Leveraging Geothermal

Monthly Partner Web Conference
February 17, 2010
Call-in number: 888 299 3188
Conference Code 202 343 9965#
About The Web Conferences

- Monthly
- Topics are structured on a strategic approach to energy management
- Help you continually improve energy performance
- Opportunity to share ideas with others
- Slides are a starting point for discussion
Web Conference Logistics

- **Phones will be Muted**
  To ask a question use **# 6 to un-mute**
  and *** 6 – to mute**

- **Questions** – use the chat window or ask question during the Q & A period.

- **Presentation slides** will be sent by email to all participants following the web conference.
Today’s Web Conference

Speakers:

• John Kelly – Geothermal Heat Pump Consortium
• Mark Tschirhart – York County School Division
• Questions & Discussion
• Announcements
GEOTHERMAL HEAT PUMP
Fundamentals & Applications

ENERGY STAR PARTNER MEETING
MARCH 17, 2010
JOHN KELLY
GEOTHERMAL HEAT PUMP CONSORTIUM
GEOEXCHANGE.ORG

• NON-PROFIT TRADE ASSOCIATION
• SUPPORT MEMBER BUSINESSES
• EDUCATE DECISION MAKERS
• ASSIST CONSUMERS
• PROTECT GROUND WATER
GEOTHERMAL HEAT PUMPS

OVERVIEW

• MARKET
• INDUSTRY
• CONCEPTS
• OTHER CONSIDERATIONS
• RESOURCES
GHP MARKET

• RESIDENTIAL
• COMMERCIAL / INDUSTRIAL
• INSTITUTIONAL
  – SCHOOLS
  – HEALTHCARE
  – CORRECTIONAL
• GOVERNMENT: DOE, DOD, GSA, USDA, etc.
GHP INDUSTRY

• MANUFACTURERS
  • HEAT PUMPS
  • HDPE PIPE, PUMPS, GROUTS, DRILL RIGS…
• HVAC COMPANIES
• DRILLERS / GROUND LOOP INSTALLERS
• ENGINEERS / ARCHITECTS
• UTILITIES
GHP CONCEPTS

• HEAT PUMP
• CONVENTIONAL HEAT PUMP
  – AIR SOURCE (conventional A/C or refrigerator)
  – WATER SOURCE (boiler/cooling tower)
• GROUND SOURCE HP(earth or water)
• GEOTHERMAL HEAT PUMP
  – WATER SOURCE (not boiler/cooling tower)
GHP CONCEPTS

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GHP CONCEPTS

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  – AIR SOURCE (conventional A/C or refrigerator)
  – WATER SOURCE (boiler/cooling tower)
Water-Source Boiler/Cooling Tower
GHP CONCEPTS

• HEAT PUMP

• CONVENTIONAL HEAT PUMP
  – AIR SOURCE (conventional A/C or refrigerator)
  – WATER SOURCE (boiler/cooling tower)

• GROUND SOURCE HP(earth or water)

• GEOTHERMAL HEAT PUMP
  – WATER SOURCE (not boiler/cooling tower)
VERTICAL OPEN LOOP
VERTICAL CLOSED LOOP
POND LOOP
GHP CONCEPTS

• GEOTHERMAL HEAT PUMP
  • WATER-TO-WATER
  • WATER-TO-AIR
  • HYBRID SYSTEMS
Hybrid – Replace boiler with ground loop
GHP CONCEPTS

GROUND HEAT EXCHANGER
(GROUND LOOP – EARTH HEAT XFER)

• BUILDING LOADS
• SOIL / ROCK CHARACTERISTICS
• MOISTURE CONTENT / WATER TABLE
• GROUT
  – HEAT TRANSFER CHARACTERISTICS
  – AQUIFER PROTECTION
• CIRCULATING FLUID
GHP System Efficiency

• COOLING
  – Energy Efficiency Ratio (EER)
  – EER = Total Cooling Capacity in BTU/hour divided by Power input in Watts

• HEATING
  – Coefficient of Performance (COP)
  – COP = Heating Capacity in BTU/hour divided by Power input in BTU/hour

• 1 kWh = 3413 BTU
GHP System Efficiency

1 UNIT OF ENERGY FROM THE GRID

4 UNITS OF ENERGY FROM THE EARTH

YIELDS:
5 UNITS OF ENERGY FOR A FACILITY

500 % End-Use Efficiency (167% Source Energy Efficiency)
GHP REGULATION

• REFRIGERANTS (R-22, R410a, etc.)
• GROUND WATER REGULATION
  – AQUIFER PROTECTION
  – ANTI-FREEZE
• LICENSING
  – GROUND LOOP DESIGN & INSTALLATION
  – DRILLING
GHP LEGISLATION

- Bailout Bill GHP Tax Incentives
- Stimulus Bill GHP Tax Incentives and Grants
- Renewable Electricity Standard
- Energy Efficiency Resource Standard
- Climate Change Carbon Provisions
- State RES, EERS and Incentives
GHP INCENTIVES

- 10% FEDERAL INCOME TAX CREDIT
- GRANT IN LIEU OF TAX CREDIT
- ACCELERATED DEPRECIATION
- STATE INCENTIVES
- UTILITY INCENTIVES
GHP CASE STUDIES

• BALL STATE UNIVERSITY – MUNCIE, IN
  CAMPUS-WIDE 45 BUILDINGS
  4,100 BOREHOLES
  http://cms.bsu.edu/About/Geothermal.aspx

• GALT HOUSE - LOUISVILLE, KY
  4,500 TONS
  1,200 HEAT PUMPS
GHP RESOURCES

• Environmental Protection Agency (Energy Star)
• U.S. Department of Agriculture
• U.S. Department of Defense
• U.S. Department of Energy
  – Federal Energy Management Program
  – National Renewable Energy Laboratory
  – Oak Ridge National Laboratory
GHP RESOURCES

Oak Ridge National Laboratory - December 2008
Geothermal (Ground-Source) Heat Pumps:
Market Status, Barriers to Adoption, and
Actions to Overcome Barriers

CONCLUSIONS

GHPs use the only renewable energy resource that is available at every building’s point of use, on-demand, that cannot be depleted (assuming proper design), and is potentially affordable in all 50 states.
GHPs have the potential to offset about 35 to 40 percent of the projected growth in building energy consumption between now and 2030.
GHP RESOURCES

• International Ground Source Heat Pump Association
  http://www.igshpa.okstate.edu/

• National Ground Water Association
  http://www.ngwa.org/

• American Ground Water Trust
  http://www.agwt.org/

• Geothermal Resources Council
  http://www.geothermal.org/

• Geothermal Heat Pump Consortium
  http://www.GeoExchange.org/)
THANK YOU

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The York County School Division

Geothermal Schools:
Not Just Theory
York County Schools: The Search for Energy Efficiency

- **1997** Performance contract - replaced T-12 lighting in ten schools and installed DDC building automation systems in seven
- **2000** Installed the first geothermal system
- **2005** Energy Star Partner *10-point Reduction Award* for decreasing energy consumption
- **2006** Energy Star Leader and *20-point Reduction Award* for decreasing energy consumption
- **2007** Received first Energy Star Awards for four schools – all which were geothermal
- **2009** Received Energy Star Leader Top Performer Award
- **2009** Received Energy Star Awards for ten schools – six are geothermal
- **2010** Retrofitting geothermal into our eighth school - nearly half of our schools are geothermal
Proof Not Just Theory: Case Studies of Four Existing Geothermal Buildings

1. Seaford Elementary School
2. Queen’s Lake Middle School
3. York Middle School
4. Bruton High School
Case Study # 1: Seaford Elementary School

Earned an Energy Star rating for three consecutive years.
Seaford Elementary School
A Certified Energy Star Building
Energy Features before Geothermal Retrofit

- F32T8 Fluorescent lighting
- DDC Building Automation System
- Air to air heat pumps
- Fresh delivered through the heat pumps-fresh air delivery was ineffective
Energy Features after Retrofit

- F32T8 Fluorescent lighting
- Occupancy sensors
- Geothermal heat pumps
- DDC Building Automation System
- Adjustable room temperature setpoints & overrides
- Permanent humidity monitoring
- Fresh air supplied to classrooms through dedicated makeup air systems
- Increased amount of fresh air delivered to classrooms
- Air-conditioned kitchen and hallways
- Added a 10,501 sqft air-conditioned gymnasium
Seaford Elementary – Electrical Consumption (kWh) by Fiscal Year
Seaford Elementary – Natural Gas Consumption (CCF) by Fiscal Year

Current Energy Intensity: 36.5 kBtu/sf/yr
Seaford Elementary School
Case Study # 2: Queens Lake Middle School

The first middle school in Virginia to earn an Energy Star rating. It has earned an Energy Star rating for three consecutive years.
Queens Lake Middle School
A Certified Energy Star Building
Energy Features *before* Renovation

- F32T8 Fluorescent lighting
- DDC Building Automation System
- Air to air heat pumps
- Fresh delivered through the heat pumps-found broken and seized dampers
- Gymnasium, locker rooms and kitchen were not air-conditioned
Energy Features after Renovation

- F32T8 Fluorescent lighting
- Occupancy sensors
- Geothermal heat pumps
- VFD equipped circulating pumps
- DDC Building Automation System
- Adjustable room temperature setpoints & overrides
- Permanent CO2 and humidity monitoring
- Air-conditioned gym, locker rooms, kitchen and hallways
- Fresh air supplied through heat wheel style units
- Increased amount of fresh air delivered to classrooms
- Square footage increased from 47,767sqft to 56,075 sqft
Queens Lake Middle – Electrical Consumption (kWh) by Fiscal Year
Queens Lake Middle - Natural Gas Consumption (CCF) by Fiscal Year

Current Energy Intensity: 32.9 kBtu/sf/yr
Queens Lake Middle School
Case Study # 3: York Middle School
An Energy Star Certified Building
York Middle School
An Energy Star Certified Building
Energy Features before Renovation

- F34T12 fluorescent lighting
- Pneumatically controlled unit ventilators
- Fresh air was delivered through the unit ventilators - fresh air delivery effectiveness was questionable
- Pilot DDC Building Automation System
- Natural gas fired boilers
- Gym, locker rooms and kitchen were not air-conditioned
Energy Features *after* Renovation

- F32T8 Fluorescent lighting
- Occupancy sensors
- Geothermal heat pumps
- VFD equipped circulating pumps
- DDC Building Automation System
- Adjustable room temperature setpoints & overrides
- Permanent CO2 and humidity monitoring
- Air-conditioned auditorium, gymnasium, locker rooms, kitchen and hallways
- Fresh air supplied through heat wheel style units
- Increased amount of fresh air delivered to classrooms
- Added 24,500 sqft classroom space and media center
York Middle School – Electrical Consumption (kWh) by Fiscal Year
York Middle - Natural Gas Consumption (CCF) by Fiscal Year

Current Energy Intensity: 27.1 Btu/sf/yr
York Middle School
Case Study # 4: Bruton High School

The first high school in Virginia to earn an Energy Star rating. It has earned the Energy Star rating for three consecutive years.
Energy Features *before* Renovation

- F34T12 fluorescent lighting
- Pilot DDC Building Automation System
- Packaged all electric rooftop multi-zone units
- Fresh air delivered through the multi-zone units - fresh air delivery was ineffective
- Gym, locker rooms and kitchen were not air-conditioned
Energy Features *after* Renovation

- F32T8 Fluorescent lighting
- Occupancy sensors
- Geothermal heat pumps
- VFD equipped circulating pumps
- DDC Building Automation System
- Adjustable room temperature setpoints & overrides
- Permanent CO2 and humidity monitoring
- Air-conditioned gym, locker rooms and kitchen
- Fresh air supplied through heat wheel style units
- Increased amount of fresh air delivered to classrooms
- Added a 2,870 sqft air-conditioned practice gymnasium
Bruton High School – Electrical Consumption (kWh) by Fiscal Year

Current Energy Intensity: 29.2 kBtu/sf/yr
Bruton High School
Comparison of a Geothermal Installation versus a Traditional HVAC System

Bruton High School – (152,656 sq ft) total yearly cost includes electricity and propane gas
Tabb High School – (157,307 sq ft) total yearly cost includes electricity and natural gas
Bruton High School - Geothermal System 1 - Instructional Wing

Outside Air: 65°F

Heat Pump Loop Return Temperature: 72.7°F

Loop Differential Pressure: 16.3

Heat Pump Loop Supply Temperature: 67.7°F

Geothermal Well Field

P-3 Stat: Closed

P-4 Stat: Open
A Side by Side Comparison…

Tabb High Boiler Room

Which would you rather maintain?

Bruton High School - Geothermal System 1 - Instructional Wing

Outside Air: 49°F

Heat Pump Loop Return Temperature: 72.7°F

Loop Differential Pressure: 16.3

Heat Pump Loop Supply Temperature: 67.7°F

Which would you rather maintain?
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Questions & Discussion

- Use # 6 to un-mute phone
- * 6 to mute phone.
Upcoming Web Conferences

April – Constant Commissioning
May – Award Winning Energy Programs
June – Driving Responsibility for Energy Use
July – How to Launch an Energy Competition

Register online at:
energystar.webex.com/meetings
• Thank you