Storing thermal energy underground
- UTES -

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ISES Webinar "Geothermal Underground Storage for Solar Applications"
August 30th, 2018
Shallow and deep geothermal

- Soils
- Surface water
- Rock
- Groundwater
- Borehole TES
- Aquifer TES
- Caverns & Pits
- Energy piles

Illustrations: Signhild Gehlin 2014
Shallow and deep geothermal

Soils

Surface water

Rock

Groundwater

Smaller applications, often single mode. Passively stored solar heat.

Borehole TES

Aquifer TES

Caverns & Pits

Energy piles

Deep geothermal

Illustrations: Signhild Gehlin 2014
Shallow and deep geothermal

Soils
Surface water
Rock
Groundwater

Borehole TES
Aquifer TES
Caverns & Pits
Energy piles

Larger applications for heating and cooling or high temperature BTES. Active storage of solar or waste heat/cold.
Shallow and deep geothermal

Soils
Surface water
Rock
Groundwater

Borehole TES
Aquifer TES
Caverns & Pits
Energy piles

Large (district) applications for heat (often at high temperature) or cold storage.

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Use of foundation for part load heating and cooling.
Shallow and deep geothermal

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Deep heat resources for large scale (district) heating or power production. No cooling, solar or storage.

Illustrations: Signhild Gehlin 2014
Geothermal energy use Worldwide 2015

Cooling not included!

ENERGY TOTAL 237 TWh
INSTALLED CAPACITY TOTAL 74 GW

Heat pumps 40%
Geothermal Power 30%
Direct Deep geothermal 30%

Heat Pumps 70%
Direct Deep Geothermal 10%
Geothermal Power 20%

Source: WGC 2015 (Lund and Boyd)
Geothermal energy use Worldwide 2015

Cooling not included!

GEOTHERMAL HEAT TOTAL 163 TWh

Heat pumps 40%
Direct Deep geothermal 30%
Geothermal Power 30%

Source: WGC 2015 (Lund and Boyd)
Top three world geothermal energy countries

- **Total: 5.6 GW, 14.4 TWh**
  - Heat: 0.048 GW, 0.2 TWh
  - GSHP: 5.6 GW, 14.2 TWh
  - Power: 0 GW, 0 TWh

- **Total: 20.8 GW, 37.5 TWh**
  - Heat: 0.6 GW, 2.5 TWh
  - GSHP: 16.8 GW, 18.5 TWh
  - Power: 3.4 GW, 16.6 TWh

- **Total: 19.3 GW, 48.65 TWh**
  - Heat: 7.5 GW, 20.6 TWh
  - GSHP: 11.8 GW, 27, 9 TWh
  - Power: 0.027 GW, 0.15 TWh

Source: WGC 2015 (Lund and Boyd)
Potential for underground thermal energy storage

Source: worldweather.org and climatedata.eu
Oil Crisis → Solar

ATES & BTES experiments in USA, CH, NL, SE, FR, JP

1970’s

1980’s

1990’s

2000’s

2010’s
Oil Crisis ➔ Solar

1970’s

ATES & BTES experiments in USA, CH, NL, SE, FR, JP

1980’s

CTES Lyckebo Avesta Kerava

ATES Hokkaido Tuscaloosa Frösundavik

BTES Sunstore & Sunclay Neuchatel Lulevärme Cormontreuil Groeningen

1990’s

ATES & BTES experiments in USA, CH, NL, SE, FR, JP

2000’s

2010’s

HT-UTES

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Oil Crisis ➔ Solar

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ATES Hokkaido Tuscaloosa Frösundavik
BTES Sunstore & Sunclay Neuchatel Lulevärme Cormontreuil Groeningen

1990's
HT ATES: Utrecht
ATES+BTES Stockton
Road: Därlingen
Solar: Neckarsulm

2000's

2010's
ATES & BTES experiments in USA, CH, NL, SE, FR, JP

H/C UTES

HT-UTES

ATES & CTES
Oil Crisis ➔ Solar

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2000’s
ATES: Arlanda
LT + Hybrids:
Näsbypark
Oshawa
Zhungguancon
Akershus

2010’s
Large
BTES: Epic
Tijanjin
BSU
ELI-NP
Sibbo

Grids:
NUS
Whisper V
Rotkreutz
Hönggerberg

HT:
Xylem
Braedstrup
Linköping

Large
BTES
HT+DH
Underground storage strategies

• Passive systems

• Active systems

• Active systems - balanced
Energy demand

HEATING RESOURCE + COOLING RESOURCE = ENERGY DEMAND

Illustration: Signhild Gehlin 2015
UTES is both heat source and cold source
The underground offers a range of cost effective possibilities to store solar, waste or other heat or cold over seasons in a non-intrusive and sustainable way. Both for smaller and larger scale.

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UTES is invisible, quiet and non-smelling.
(If it weren’t, maybe we would have had more of it?)

Thank you!