Aquifer Thermal Energy Storage (ATES)
Technology Development and Major Applications in Europe

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Basic principle of ATES

DIRECT COOLING

COOLING

750

AQUIFER

150

HP - SPACE HEATING

HEATING

1000

250 el

150

AQUIFER
ATES – direct cooling and pre-heating

**Summer**
Temp > 15°C

- Cooling
- Outside air
- Ventilation air
- 7°C
- 15°C

**Winter**
Temp < 7°C

- Preheating
- Outside air
- Ventilation air
- 7°C
- 15°C
ATES – direct cooling and HP assisted heating

Summer
Temp > 15°C

Ventilation air and floor cooling

7°C → 15°C

Winter
Temp < 7°C

Ventilation air and floor heating

30°C → 40°C

Heatpump

7°C → 15°C

Cold

AQUIFER

Heat
Suitable climate
Suitable underground

- depth
- thickness
- permeability
- flow
## Major ATES applications in Europe

<table>
<thead>
<tr>
<th>Country</th>
<th># of ATES projects (ca)</th>
<th>Aquifer type</th>
<th>Major application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>10</td>
<td>Sand</td>
<td>Hospitals</td>
</tr>
<tr>
<td>Denmark</td>
<td>10</td>
<td>Sand/gravel, chalk</td>
<td>Industrial</td>
</tr>
<tr>
<td>Netherlands</td>
<td>700</td>
<td>Sand</td>
<td>Large buildings</td>
</tr>
<tr>
<td>Sweden</td>
<td>70</td>
<td>Chalk, sand/gravel</td>
<td>Large buildings</td>
</tr>
</tbody>
</table>
Aquifers in Europe (Unesco, 2004)
NIKE office, Hilversum (NL)

HVAC system with HP and ATES

Cooling capacity: 2,000 kW
Operational since: 1999
Maria Hospital, Overpeltt (BE)

Cooling capacity: 1,500 kW
In operation since: 2005
IKEA store, Duiven (NL)

Cooling capacity: 750 kW
In operation since: 1999
Spoorwijk housing development, the Hague (NL)
Westway housing project London (UK)

Cooling capacity: 250 kW
Operational since: 2006
Freesia growery, Luttelgeest (NL)
Well footprint
Mixed Development Amsterdam (NL)

Cooling capacity: 4,000 kW
Operational since: 2001
Recent developments

- Standardization of ATES systems:
  - cost reduction
  - smaller projects economic feasible

- Utility involvement:
  - outsourcing heat and cold production
  - ATES based local DH&C systems
Permit application in the Netherlands

ATES project requires permit under Groundwater Act. Very large projects (abstraction > 3,000,000 m³/y) follow the permitting procedure of the Environmental Act. EIA is part of the application documents.

Contents:

• System description
• Hydraulic impact
• Thermal impact
• Impact on water quality
• Settlement risk
• Impact on other users of groundwater
• Energy saving/GHG reduction
Permit application in the Netherlands

Time between application and permit 9-12 months. Public consultation part of procedure. ATEs excluded from groundwater taxation.

Permit conditions generally include:

- thermal energy balance over longer period (several years)
- maximum values for pumping rate (hourly and annually) and infiltration temperature
- monitoring and reporting of groundwater volumes pumped, energy flows, and maximum infiltration temperatures
IKEA store Amersfoort

• Cooling capacity ATES 1.4 MW
• Cooling supplied 0.9 GWh/y
• Max. flow rate 200 m³/h
• No. of wells 2 x 1

Eindhoven University Campus
ATES based infrastructure - Phase 1

• Cooling capacity ATES 20 MW
• Cooling supplied >15 GWh/y
• Max. flow rate 2,250 m³/h
• No. of wells 2 x 18
Isotherms in °C end of winter (year 20)
Isotherms in °C end of winter (year 20)
Isotherms in °C end of winter (year 20)
Energy saving with ATES system

Cooling

• 60-80% saving on electricity consumption for cold production
• 80-90% reduction of electrical peak for cold production

Heating

20-30% saving on primary energy consumption for heat production
In the Netherlands ATES has become a standard design option for sustainable supply of heating and/or cooling.

Most cost effective application: combined heating and cooling for larger buildings.

Monitoring has shown that adverse environmental impacts are limited and can be predicted quite well.
Thank you for your attention!