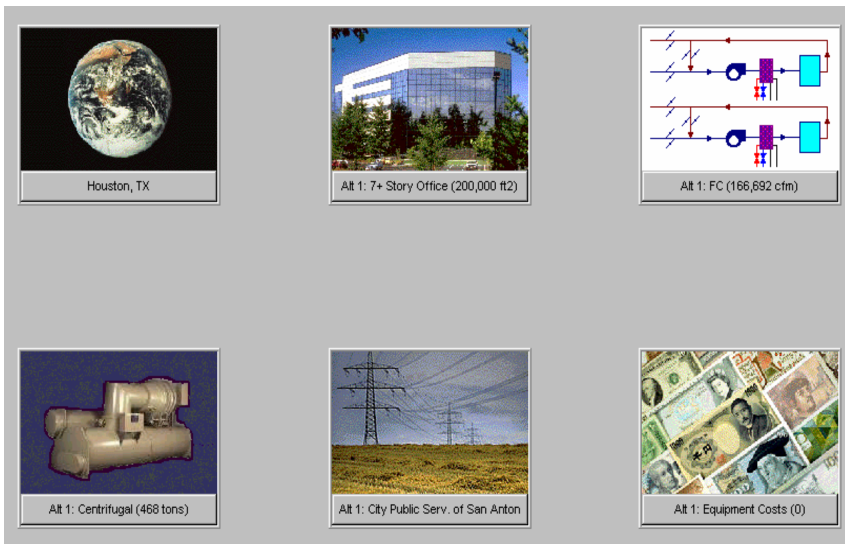
Geothermal & Geological Study → Thermal Conductivity Test

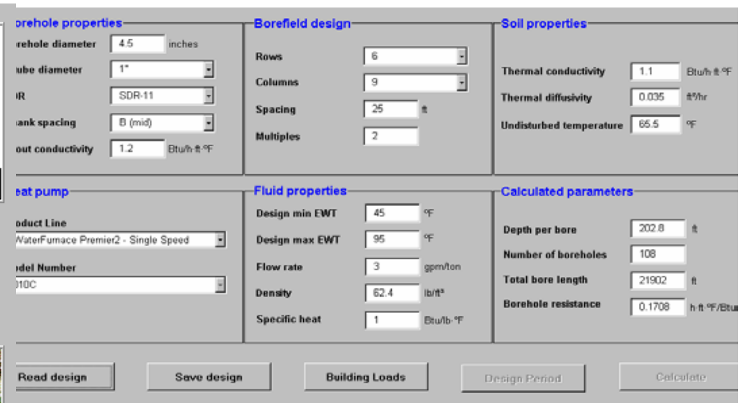




Stage 1: Engineering Analysis

Analysis of the building thermal needs & design of the EHX





Analysis of the building heating and cooling load through Trane Analyzer

Design of the Earth Heat Exchanger (EHX) with EnLink Software (Geodevelopper)

Stage 2: Drilling, Looping & Grouting

Drilling the wells for the Earth Heat Exchanger

Looping & Grouting with EnLink patented Coil Tubing Unit (CTU)

The Drill Rig drills as deep as 400 feet

U.S. Department of Energy
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Stage 2: Trenching & Manifolding

Trenching and Manifolding

Well fields

Connecting the wells with each other

Stage 3: Connection with building

Main connection to the building

Interior piping network connects all the Water Source Heat Pumps to the EHX

Emission Reductions Over System Life

LET'S DO SOMETHING FOR OUR PLANET

Lubbock Christian University emission reductions over system life,

Carbon Dioxide (CO_2) in pounds	Sulfur Dioxide (SO_2) in grams	Nitrogen Oxide (NO_X) in grams
971,998	617,039	861,661

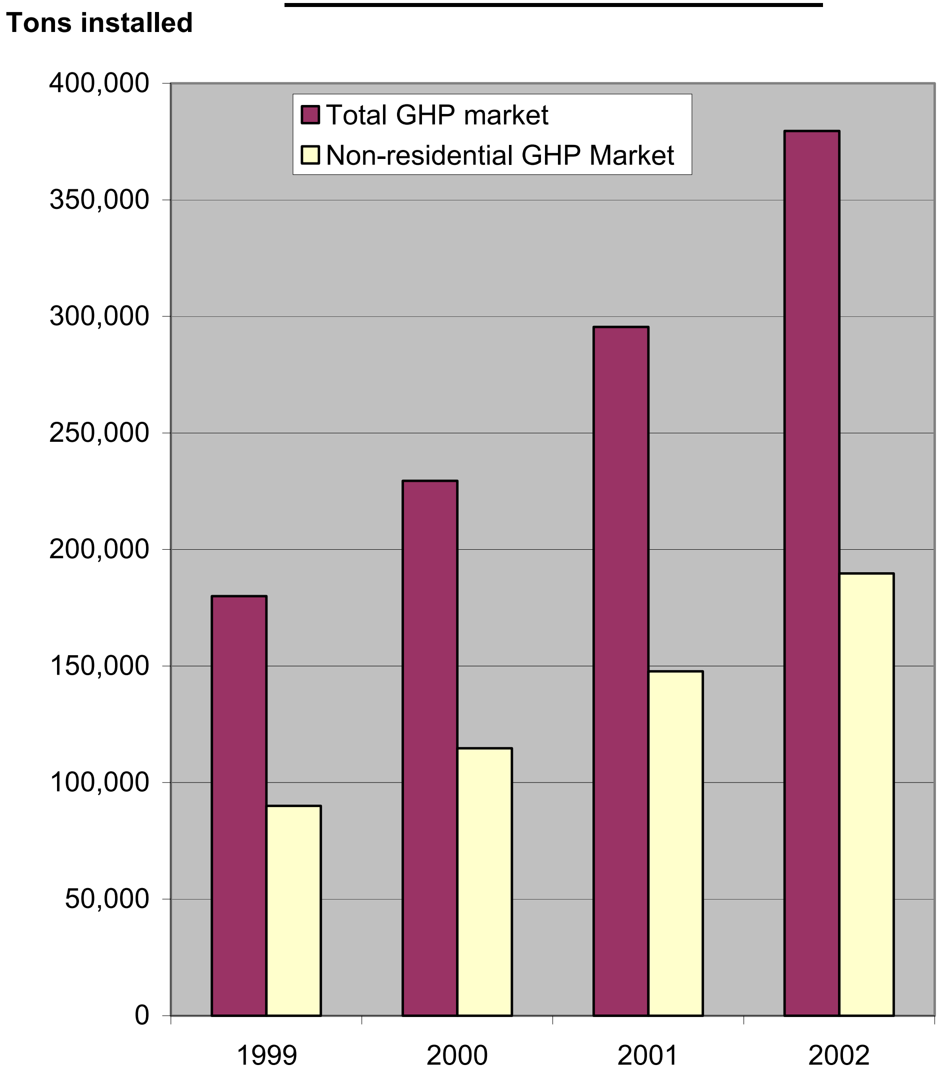
. . . according to the EPA, are equivalent to planting 1,944,000 trees, or removing 3,888 vehicles from our roads.

EnLink will process the Energy Star Building Certification for LCU.

The US GHP Market

GHP Market in United States

Evolution of the US GHP Market



Industry Growth Challenges

- Lack of industry infrastructure
- Earth Heat Exchanger design inconsistencies
- Multiple vendors for one project
- Poor customer service training
- Lack of positive case studies
- Materials and methods used that were not specific to the industry

Some GHP Users

Commercial Applications
- Conoco
- Philips 66
- Holiday Inn
- Comfort Inn
- Wendy's

Federal Organization
- US Military Bases
- US Post Office
- Oklahoma State Capital
- US Merchant Marine Academy

… Other federal buildings

The Bush Ranch in Crawford, TX.

Schools
- Poudre Schools
- Gadsden ISD
- Colorado Springs
- Adelphi University
- Lubbock Christian University

And others independent school district in NY, California, Colorado …

Community
- Medina Church of Christ
- Du Pont Medical Center
- Wildlife Center of Virginia
- Kopernik Space Education Center (NY)

Industry Organizations and supporters

GEOEXCHANGE®

WWW.GHPC.org

IGSHPA
Down to Earth Energy

International Ground Source Heat Pump Association

www.igshpa.okstate.edu

> **"GeoExchange is the most energy-efficient, environmentally clean, and cost-effective space conditioning system available."**
>
> **EPA (Environmental Protection Agency)**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

www.epa.gov

http://www.ashrae.org/

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Engineering for the World We Live In

EUROPEAN ORGANIZATIONS

- ✓ **European Heat Pump Association**
  www.ehpa.org
- ✓ **Association Française des Pompes à chaleur**
- ✓ **Federation of Environmental Trade Associations**
  www.feta.co.uk
- ✓ **Sustainable Energy Ireland**
  www.sei.ie

Thank You!

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