A GROUND SOURCE ENERGY PLANT FOR THE NEW ASSEMBLY FOR WALES

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GROUND SOURCE ENERGY PLANT FOR THE NEW ASSEMBLY FOR WALES
SENEDD: THE GREEN BUILDING

• Designed by Lord Richard Rogers
• Design life span: 100 years
• Mainly natural materials
• Total cost: £ 65 10^6

• Ground loop heat exchanger: 27 BHE of 100 meters
  - Heating load ± 75 MWh, cooling load ± 80 MWh
  - Peak load ± 80 – 130 kW

• Geo-energy plant with 3 heatpumps (6 stages)
  - simultaneous heating and cooling
  - Free cooling option
  - Additional IT-suite cooling
  - Component optimisation
  - Control system optimisation
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SENEDD - CARDIFF - WALES
PREPARATION: TEST DRILLING & GRT

- 2 Test boreholes, 100 and 60 meters
- Each BHE two tests: extraction & injection

Significantly higher $\lambda$ during injection

<table>
<thead>
<tr>
<th>source</th>
<th>energy flux (Watts)</th>
<th>$\lambda$ (w/mK)</th>
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</thead>
<tbody>
<tr>
<td>geologic log &amp; ref tables</td>
<td></td>
<td>2.26</td>
</tr>
<tr>
<td>60-meters, injection</td>
<td>54.95</td>
<td>2.53 ± 0.042</td>
</tr>
<tr>
<td>60-meters, extraction</td>
<td>-27.47</td>
<td>2.21 ± 0.015</td>
</tr>
<tr>
<td>100-meters, injection</td>
<td>19.06</td>
<td>2.78 ± 0.028</td>
</tr>
<tr>
<td>100-meters, extraction</td>
<td>-15.24</td>
<td>2.57 ± 0.046</td>
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INSTALLING BHE SYSTEM

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GEO ENERGY PLANT DESIGN

• Simultaneous heating and cooling
• Operational efficiency
  - Optimization of plant design using dynamical simulation (TRNSYS)
  - Matching compressor sizes to building load
  - Low velocity pipework and valves with low $K_v$
  - Quality of materials and workmanship
  - Control concepts
• Small plant footprint and limited height
• Suitable for off-site construction and on-site assembly
• **Heating and cooling load distribution**
  - Smallest step 15 – 25 kW, total capacity requested > 125 kW
  - 3 heatpumps, 2 compressors each installed
    - 30-35 kW compressor capacity, 180-210 kW total capacity)
  - Some overcapacity, adds redundancy
• Design concept P&I D schematic
• Plant design & optimisation using TRNSYS
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- **TRNSYS simulation design detail**
  - Optimize inertia tank for cost/size and heat pump cycles
GEO ENERGY PLANT DESIGN

- 3D plant construction/ engineering
- Design and detail engineering in parallel with construction
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CONTROL STRATEGY

• System recognizes three modes
  - Free cooling
  - Mechanical cooling
  - Mechanical heating

• Setpoints for e.g. primary pumps change depending on mode and capacity requirement
  - Allowing lower relative flow at higher capacity means smaller pumps that run more efficiently at low capacity
  - 2-Phase in stead of 3-Phase pumps could be used

• Control philosophy easy to extend to hybrid systems
**CONTROL STRATEGY**

- System should run independently from BMS
- System should run efficiently at average (low) load, and able to provide peak load
- Hierarchical level of controls:

  - **Tier 1 - Component level**:
    - Standard component controls
    - PID-controls, motors, valves etc.
  
  - **Tier 2 - Operational level**:
    - State matrix for Modes
    - Valve positions, setpoints for components during different modes

  - **Tier 3 - System level**:
    - Increasing complexity
    - Increasing number

  - **Intelligence**
    - Decision what mode system should run in
The National Assembly building has been awarded a BREEAM ‘Excellent’ Rating – boasting the highest score ever achieved by a BREEAM assessed development in Wales. This puts the new assembly building in the highest category of sustainable design in the UK.