

Let's Dig it: Using the Ground for Thermal Energy Storage



The Experience of the Riverina Highlands Building, Tumut NSW



Presented by:

Yale Carden, Managing Director, GeoExchange Australia Pty Ltd and
Jo Spicer, Environmental / GIS Officer, Tumut Shire Council

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Presentation Overview



- Why Thermal Energy Storage?
- Thermal is Energy Too
- Ground Heat Exchanger as Thermal Energy Storage
- The Riverina Highlands Building Energy Efficiency Project (RHBEEP)
- Contacts

Why Thermal Energy Storage



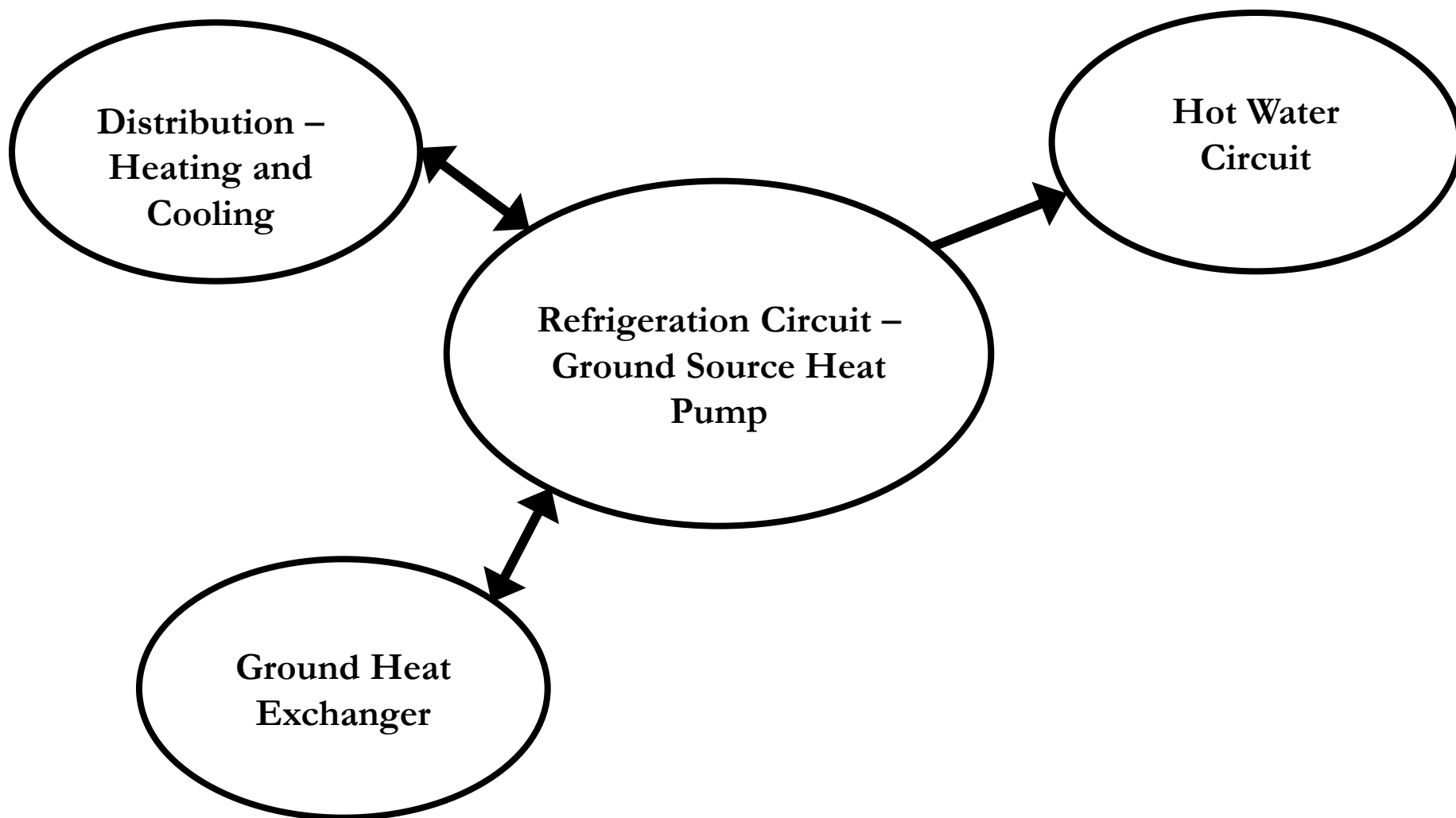
- Up to 80 % annual energy savings
- Reduce peak load up to 50 %
- Remove cooling towers
- Remove external plant and free up building design
- Disconnect natural gas and other fossil fuels
- Increase renewables potential for full load capacity
- Easily integrates with other energy solutions

Thermal is Energy Too



- ClimateWorks: Top 10 Energy Productivity Solutions
- Thermal energy can also be renewable – not just gas and fossil fuels
- Thermal sources in the built environment:
 - Atmosphere
 - Ground
 - Building Foundations / Car Parks
 - Water Bodies
 - Sewer and Wastewater
 - Other Buildings
- Flexibility to optimise demand requirements with available source(s):
 - Heating, cooling and hot water demands:
 - Simultaneous
 - Diurnal
 - Seasonal
 - Available thermal sources – mix and match

Geoexchange: Thermal Connectivity



Ground Heat Exchangers

- Use of constant, stable temperatures as:
 - Heat Source (heating)
 - Heat Sink (cooling)
 - Thermal Energy Storage
- Generic term that includes the ground, water bodies, sewer, building foundations

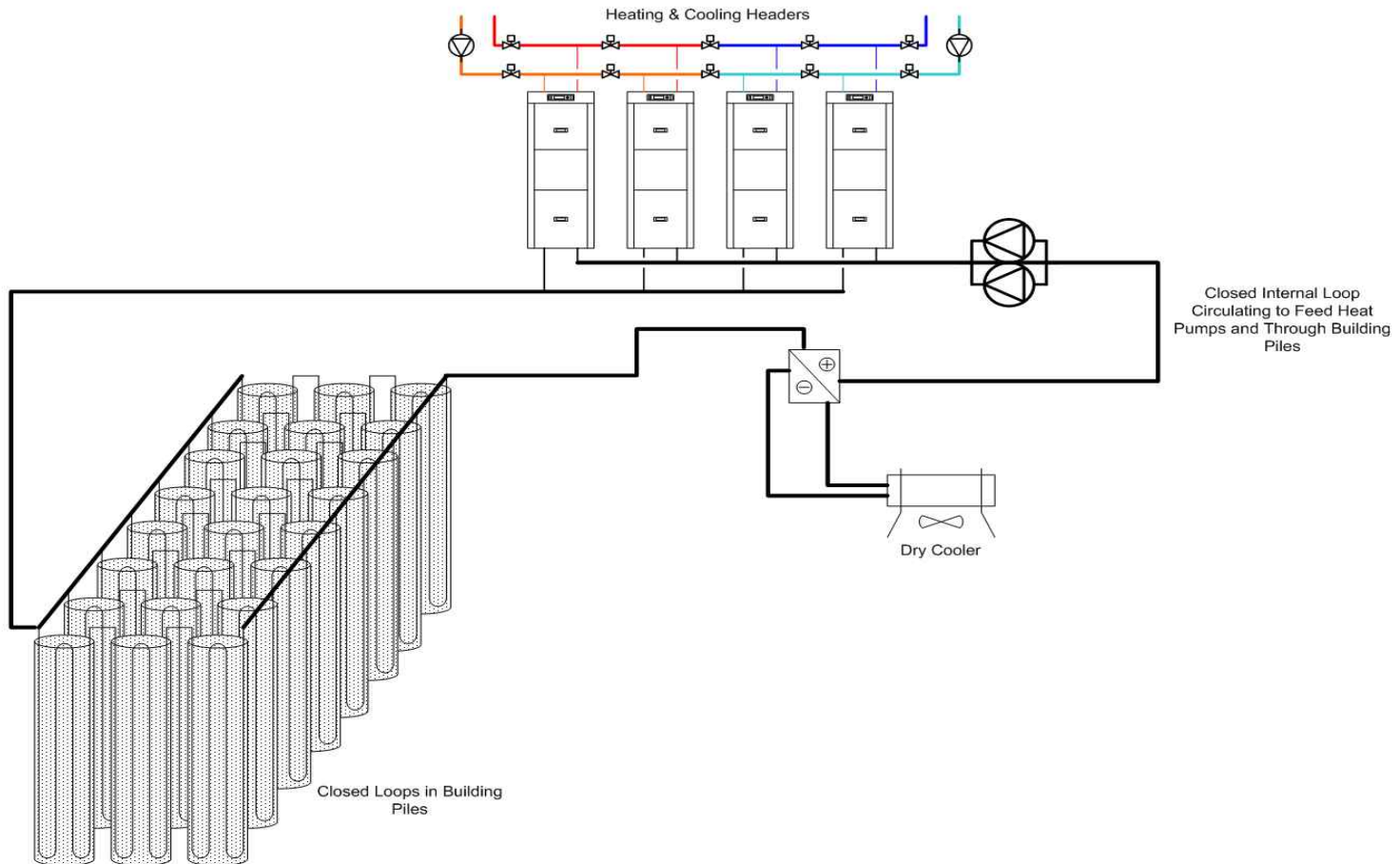
So easy,
a caveman could do it.



Ground and Water Loops



Energy Piles

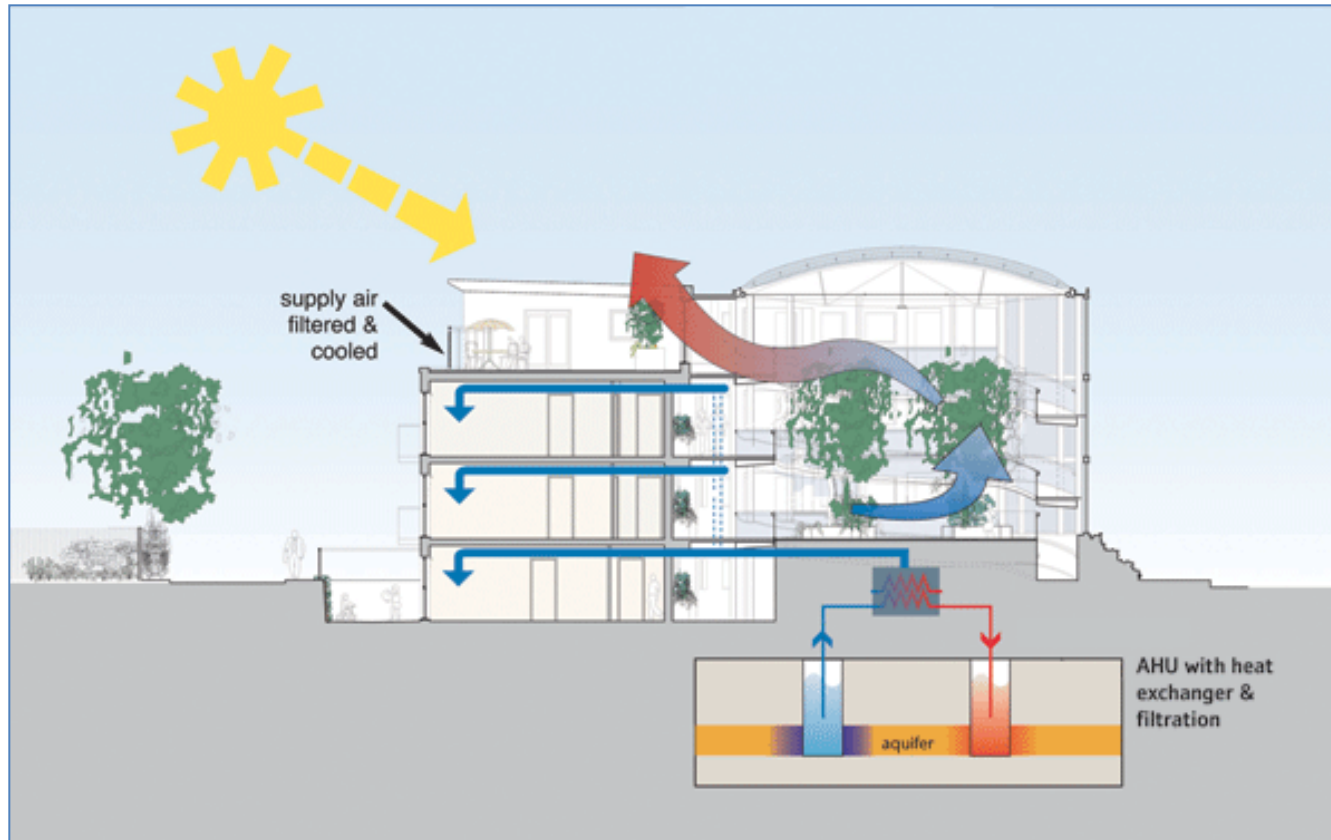


Sewer Heat Recovery



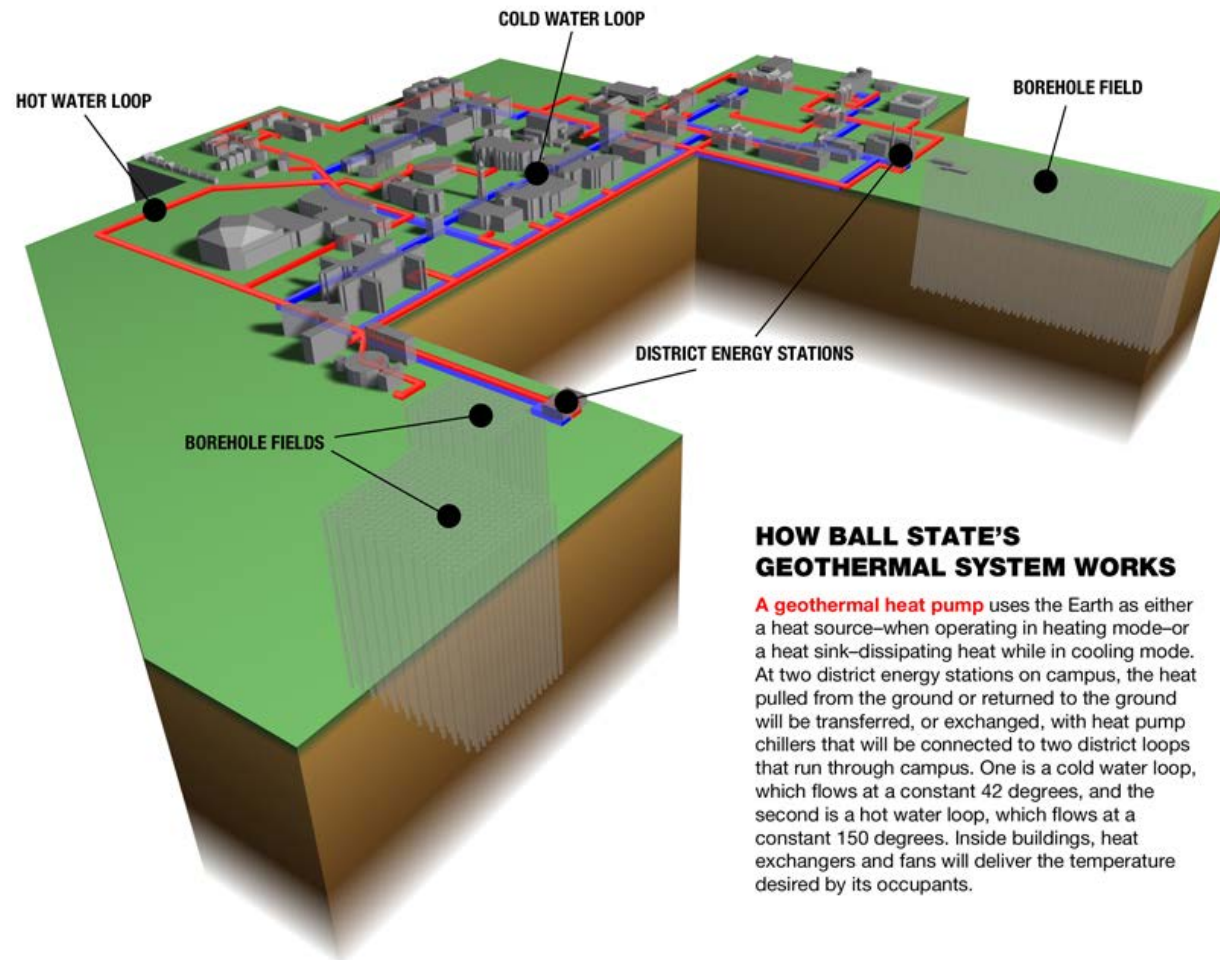
- Also includes wastewater / treated effluent
- Not just heating – cooling also possible
- 20-25C heat source / sink is common
- Match 'water' flow to heating / cooling requirements
- Local projects using treated effluent:
 - Hobart Aquatic Centre, Hobart
 - Grand Chancellor Hotel, Hobart

Aquifer Thermal Energy Storage



Source: www.building.co.uk

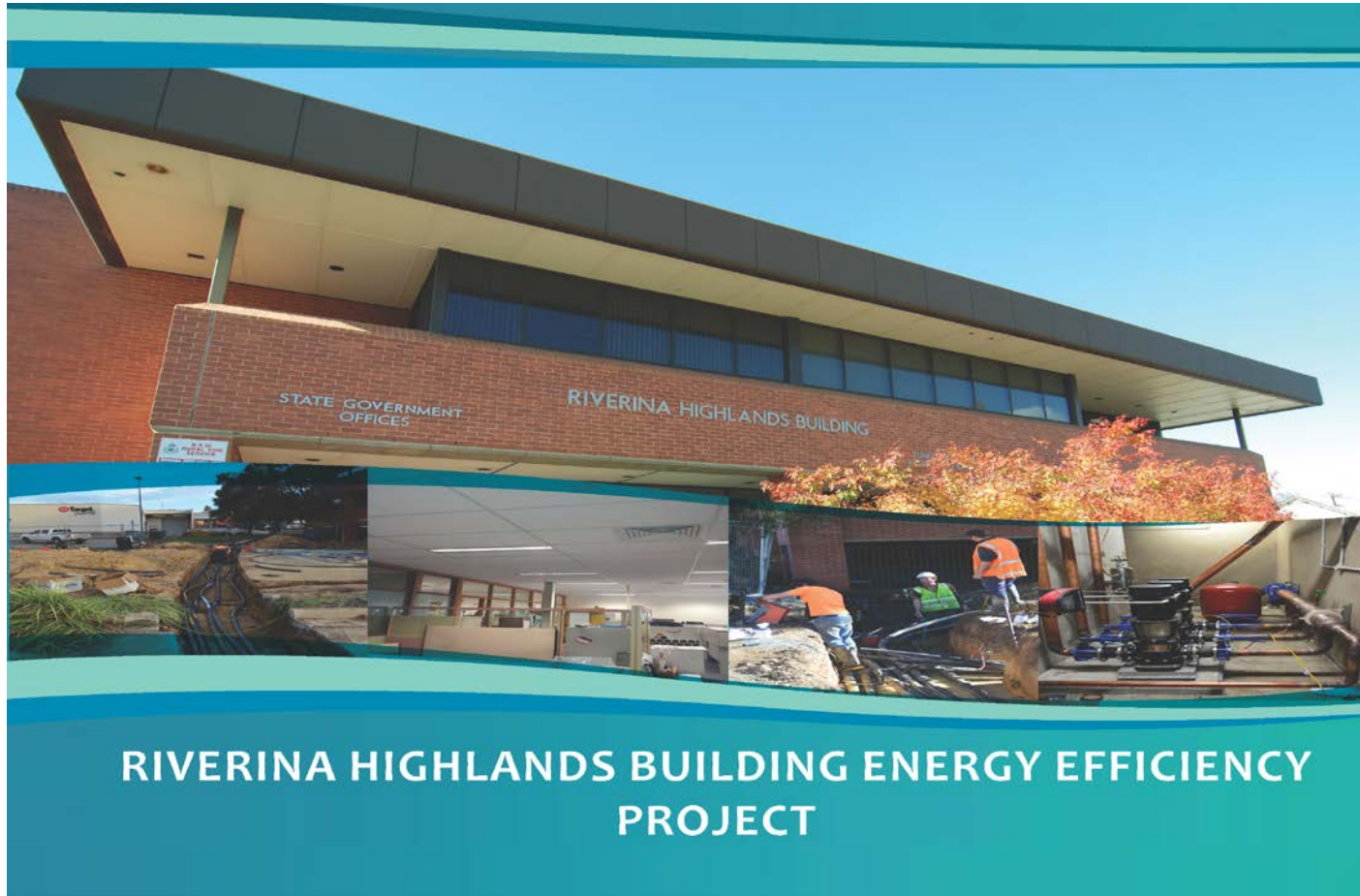
District Geoexchange Systems



HOW BALL STATE'S GEOTHERMAL SYSTEM WORKS

A geothermal heat pump uses the Earth as either a heat source—when operating in heating mode—or a heat sink—dissipating heat while in cooling mode. At two district energy stations on campus, the heat pulled from the ground or returned to the ground will be transferred, or exchanged, with heat pump chillers that will be connected to two district loops that run through campus. One is a cold water loop, which flows at a constant 42 degrees, and the second is a hot water loop, which flows at a constant 150 degrees. Inside buildings, heat exchangers and fans will deliver the temperature desired by its occupants.

Case Study: Tumut Council, NSW



RIVERINA HIGHLANDS BUILDING ENERGY EFFICIENCY PROJECT

The Situation

- A thermally inefficient building
- Summers were hot and uncomfortable. Winter was not much better
- The HVAC plant failed on a regular basis
- HVAC simply did not meet the building occupant's requirements
- Inefficient and expensive lighting



Objectives and Actions



- Riverina Highlands Building Energy Efficiency Project (RHBEEP) objectives:
 - Reduce energy expenditure
 - Reduce reliance on imported energy
 - Reduce GHG (Green House Gas) emission
 - Improve comfort levels in the building
- What we did:
 - GeoExchange HVAC/GSHP system installed
 - Lighting upgrade
 - Sub metering
 - Ceiling insulation

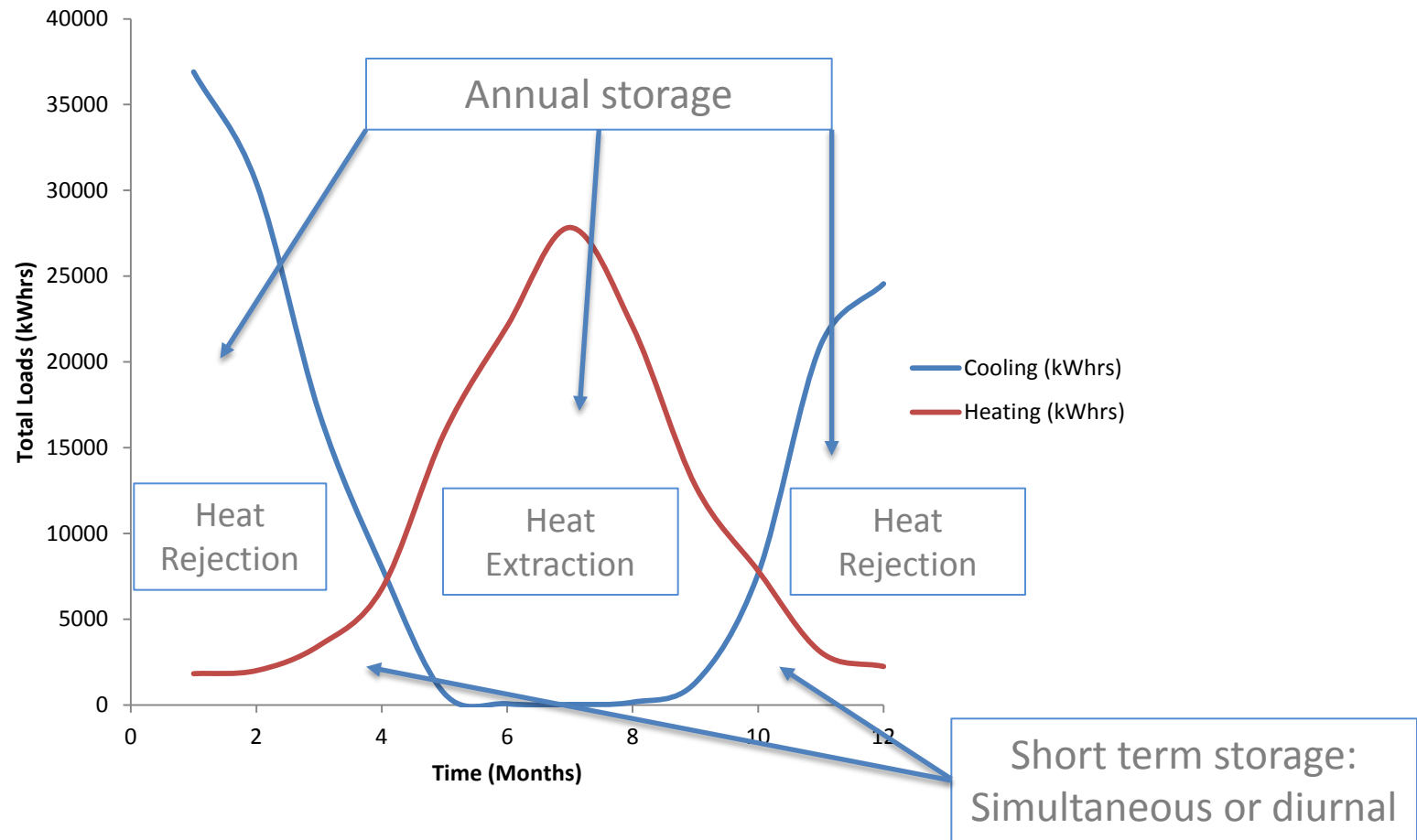


The Installed System



- The Ground Heat Exchanger:
 - 35 Boreholes
 - 92 m deep
 - 40 mm diameter polyethylene pipe
 - 7 m spacings
- Ground Source Heat Pumps:
 - 26 x WaterFurnace 7 series
 - Variable speed compressor
 - Variable speed fan
 - Energy performance monitoring
- Pumping System:
 - Variable speed pumps to match heating / cooling load

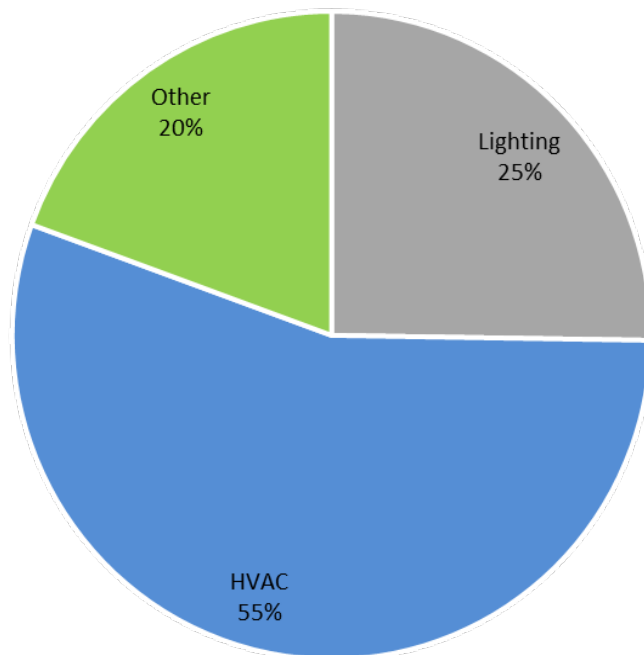
RHBEEP and Thermal Energy Storage



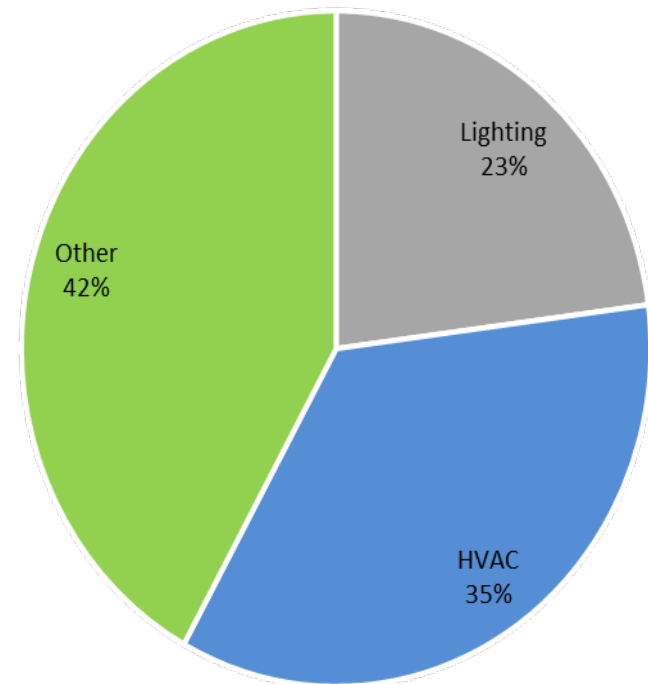
Before and After: Building Energy



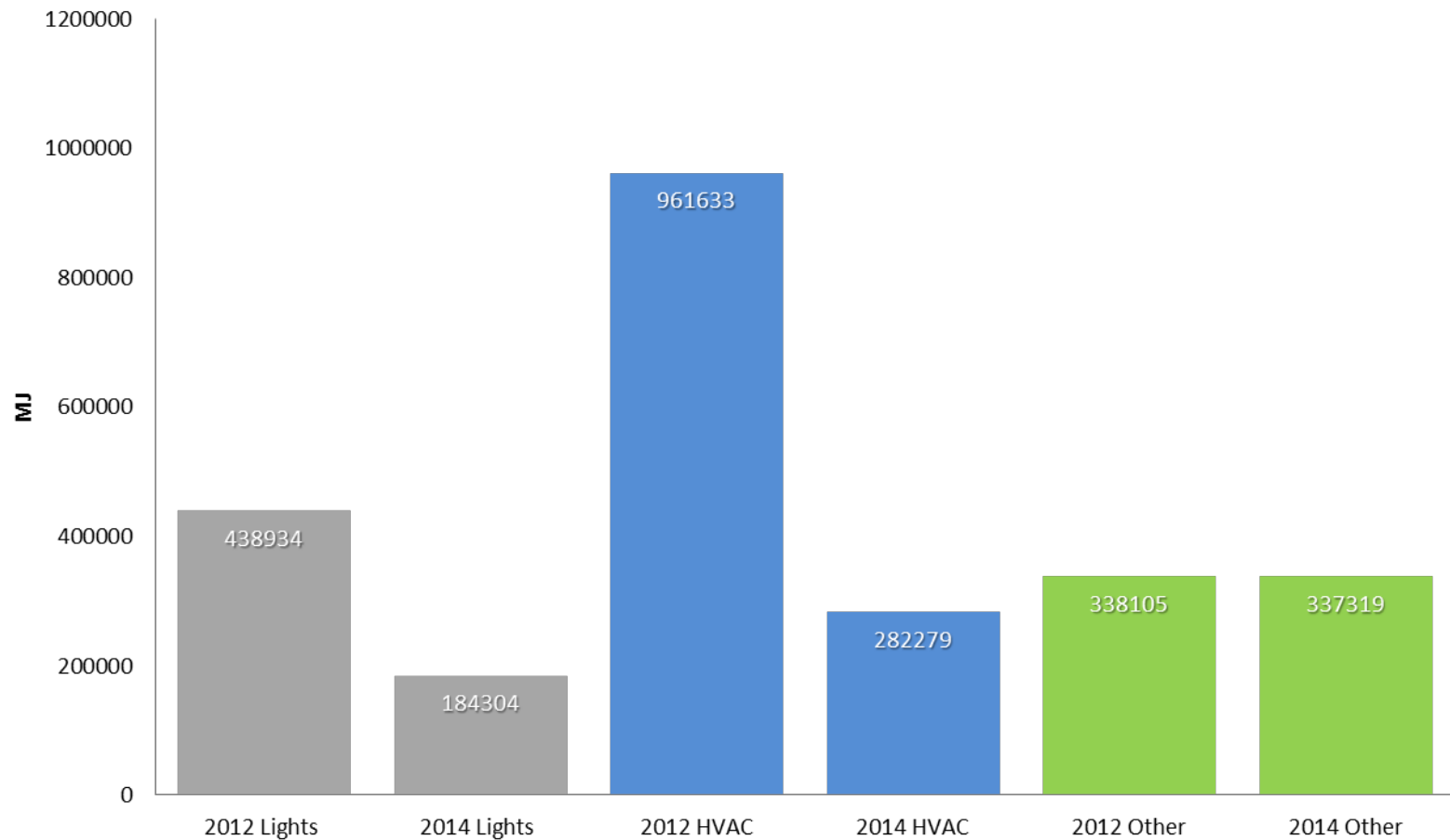
2012



2014



Before and After: Building Energy



Before and After: HVAC only



2012: 961 633 MJ

2014: 282 279 MJ

71%

Before and After: Ancillary Benefits



- RHBEEP is demonstration that:
 - Integration of technologies
 - Site specific design
 - Programmed optimisation
- Is effective in
 - Reducing energy consumption, whilst
 - Maintaining a comfortable and pleasant work environment
- Increased storage capacity in the plant room by approximately 500%



Before and After: Summary



- Building energy savings: **~80 % and \$94 000 per annum**
- HVAC energy savings: **~71 % and \$85 000 per annum**
- Maintenance / tenancy savings: **~\$80 000 per annum**
- Electricity demand reduction: **151 kVA (75 %) Geoexchange at 49 %**
- GHG Reduction: **79 tCO₂**
- Simple Payback: **~7.6 years**
- Return on Investment: **11-12 %**



Contact Details



Yale Carden

GeoExchange Australia Pty Ltd

IGSHPA – Australasia

Phone: 02 8404 4193

Email: ycarden@geoexchange.com.au

Website: www.geoexchange.com.au

Joanne Spicer

Tumut Shire Council

Phone: 02 6941 2555

Email: jspicer@tumut.nsw.gov.au

Website: www.tumut.nsw.gov.au

The RHBEEP Project

<http://www.tumut.nsw.gov.au/riverina-highlands-building-energy-efficient-project-rhbeep.aspx>
