Geothermal energy storage systems

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Geothermal Energy Applications

- Geothermal energy storage systems
  - Shallow
    - Ground Source Heat Pump (GSHP)
    - Boreholes Thermal Energy Storage (BTES)
  - Mid-deep
    - Aquifer Thermal Energy Storage (ATES)
    - Low Temp Geothermal Energy
  - Deep
    - High Temp ATES
    - High temp Geothermal energy
GSHP/BTES/ATES
(< 25 °C)
High Temp BTES (> 60 °C)

Low temp GE
(25 – 60°C)

High Temp ATES
(30 – 90°C)

High temp GE
(> 60°C)

Ultra High temp GE (> 150°C)
Example: growth ATES systems in NL

1990

10 systems

2000

200 systems

2010

1200 systems
State of the art technology 2011

- Boreholes
  - Ground Source Heat Pump (GSHP) for heating
  - BTES and heat pump for heating and (limited) cooling

- Aquifer Thermal Energy Storage (ATES)
  - Cooling only (charging cold in winter)
  - Heat pump for heating (charging heat in summer)
  - Cooling and heat pump for heating (energy balancing)

- High temp ATES/BTES (pilot stage)
  - Direct heating by storage of (waste) heat
Situation in 2050

- Still large energy demand in existing buildings (50-80%)
- New buildings will have (very) low energy demand
- More use of renewable energy sources
- More large scale applications
- Focus on running phase of projects
- Better business models
- Upgrade of legal framework
Existing buildings

- Existing buildings (1900 – 2010) represent the largest amount of energy demand
- Many geothermal applications will still exist, because existing buildings will still be there
- Market penetration will increase in this segment by retro-fit to renewable systems with heat pump technology
- High temperature heat is still needed for heating: high temperature energy storage
New buildings

- New buildings (2010 – 2050) will have (very) low energy demand, for example passive houses with no energy demand at all

- Temperature levels will change:
  - (Ultra) low temperature heating (25 – 35 ºC)
  - (Ultra) high temperature cooling (10 – 17 ºC)

- Heat pump is not necessary any more?
- BTES coupled to solar heat systems for direct heating?
- All-electric solutions will come up
More use of renewable energy sources

- Re-use of waste heat will increase in industry for higher energy efficiency: storage of high temperature necessary
- Solar heat will be used to heat buildings direct and through high(er) temperature geothermal energy storage
- Surface water will supply cooling by means of storage
- Other sources can be coupled to ATES/BTES: surface water, effluent from sewage, roads and infrastructure
- Large integrated renewable energy systems are possible
More large scale applications

- Coupling of different types of user leads to higher efficiency: office buildings and houses; industry and greenhouses
- Big savings demand big projects
- Better use of renewable energy sources by coupling users: houses (heat demand) and greenhouses (solar collector)
- Market penetration can rapidly increase
## Type of projects

<table>
<thead>
<tr>
<th></th>
<th>Individual small</th>
<th>Individual large</th>
<th>Collective small</th>
<th>Collective large</th>
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<tbody>
<tr>
<td>Heating only</td>
<td>single home</td>
<td>greenhouse</td>
<td>housing area</td>
<td>housing or greenhouse area</td>
</tr>
<tr>
<td>Cooling only</td>
<td>switch station</td>
<td>data center, industry</td>
<td>mono-industrial area</td>
<td></td>
</tr>
<tr>
<td>Heating / cooling</td>
<td>small building</td>
<td>building</td>
<td>building or housing area</td>
<td>integrated area, greenhouse area</td>
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Focus on running phase

- Savings are reached in the running phase, not during project development/realisation phase
- Total energy systems is important: user-supply-storage
- Control strategies will become robust and smart
- Systems will be self learning which leads to high efficiency
- Technical life time should be equal to life time building
Business models

- Many users, real estate developers, suppliers, energy companies are tied together in projects
- Organisation will be part of the business model: how to integrate all parties involved?
- More and various business models are developed to meet these complex projects
- Financing by sharing profits with all parties involved
- From technology to comfort
Business models will change from the traditional cost-based enterprise to a value-based approach.

The value-based approach aims to deliver what the customer ultimately desires: comfort – rather than technology and energy.
Upgrade of legal framework

- 100% renewable energy will be state of the art in building directives
- Legislation will be fully equipped to deal with large scale application of geothermal energy storage (groundwater, underground, energy)
- Planning of the underground becomes important issue
Example: Masterplan ATES

2.000 woningen

Legenda
- zoekgebied koude bronnen
- zoekgebied warme bronnen
- thermische scheidslijn
- aandachtsgebieden positionering bronnen:
  - I kabels en leidingen
  - II verontreinigingen
  - thermisch invloedsgebied
  - III bestaande energieopslagsystemen
Innovation curve Europe 2011
Innovation curve Europe 2050

- Early adopters (13.5%)
- Early Majority (34%)
- Late Majority (34%)
- Laggards (16%)

- Innovators (2.5%)

'Take-off' in the region 5%-15% of the market