GeoExchange Renewable Energy Infrastructure

CARBON REDUCTION IN THE BUILT ENVIRONMENT
MELBOURNE FORUM 20 OCTOBER 2009

DR MIREK PIECHOWSKI
MEINHARDT BUILDING SCIENCE GROUP

www.meinhardtgroup.com
GeoExchange
Ground Coupled Heat Pumps
Ground Source Heat Pumps
Geothermal Heat Pumps
What is GeoExchange
Reduce maximum demand
Reduce annual energy use
Low temperature heat sink in summer
High temperature heat sink in winter
Seasonal thermal energy storage
Why GeoExchange
Ground temperature profile and seasonal energy storage

- Hourly air temperature in Melbourne
- Undisturbed ground temperature at 50m
- Annual energy storage effect
Horizontal Ground Heat Exchanger
Pond loop Ground Heat Exchanger
Water bores Ground Heat Exchanger
Foundation piles Ground Heat Exchanger
GeoExchange as renewable energy infrastructure
GeoExchange as renewable energy infrastructure
Making the most of natural gas
Thermal output per kg of CO₂ emissions

- Geo / Cogen: COP = 4.5
- Gas Boiler: ? = 80%
- Grid Geo: COP = 4.5
- Grid A/C: COP = 2.8
<table>
<thead>
<tr>
<th></th>
<th>Floor Area</th>
<th>Maximum Occupancy</th>
<th>Typical Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior School</td>
<td>1,935</td>
<td>500</td>
<td>350</td>
</tr>
<tr>
<td>Junior School</td>
<td>2,155</td>
<td>750</td>
<td>500</td>
</tr>
<tr>
<td>Science/Art/Technology</td>
<td>3,130</td>
<td>450</td>
<td>450</td>
</tr>
<tr>
<td>Administration</td>
<td>600</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7820</strong></td>
<td></td>
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</tbody>
</table>
Wangaratta High School, Victoria
Wangaratta High School – Case Study
Wangaratta High School – Case Study
Integration with building design

BUILDING FEATURES:
- slab edge insulation
- increased levels of wall and roof insulation
- double glazing
- shaded facades
- large ceiling fans
- natural ventilation
- daylighting
- building management system
- rainwater harvesting for toilet flushing

pipes in floor slab circulate chilled or heated water

heat pumps provide cooling in summer and heating in winter to water flowing into floor slab

ground heat exchanger: 100m deep ground loops @ 10m centres

heat rejected from building absorbed by ground

Image: Taylor Oppenheim Architects
Wangaratta High School – Case Study
Wangaratta High School – Case Study

Demand and Electrical Input for the Two Systems

- **Demand**
  - ASHP: 500,000 kWh
  - GeoExchange: 400,000 kWh

- **Heating**
  - ASHP: 200,000 kWh
  - GeoExchange: 100,000 kWh

- **Cooling**
  - ASHP: 150,000 kWh
  - GeoExchange: 75,000 kWh
Wangaratta High School – Case Study

Cost and CO₂ Emissions

<table>
<thead>
<tr>
<th></th>
<th>CO₂ Emissions, tons</th>
<th>Cost, $</th>
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</thead>
<tbody>
<tr>
<td>Heating - ASHP</td>
<td>250</td>
<td>20,000</td>
</tr>
<tr>
<td>Cooling - ASHP</td>
<td>250</td>
<td>20,000</td>
</tr>
<tr>
<td>Heating - GEOEXCHANGE</td>
<td>150</td>
<td>10,000</td>
</tr>
<tr>
<td>Cooling - GEOEXCHANGE</td>
<td>150</td>
<td>10,000</td>
</tr>
</tbody>
</table>

Annual energy cost, $
Four Seasons Energy Program

- Fully funded feasibility study
- Bridging finance for ground heat exchangers
- Preparation of case studies
- Dissemination of information
Challenges and opportunities

Integrated urban planning
Energy cost
Installation cost
Revenue generation
GeoExchange Renewable Energy Infrastructure

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DR MIREK PIECHOWSKI
MEINHARDT BUILDING SCIENCE GROUP

www.meinhardtgroup.com
Introduction to Building Science Group

Dr Mirek Piechowski
Team leader
LEED AP

Michael Shaw
NABERS Assessor
Green star AP

Anila Weerakkody
LEED AP

Adrian Rowe

Dr Eddy Rusly

Ross McCarthy

Nick Kovess