Ground Source Heating and Cooling - A significant contribution to CO2 reduction in Sweden

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The Climate Change

Concerns related to usage of fossil fuels

- Global Warming (0.6 °C since 1960)
- Increased Sea Level
- Increased Number of Extremes
- Ozone Depletion
- Acid Rain
The Task for the Future

How to provide for space heating and comfort cooling without burning fossil fuels?
Traditional Renewable Sources

- Solar
- Hydropower
- Wind
- Biomass
“The Fifth Alternative”

Ground Source Energy

- The Underground for heat and cold extraction

- Air and Surface Water for seasonal (or diurnal) storage
Main Heat Extraction Systems

- The “Groundwater Heat System”
- The “Rock Heat System”
- The “Topsoil Heat System”
- Referred to as GSHP (Ground Source Heat Pumps)
Main Cold Extraction systems

- Boreholes preferably for cooling of TELECOM equipment
- Aquifers for Industrial Cooling and District Cooling (DC)

District cooling, by city (and supplier), 1992–2003

Source: Swedish District Heating Association
Underground Thermal Energy Storage (UTES)

Commercial Systems

- ATES (Aquifer Storage)
- BTES (Borehole Storage)
- CTES (Cavern Storage)
Example ATES (Heating and Cooling)

The Bo 01 ATES plant

- 100% renewable
- Sea water, the main source
- Wind power for the heat pump
- Some solar energy and biogas also used

The ATES System

- 10 Wells/120 m³/h flow rate
- Produce 6,100 MWh
- Save 1,200 MWh Electricity
- Save 2,600 MWh Natural Gas
- CO₂ Reduction 11 Mt/year
Example ATES (Cooling only)

Stockholm City DC

- Use deep sea water as a source
- Cold storage during night
- Cold extraction for peak shaving on hot summer afternoons
- Payback time > 1 year

- 12 Wells, 600 l/s flow rate
- Working temp, 4/14 °C
- Load capacity, 25 MW
- Electricity saving, approx 4 GWh/a
- Corresponds to 1.2 Mt CO₂ /year
Example Medium BTES

The IKEA Meeting Point

- New office, Helsingborg, Sweden
- 36 boreholes á 140 m
- 340 kW heat and 450 kW cold capacity
- 600 MWh heat / 400 MWh cold annually
- Pay-back time, approx 6 years

CO₂ reduction: 2,3 Mt yearly
GSHP Market Growth

- 270,000 at the end of 2004
- Number one in the world (per capita)
- Drilling industry doubled in 10 years
- New HVAC companies established
- New equipment suppliers established
GSHP Contribution to CO\textsubscript{2} Reduction (Sweden)

Natural Heat Extraction, 2004

- For Single Residents, 7 900 GWh
- Larger Distribution Systems, 2 100 GWh

Corresponds to

- 10 \% of total space heating demand
- Reduce CO\textsubscript{2} emission with 2,3 Million tons
- Equivalent to 3,5 \% of the total emission

Comments

- Not recognised in official statistics
- Already credited in CO\textsubscript{2} emissions
- For electricity, the European mix is used
### Calculation of emission reductions

- **Savings of fossil fuels are fairly well established**
- **Savings of power is a subject for discussions**

<table>
<thead>
<tr>
<th>Emissions</th>
<th>Oil BO 3</th>
<th>SE Power Normal</th>
<th>EU Power Normal</th>
<th>EU Power Marginal</th>
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<tbody>
<tr>
<td>CO2 Kg/MWh</td>
<td>345</td>
<td>40</td>
<td>290</td>
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<tr>
<td>NOX Kg/MWh</td>
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<td>Solids Gr/MWh</td>
<td>120</td>
<td>14</td>
<td>70</td>
<td>350</td>
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</tbody>
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Conclusions

- Ground Source Heating and Cooling is well established in Sweden and also recognized by the general public.

- Currently there are some 300,000 smaller GSHP, some 50 large scale ATES and some 300 BTES systems in operation, contributing to a significant reduction of environmental harmful emissions.

- The technologies are proven to be energy efficient, profitable and in most cases simple to operate.

- As a tendency, the market for single residential houses is leveling out but replaced with an increased interest for larger systems.
Thank you for your attention!

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