The Role of Thermal Potential in Enhancing Energy Efficiency / Productivity

Presented by:
Yale Carden
GeoExchange Australia Pty Ltd
27 June 2018

Presentation Overview

- Start With Why
- What is Thermal Potential?
- Enhancing Energy Efficiency / Productivity
- Geoexchange 101
- Case Studies
- Conclusions

The First Why

- '…we must consider environmental sustainability as one of the world's greatest challenges.'
- '…must promote sustainability through educational programs and school operations.'
- 'We must focus on minimising our carbon emissions and environmental footprint through energy, water consumption and waste recycling.'

The Other Why: Cost and Performance

- Operations:
  - Existing system becoming old and maintenance increasing
- Cost:
  - Increasingly expensive to operate
- Comfort:
  - Uncontrollably warm in summer months

Parallels with Energy Sector

Energy Sector	HVAC Sector
Local Energy Potential	Local Thermal Potential
Renewable Sources	Renewable Sources
Decreasing Demand	Decreasing Demand
Energy Storage	Thermal Storage
Controls: Smart Meters	Controls: Optimised Strategies
Decentralising Systems	Centralising Systems

Renewable (Electrical) Energy Potential

Renewable (Electrical) Energy Potential

Typical Commercial Heating / Cooling System

Cooling Towers

- Ambient air
- Use water
- Legionella control

Boilers

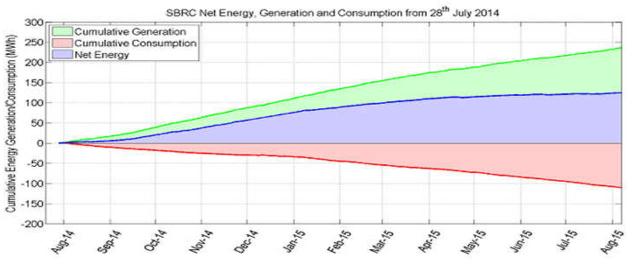
- Burn fossil fuels
- Non-renewable
- Alternative gas supplies

What is Thermal Potential?

- Demand Management Tool – the (forgotten) half of the energy equation
- Thermal is energy too!
- Thermal energy can also be renewable – not just about burning gas and fossil fuels
- Thermal potential consists of:
  - Heat sources (heating)
  - Heat sinks (cooling)
  - Thermal energy storage, including phase change materials
- Multiple thermal sources in the built environment

Integrating to Enhance Energy Productivity

- Renewable (Electrical) Energy
- Renewable (Thermal) Energy
- Can we integrate the two and enhance energy productivity?
  - Greatest $ output for smallest kW input BECOMES
  - Greatest $ / kW output for smallest **carbon** input



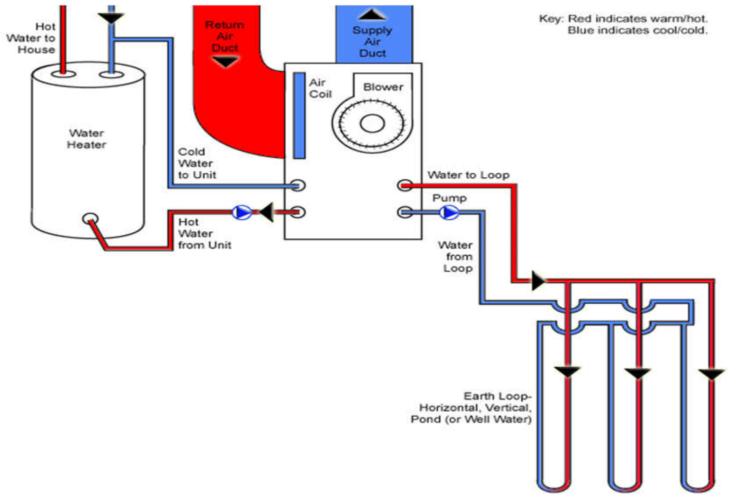
Source: www.sbrc.uow.edu.au/sbrcbuilding/index.html

Geoexchange 101: The Basics

Geoexchange 101: The Basics

- Transfers heat from the earth into the building in winter (**earth as heat source**)
- Transfers heat from the building into the ground in summer (**earth as heat sink**)
- Geoexchange or low temperature geothermal **NOT** 'hot rocks'
- Solar radiation not heat from the Earth's crust

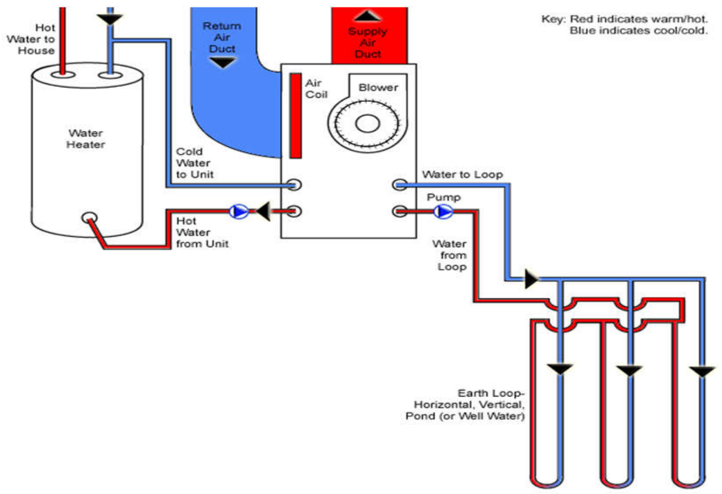
The Geoexchange Cooling Cycle



40 C

17 C

The Geoexchange Heating Cycle

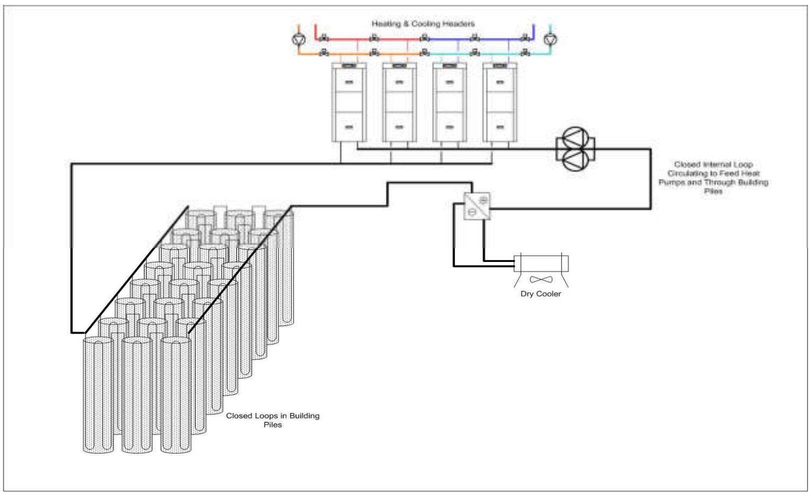


-5 C

17 C

Ground Heat Exchanger

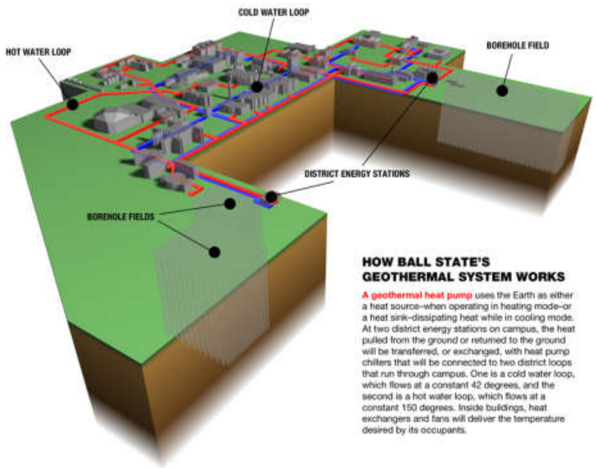
Energy Piles



Sewer Heat Recovery

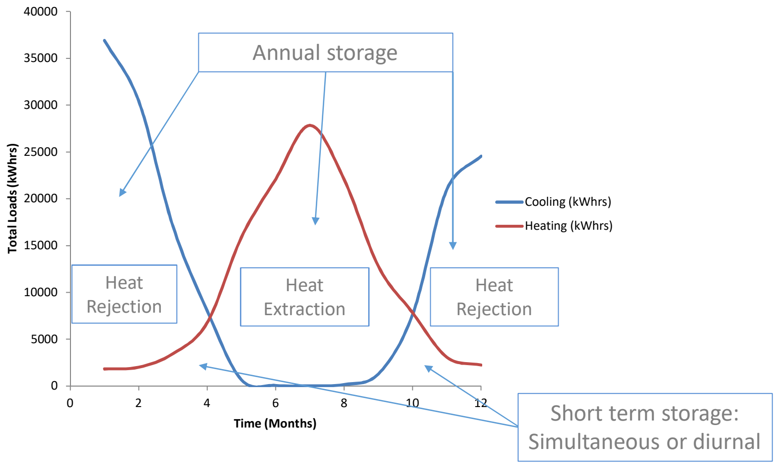
- Also includes wastewater / treated effluent
- Not just heating – cooling also possible
- 20-25C heat source / sink is common
- Match 'water' flow to heating / cooling requirements
- Local projects using treated effluent:
  - Hobart Aquatic Centre, Hobart
  - Grand Chancellor Hotel, Hobart

District Geoexchange Systems

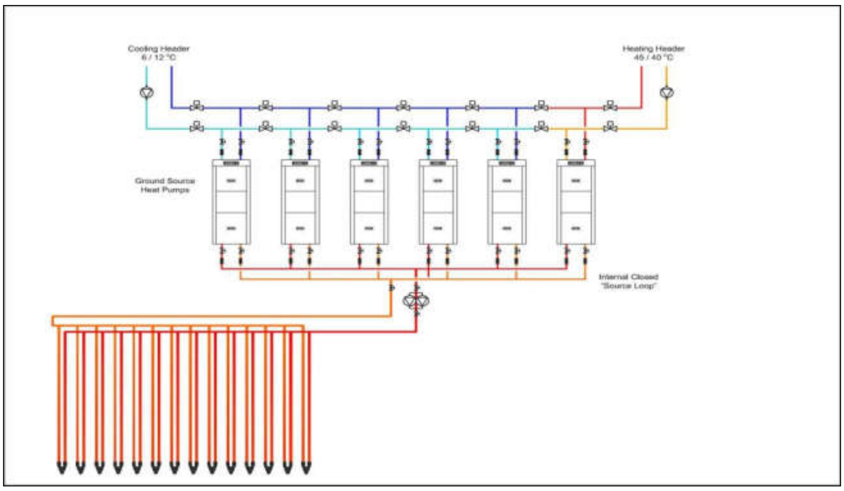


The Role of Thermal Potential in Enhancing Energy Efficiency / Productivity

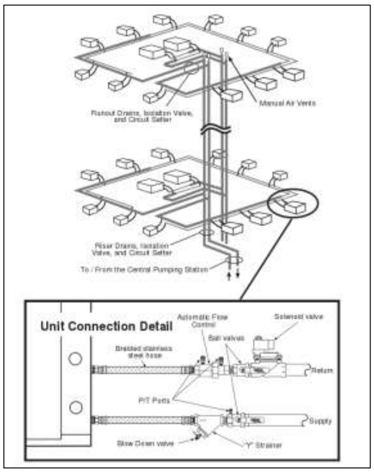
Thermal Energy Storage



GSHPs: Water to Water / Reversible Chillers (Pool)



GSHPs: Water to Air (Ducted) Units



Case Study: St Peters College

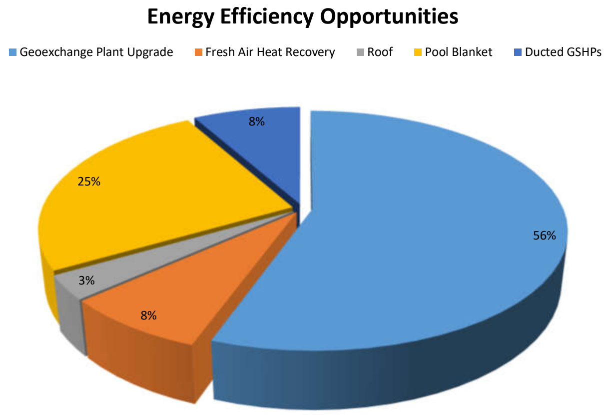
- Existing system uses ambient air
- Thermal potential approach considered the following:
  - Gas;
  - Ambient air (used for heat recovery);
  - Ground with vertical borehole GHX;
  - Ground with horizontal GHX;
  - River water under existing irrigation license;
  - Treated effluent.
- River water was Client preference. However, logistical and future-proofing issues;
- Vertical GHX preferred over horizontal GHX
  - Minimise impact on sport fields;
  - Enable future expansion of system.

The Ground Heat Exchanger

The Ground Source Heat Pumps

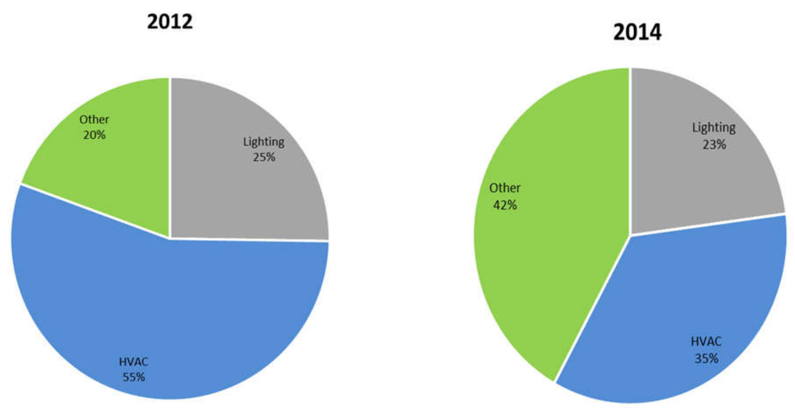
- 2 x water to water / reversible chillers
- 6 x various water to air (ducted) GSHPs
- Heat Recovery System
- Variable Speed Pumps

Energy Efficiency Opportunities



The Role of Thermal Potential in Enhancing Energy Efficiency / Productivity

Case Study: RHBEEP - Tumut (Snowy) Shire Council



The Role of Thermal Potential in Enhancing Energy Efficiency / Productivity

Case Study: RHBEEP - Tumut (Snowy) Shire Council

- Building energy savings: **80 % or $94 000 per annum**
- HVAC energy savings: **71 % or $85 000 per annum**
- Maintenance / tenancy savings: **$80 000 per annum**
- Electricity demand reduction: **151 kVA (75 %) Geoexchange at 49 %**
- Annual GHG Reduction: **79 tCO_2**
- Simple Payback: **7.6 years**
- Return on Investment: **11-12 %**

Case Study: Geoscience Australia

- The Ground Heat Exchanger:
  - 350 Boreholes
  - 104 m deep
  - 1.25” diameter polyethylene pipe
  - 4.5 m spacings
- Ground Source Heat Pumps:
  - 220 x WaterFurnace water to air GSHPs: Premier2
  - 2-speed compressor
  - 3-speed fan
  - BMS connectivity
  - R22 refrigerant

Case Study: Geoscience Australia

The Role of Thermal Potential in Enhancing Energy Efficiency / Productivity

Case Study: Geoscience Australia

The Role of Thermal Potential in Enhancing Energy Efficiency / Productivity

Case Study: Geoscience Australia

The Role of Thermal Potential in Enhancing Energy Efficiency / Productivity

Conclusions: Enhancing Energy Efficiency?

- Create energy from renewable sources – use as efficiently as possible
- Thermal is energy too…and it can be renewable
- Identify local thermal potential
- Can we use renewable (thermal) energy when renewable (electrical) energy is available?
- Timing issues? Storage is the key – electrical or thermal
- Optimised / Predictive Control Strategies
- Canberra is ideal climate for the technology with great local case studies

The Role of Thermal Potential in Enhancing Energy Efficiency / Productivity

Thank you

Yale Carden

GeoExchange Australia Pty Ltd

Phone: 02 8404 4193

Email: ycarden@geoexchange.com.au

Website: www.geoexchange.com.au

The RHBEEP Project
www.tumut.nsw.gov.au/riverina-highlands-building-energy-efficient-project-rhbeep.aspx

Sustainable Buildings Research Centre, University of Wollongong
www.sbrc.uow.edu.au