IKEA Taps Geothermal to Enhance Energy Efficiency & Environmental Stewardship

International Ground Source Heat Pump Association
Kansas City, MO
October 7, 2015
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This presentation is an overview of some of the strategies taken by one of the largest home furnishing retailers in the world to employ geothermal technologies to lower operating costs and reduce environmental impacts. Focus will be on two IKEA stores in the U.S., one in Merriam, KS (Kansas City area) and the other in Centennial, CO (Denver area). The presenter is neither an agent or spokesperson for IKEA.
Perspective: IKEA is a global home furnishing retailer providing home furnishing products

• The IKEA Vision:
  – To make a better everyday life for the many

• The IKEA Mission:
  – To provide well designed, stylish, functional home furnishings at affordable prices

• The IKEA Approach:
  – Furniture & accessories
  – All under one roof
  – 10,000 items available on-site
  – See product, take home, assemble the same day
  – Products designed/produced exclusively by IKEA
• World’s leading home furnishing company
• Still privately held, operations mostly in Sweden
• 377 stores in 48 countries (41 stores in US to date)
• 147,000 people employed
• Global sales $33 billion (2014):
  – Germany – 14%
  – USA - 12%
  – France - 8%
  – Russia - 6%
  – United Kingdom - 6%
• US sales $4.6 billion (2014)
• Recent focus has been on US expansion
• IKEA’s corporate objective is to employ sustainable building practices whenever feasible
• Consistent with the company’s goal of being energy independent by 2020, IKEA globally has installed more than 700,000 solar panels, owns/operates approximately 300 wind turbines in Europe, 104 wind turbines in the US, and has geothermal systems at approximately 50 locations
• Solar panels on 90% of US locations, including the Centennial and Merriam stores
• IKEA, drawing from its Swedish heritage and respect of nature, proves it can be profitable while minimizing environmental impacts
IKEA’s US sustainable efforts include:

- Incorporation of energy-efficient HVAC mechanical and lighting systems
- Use of recycled construction materials and recycling of construction waste
- Natural skylighting in warehouse facilities
- Water conserving lavatories
- BAS (building automation system) optimization to minimize power consumption and reduce corporate carbon footprint
Operational strategies include:

- Elimination of plastic bags during customer check-out process
- Phase-out of incandescent light bulb sales
- Facilitating the recycling of compact fluorescent bulbs
- By 2016 selling and using only LED bulbs
IKEA Centennial perspective:
• Large scale home furnishing store
• Open 7 days/week
• 415,000 ft² of conditioned space
• Two levels retail space
• Large under-store two level parking capacity
• Two restaurants – one for up to 550 customers, one for staff
• Largest single facility GSHP installation in Colorado to date
Mechanical summary:

- 130 boreholes, 500’ depth, 1.25” DR11 HDPE – installed under building footprint
- Central plant, ten 35 ton water-water heat pumps, driving VAV system for most of store
- Nine 1500 gallon ice storage tanks
- Two mechanical rooms
- Eight packaged water-air heat pumps, 1.5 to 6.0 tons
- Twenty six hydronic air handlers – 1,000 to 18,400 cfm; 24 of these are roof top OA units with energy wheels
- 38,000 ft² radiant heat dissipation slab
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IKEA – Centennial, Colorado (Denver)

Summary, Basis of Design:

• Cooling dominant annual load profile
• 1st stage heat rejection to domestic hot water, conditions permitting
• 2nd stage heat rejection to radiant heat dissipation, conditions permitting (~38,000 ft²)
• 3rd stage heat rejection, GHX (ground heat exchanger)
• Ice is generated during off-peak, usually after store is closed, or when conditions permit
• Ice to supplement heat pumps to moderate SCWT (supply chilled water temperature) as required to delivery system
• Use OA (outside air) units to purge/cool facility in evening, conditions permitting
• Water cooled condensers for restaurant refrigeration units tied to hydronic loop to scavenge waste heat
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IKEA – Centennial, Colorado (Denver)

Conceptual mechanical schematic

- Distributed Packaged Water-Air Heat Pumps
- Radiant slab - heat rejection
- Central Water-Water HP Plant
- GHX – 130 boreholes x 500’ depth
- OA ERVs
- VAV System
- Heat rejection - domestic hot water
- TES (Ice Storage)
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IKEA – Centennial, Colorado (Denver)

130 bores x 500’, under building footprint
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IKEA – Centennial, Colorado (Denver)

Ten 35 ton W-W heat pumps
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IKEA – Centennial, Colorado (Denver)

(13) 3” HDPE header pairs
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IKEA – Centennial, Colorado (Denver)

Each ice storage tank is rated for 1500 gallons capacity
Total of nine tanks - 13,500 gallons
Heat rejection PEX manifolding
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IKEA – Centennial, Colorado (Denver)

Heat rejection slab PEX circuits

*Photos courtesy Ed Lohrenz, GeoXergy*
The Centennial store employs an interactive kiosk at the entrance to educate customers on its energy efficient design.
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IKEA – Centennial, Colorado (Denver)

The kiosk describes the stores energy efficient features with a scaled architectural model.
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IKEA – Centennial, Colorado (Denver)

Radiant slab heat dissipation (kiosk)
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IKEA – Centennial, Colorado (Denver)

Rooftop photovoltaic panels (kiosk)
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IKEA – Merriam, KS (Kansas City)
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IKEA – Merriam, KS (Kansas City)

IKEA Merriam perspective:
• Large scale home furnishing store
• Open 7 days/week
• 359,000 ft² of conditioned space
• Two levels retail space
• Large under-store parking
• Two restaurants – one for up to 450 customers, one for staff
• Largest single facility GSHP installation in tri-state (KS-MO-NE) area to date
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IKEA – Merriam, KS (Kansas City)
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IKEA – Merriam, KS (Kansas City)

**Mechanical summary:**

- 180 boreholes, 600’ depth, 1.25” HDPE – installed external of building footprint
- Heat pump schedule, 753 nominal tons:
  - 665 tons, roof-top water-air heat pumps
  - 43 tons, packaged water-air heat pumps
  - 45 tons, water-water heat pumps
- Simple 2-pipe system
- Primary/secondary pumping strategy
- Conventional RTU ERV units
- One mechanical room
Summary, Basis of Design:

• Cooling dominant annual load profile
• Primary/secondary pumping strategy – enhanced load sharing
• Water-water heat pumps used for direct extraction of heat rejected from cooling, recycle energy for domestic hot water and relieving load on GHX
• GHX pumps into building only as necessary to temper EWT to heat pumps – reduces pumping power
• Use OA (outside air) units to purge/cool facility in evening, conditions permitting
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IKEA – Merriam, KS (Kansas City)

Conceptual mechanical schematic

- Distributed Packaged Water-Air Heat Pumps
- Ground Heat Exchanger 180 boreholes x 600’ depth
- Primary Pumping (Pressure Controlled)
- Distributed Roof Top Water-Air Heat Pumps
- Water-Water Heat Pumps
- GHX Injection Pumping (Temperature Controlled)
- OA ERVs
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IKEA – Merriam, KS (Kansas City)

TC test boring, 2013 (left); production drilling 2014
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IKEA – Merriam, KS (Kansas City)

Yellow highlight – approximate GHX field limits
Asymmetric field enhances heat dissipation
(15) 4” header pairs x (12) 600’ depth bores per header pair
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IKEA – Merriam, KS (Kansas City)

L – Ground heat exchanger (GHX) header pairs
C - Staged, VFD temperature controlled injection pumps from GHX
R - Staged, VFD pressure controlled building circulation pumps
Note: Pumps are capable of ultra-low turn down efficiency
Controls are configured for key metric trending, continuous and concurrent, including:

- GHX supply & return water temperature, flow rates
- Building loop supply & return water temperature, flow rates
- Circulation pump power consumption, flow rate
- Heat absorbed and rejected between GHX and building (energy trending)
- Outside and indoor air temperatures

Value to IKEA:

- Real world evaluation of cost effectiveness of GSHP system
- System diagnostics for facilities maintenance, service

Value to architects and engineers:

- Data to optimize future projects (lessons learned)
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IKEA – Merriam, KS (Kansas City)

As with the Centennial store, in addition to its GSHP mechanical system, Merriam incorporates:

- Energy-efficient lighting systems
- Use of recycled construction materials and recycling of construction waste
- Natural skylighting in warehouse facilities
- Water conserving lavatories
- BAS (building automation system) optimization to minimize power consumption and reduce corporate carbon footprint
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IKEA – Merriam, KS (Kansas City)

Grand Opening – Facility completed
September 10, 2014
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IKEA – Merriam, KS (Kansas City)

Incoming! – September 10, 2014

Kansas City Star photo
Special thanks for insight on IKEA’s green strategies, corporate philosophy, and permission to make this presentation –
Mr. Joseph Roth
IKEA U.S. Expansion/Property Public Affairs
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