

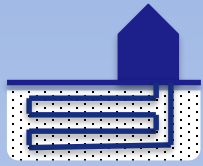


Storing thermal energy underground - UTES -

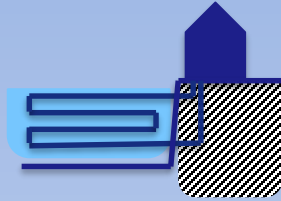
Dr. Signhild Gehlin
Swedish Geoenenergy Center

ISES Webinar "*Geothermal Underground Storage for Solar Applications*"
August 30th, 2018

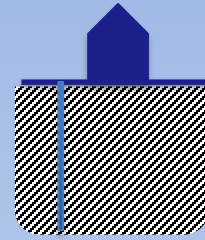
Shallow and deep geothermal



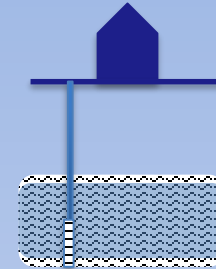
Soils



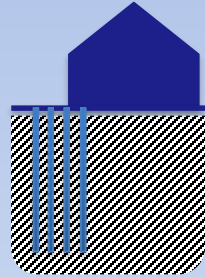
Surface water



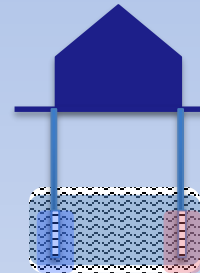
Rock



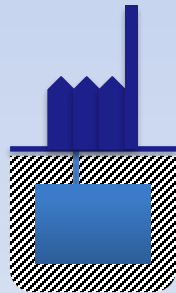
Groundwater



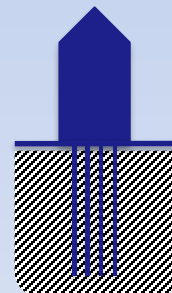
Borehole TES



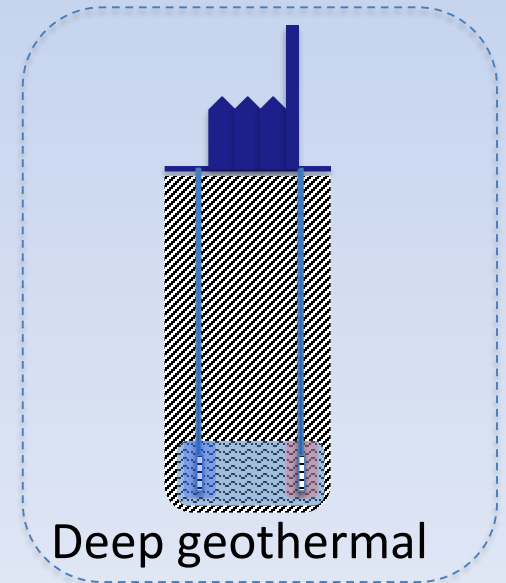
Aquifer TES



Caverns & Pits

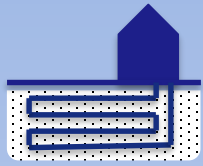


Energy piles

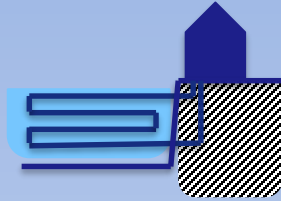


Deep geothermal

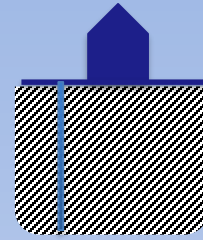
Shallow and deep geothermal



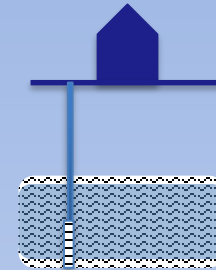
Soils



Surface water

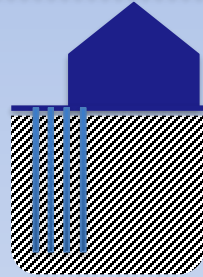


Rock

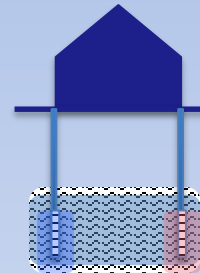


Groundwater

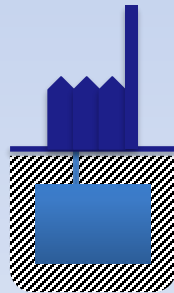
Smaller applications, often single mode. Passively stored solar heat.



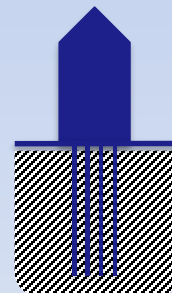
Borehole TES



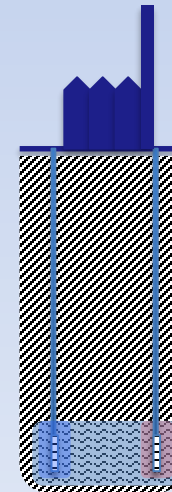
Aquifer TES



Caverns & Pits

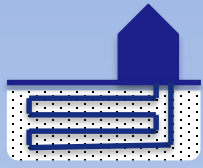


Energy piles

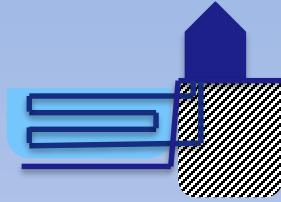


Deep geothermal

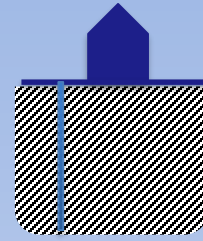
Shallow and deep geothermal



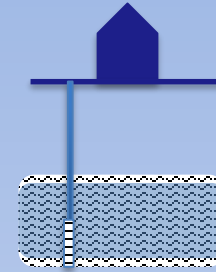
Soils



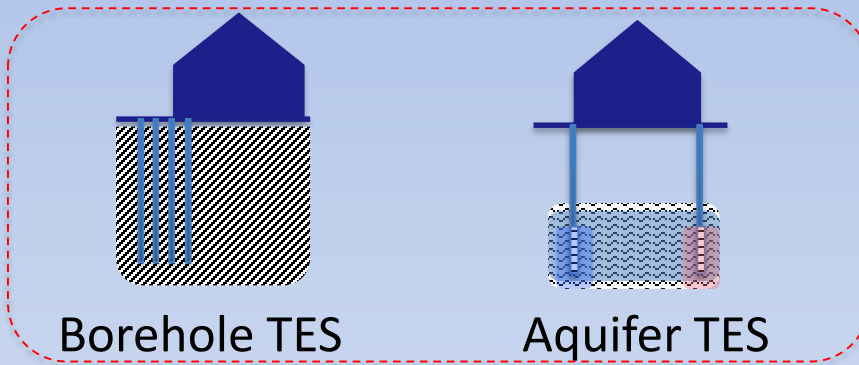
Surface water



Rock



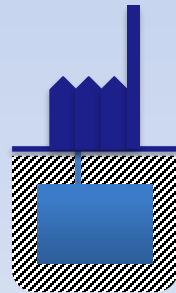
Groundwater



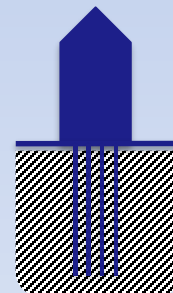
Borehole TES

Aquifer TES

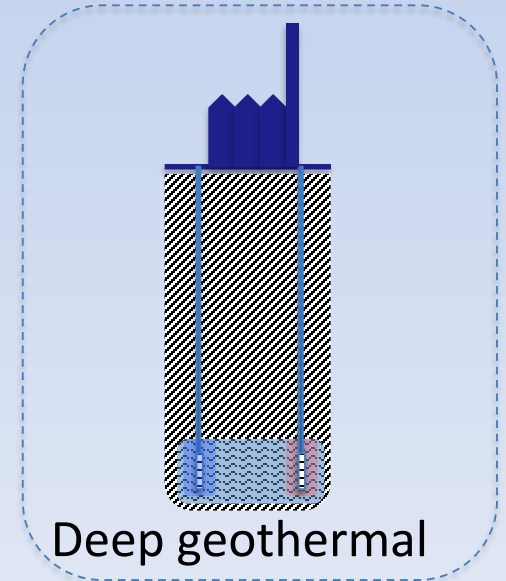
Larger applications for heating and cooling or high temperature BTES. Active storage of solar or waste heat/cold.



Caverns & Pits

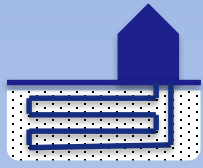


Energy piles

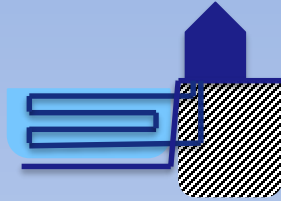


Deep geothermal

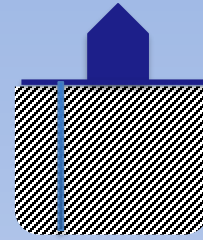
Shallow and deep geothermal



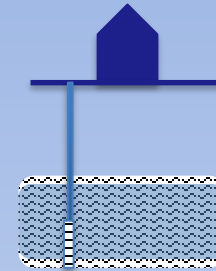
Soils



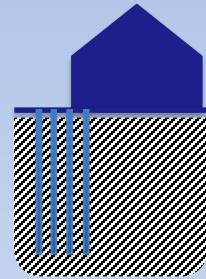
Surface water



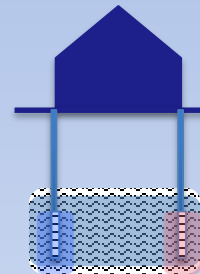
Rock



Groundwater

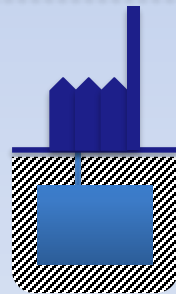


Borehole TES

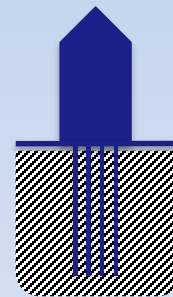


Aquifer TES

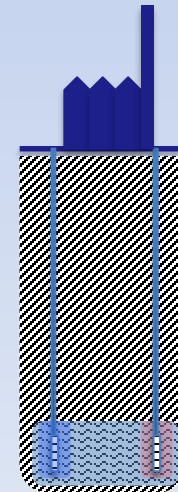
Large (district) applications for heat (often at high temperature) or cold storage.



Caverns & Pits

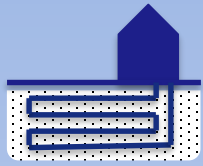


Energy piles

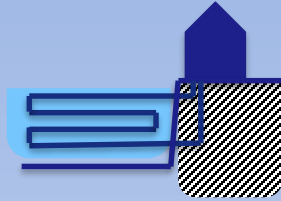


Deep geothermal

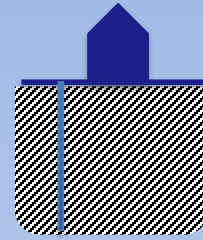
Shallow and deep geothermal



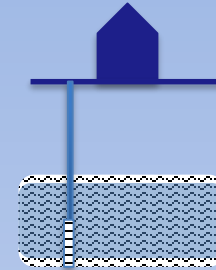
Soils



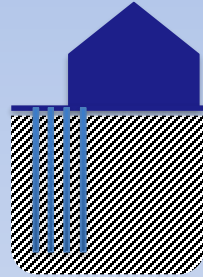
Surface water



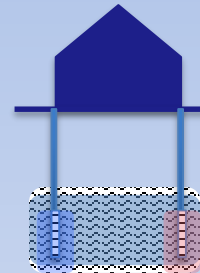
Rock



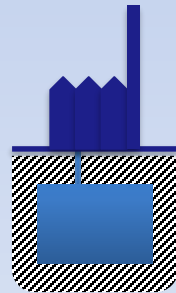
Groundwater



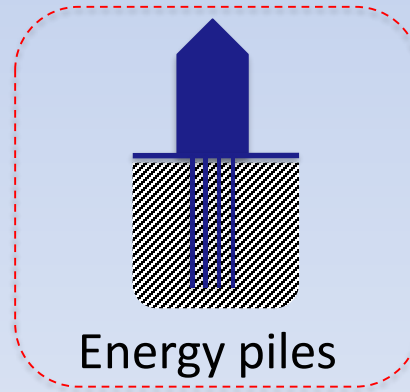
Borehole TES



Aquifer TES

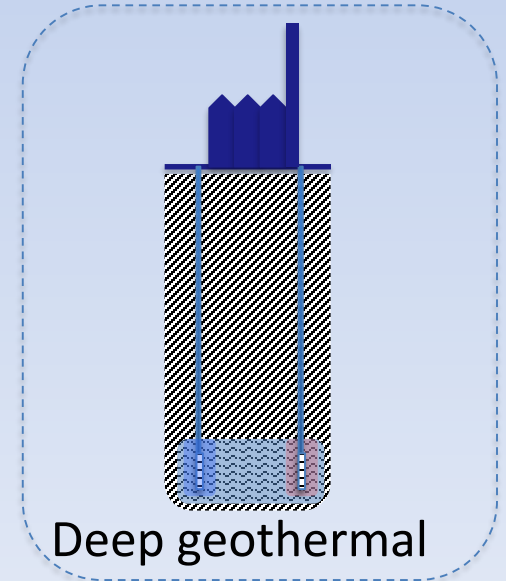


Caverns & Pits



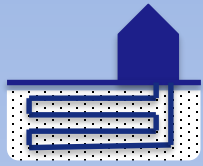
Energy piles

Use of foundation
for part load
heating and cooling.

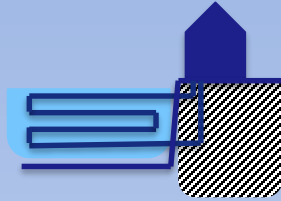


Deep geothermal

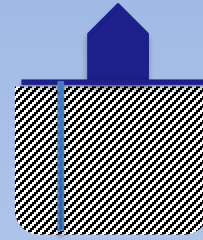
Shallow and deep geothermal



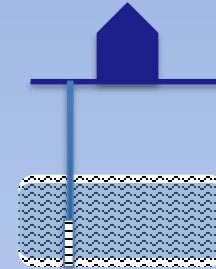
Soils



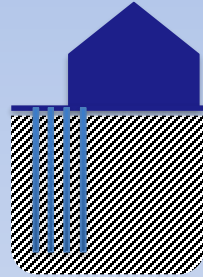
Surface water



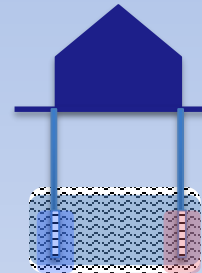
Rock



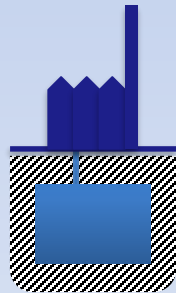
Groundwater



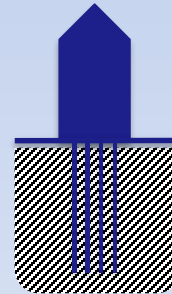
Borehole TES



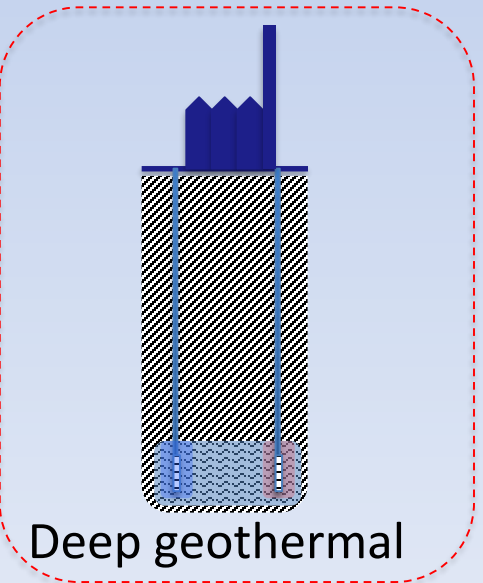
Aquifer TES



Caverns & Pits



Energy piles



Deep geothermal

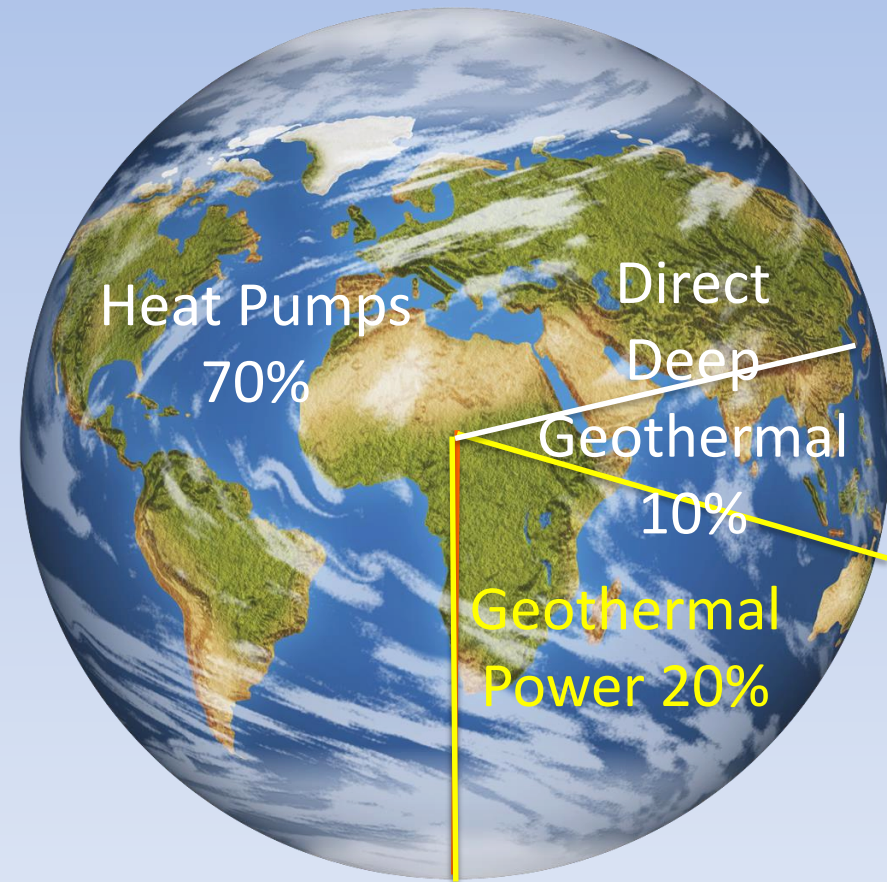
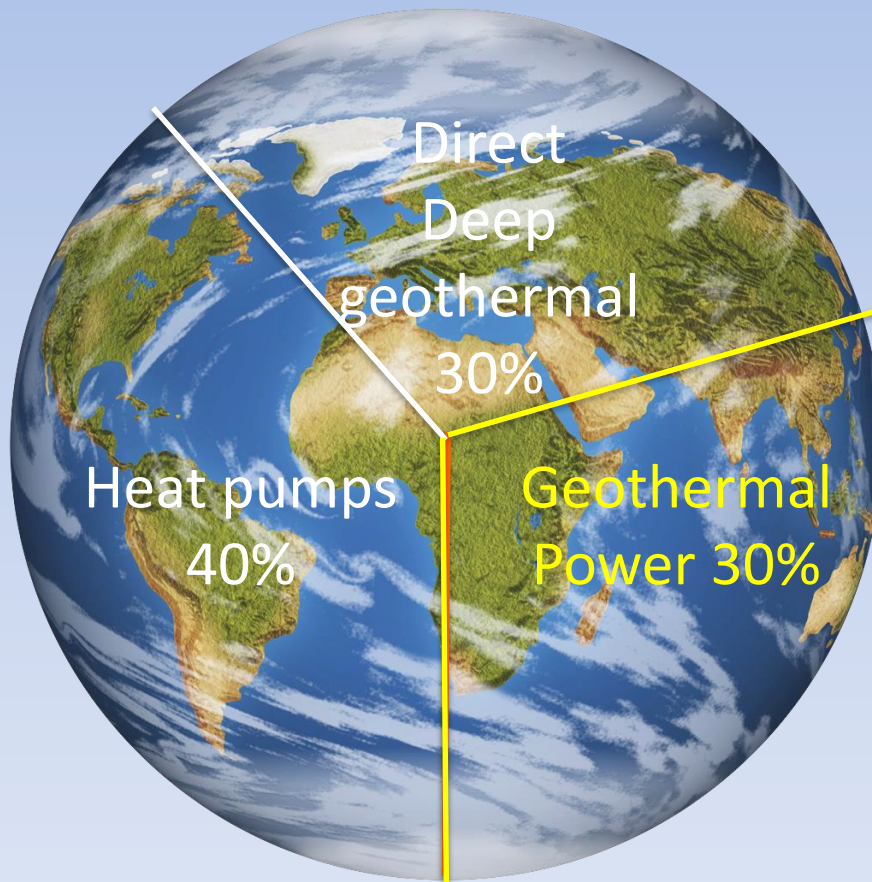
Deep heat resources for large scale (district) heating or power production. No cooling, solar or storage.

Geothermal energy use Worldwide 2015

Cooling not included!

ENERGY TOTAL 237 TWh

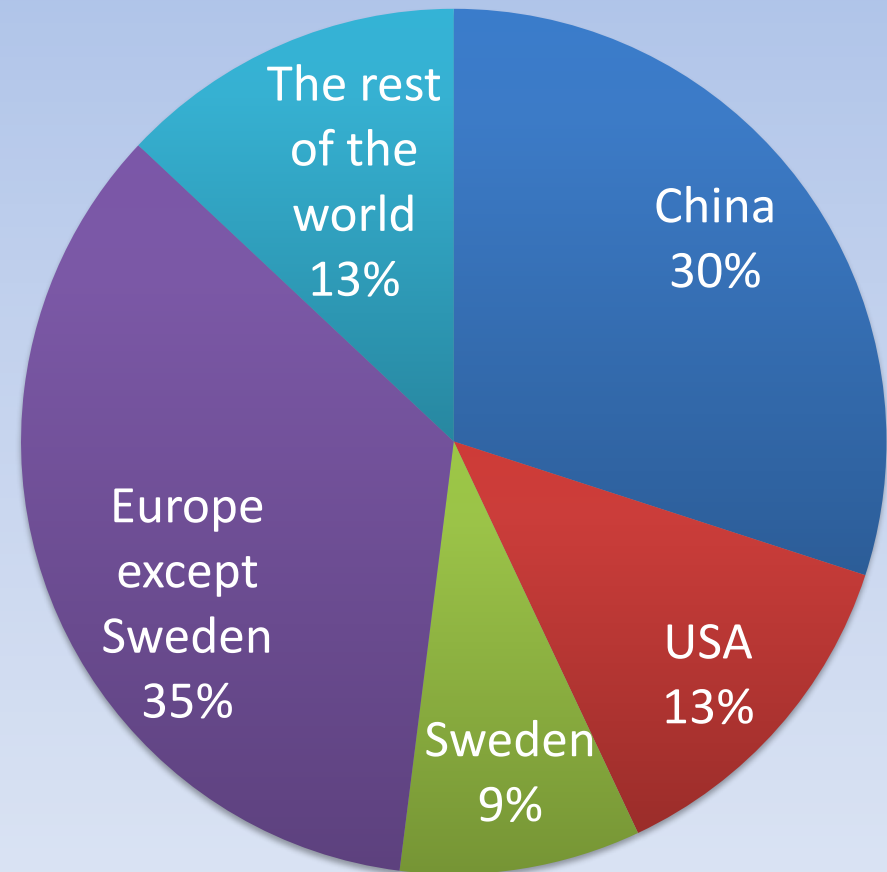
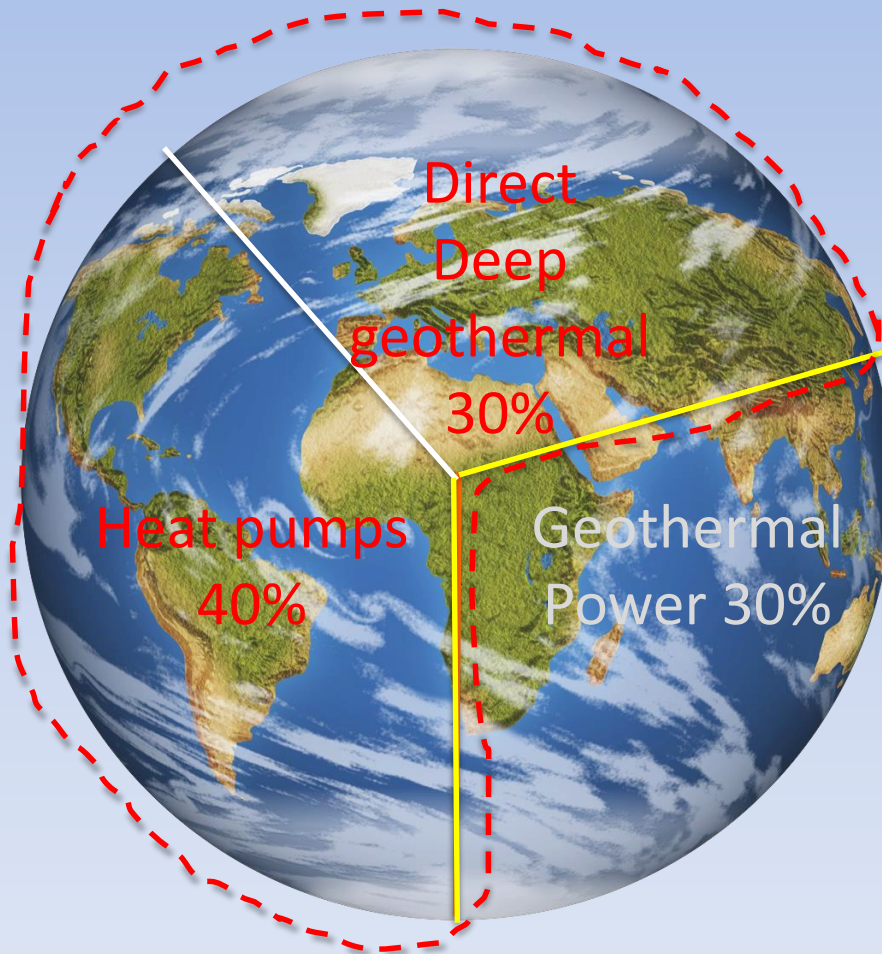
INSTALLED CAPACITY TOTAL 74 GW



Geothermal energy use Worldwide 2015

Cooling not included!

GEO THERMAL HEAT TOTAL 163 TWh



Top three world geothermal energy countries



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

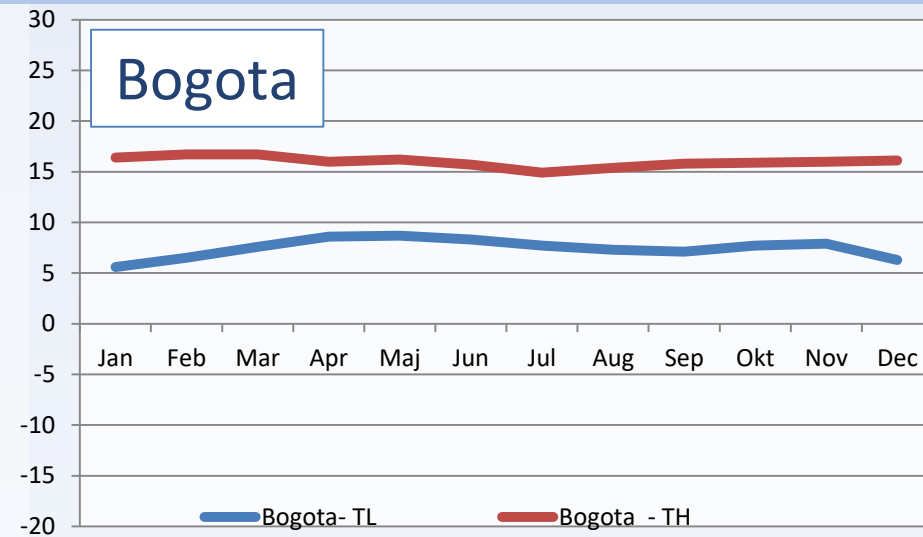
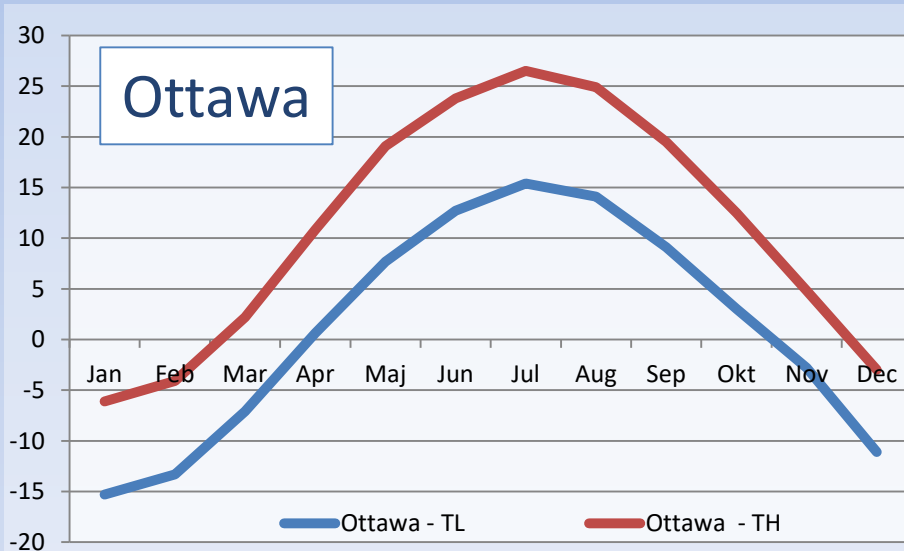


Total: 5.6 GW, 14.4 TWh
Heat: 0.048 GW, 0.2 TWh
GSHP: 5.6 GW, 14.2 TWh
Power: 0 GW, 0 TWh



Total: 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

Potential for underground thermal energy storage





1970's

1980's

1990's

2000's

2010's

ATES &
BTES
experi-
ments in
USA, CH,
NL, SE,
FR, JP

1970's

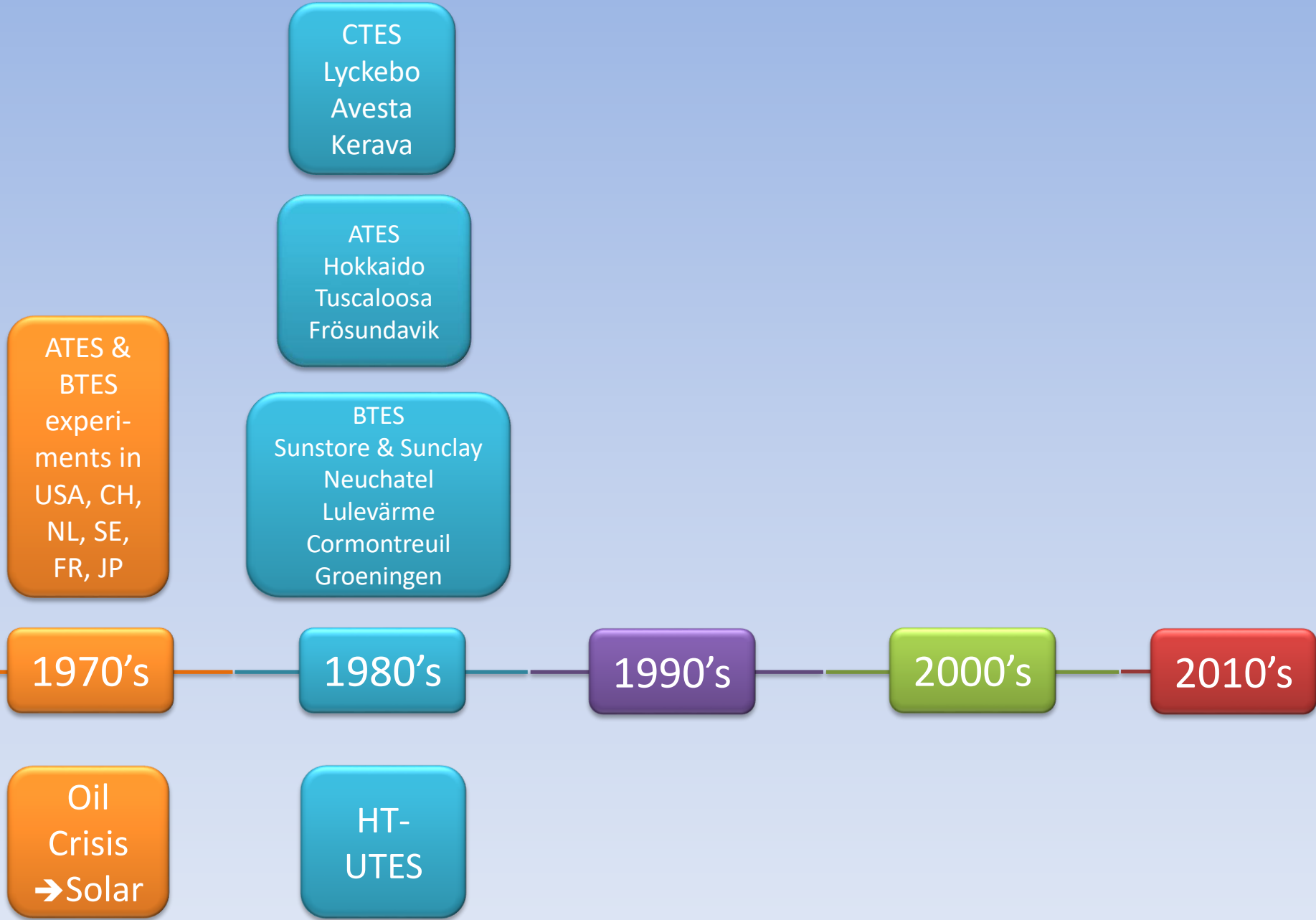
1980's

1990's

2000's

2010's

Oil
Crisis
→Solar



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

CTES
Lyckebo
Avesta
Kerava

ATES
Hokkaido
Tuscaloosa
Frösundavik

BTES
Sunstore & Sunclay
Neuchatel
Lulevärme
Cormontreuil
Groeningen

1970's

1980's

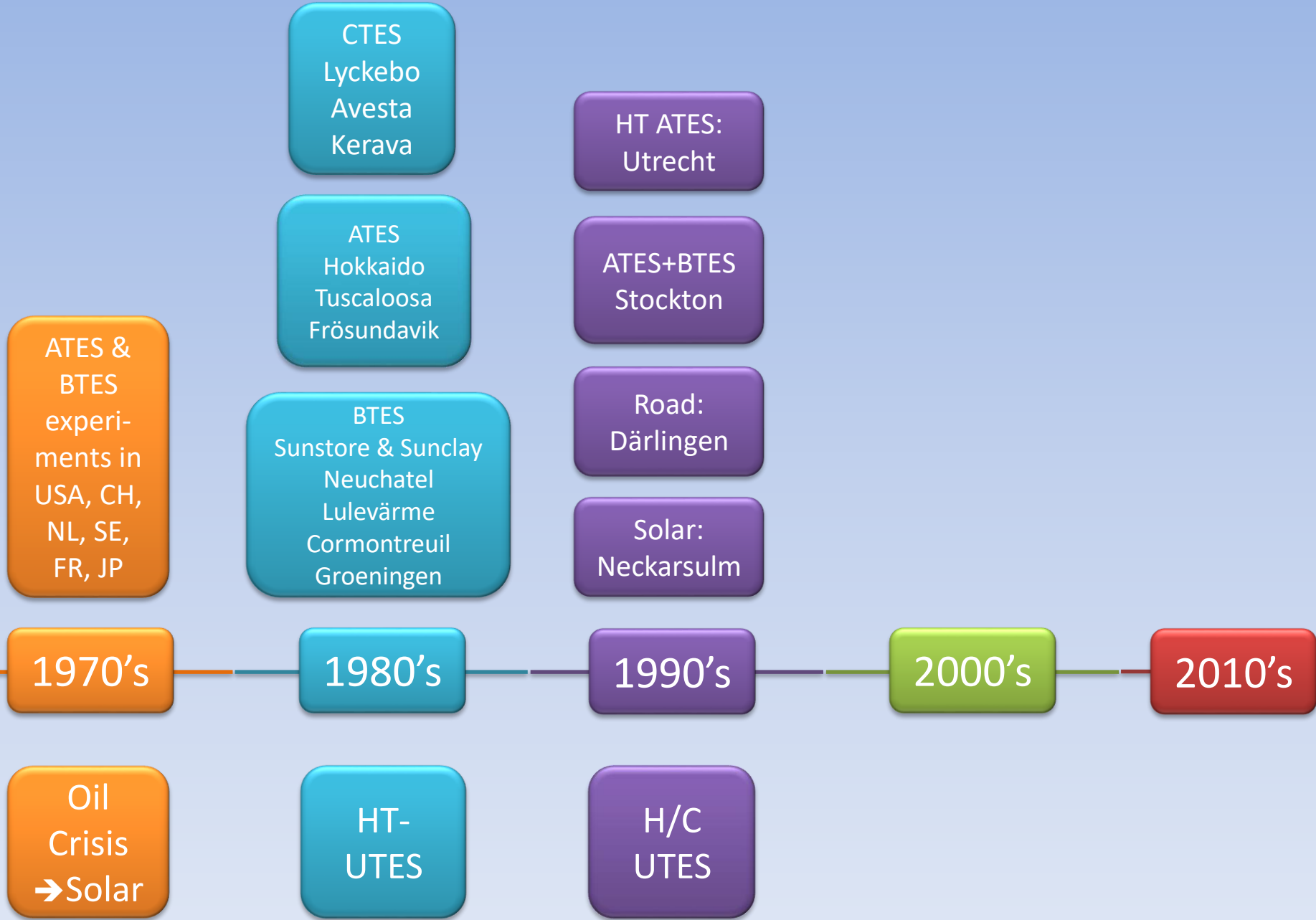
1990's

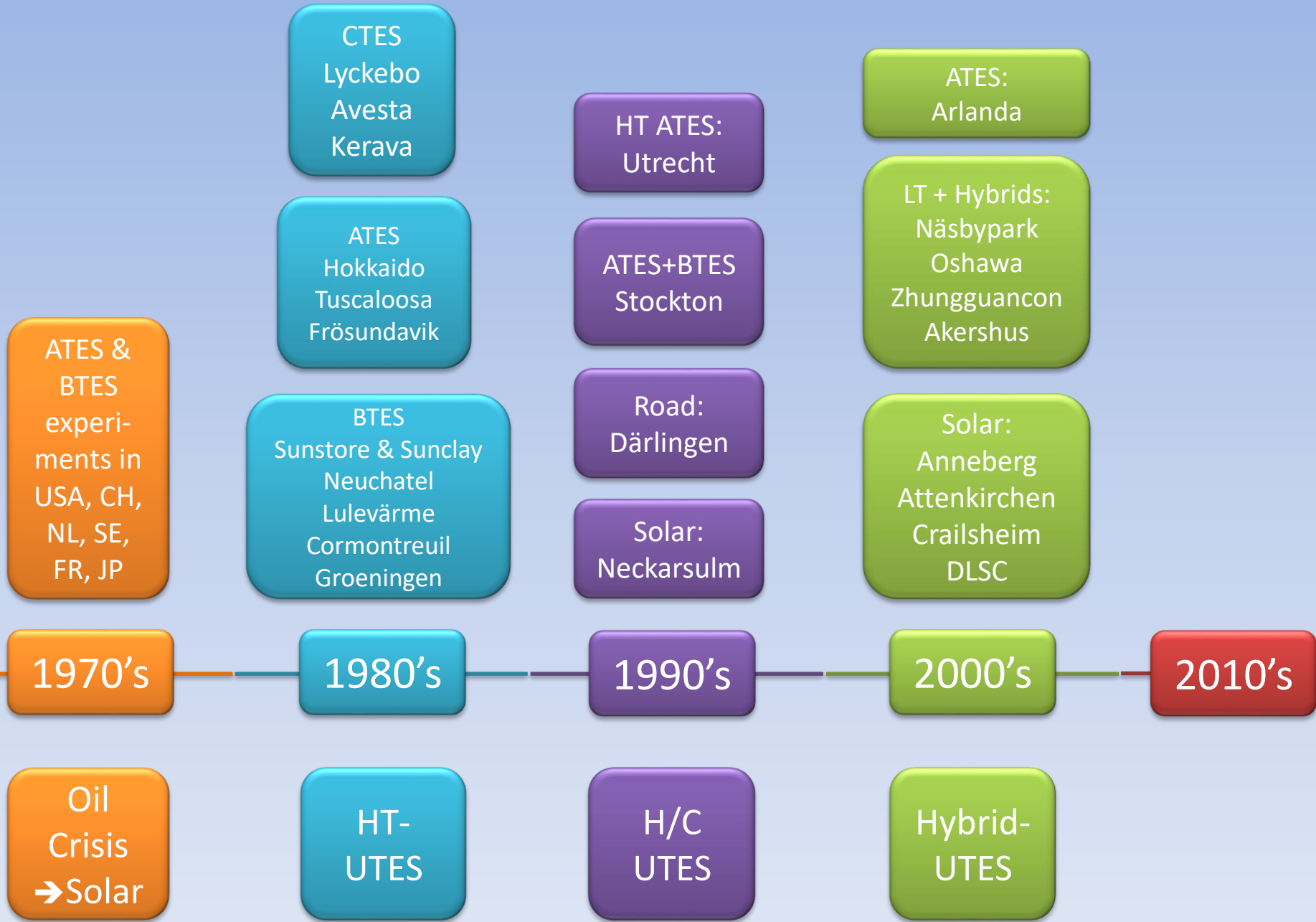
2000's

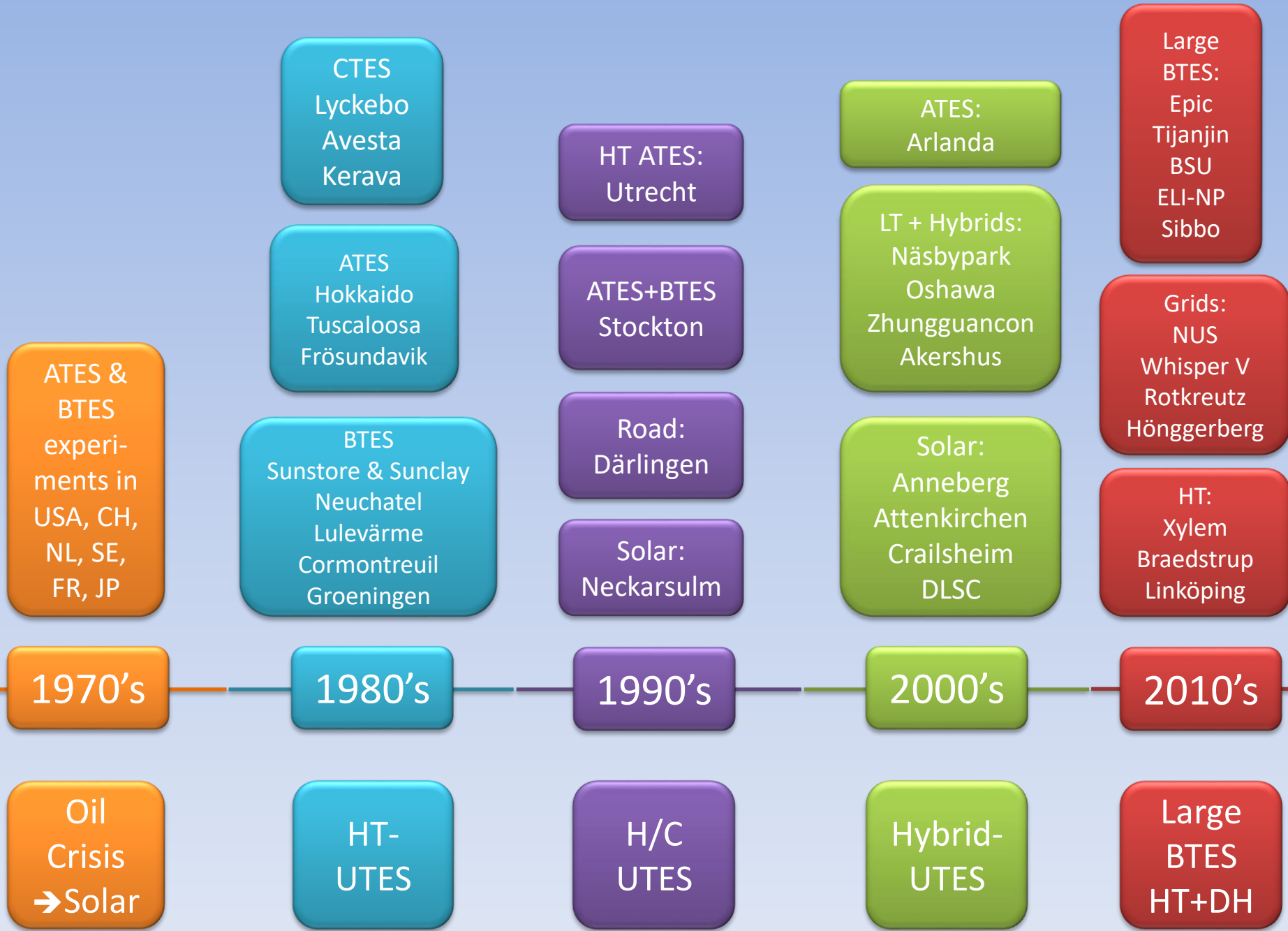
2010's

Oil Crisis
→ Solar

HT-UTES

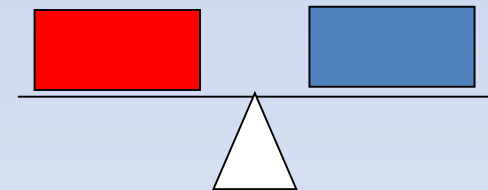
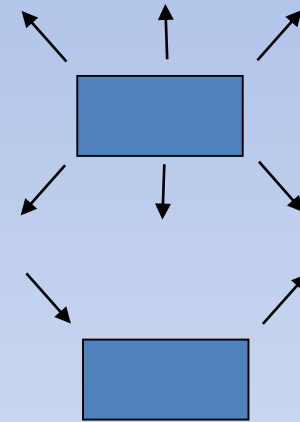






Underground storage strategies

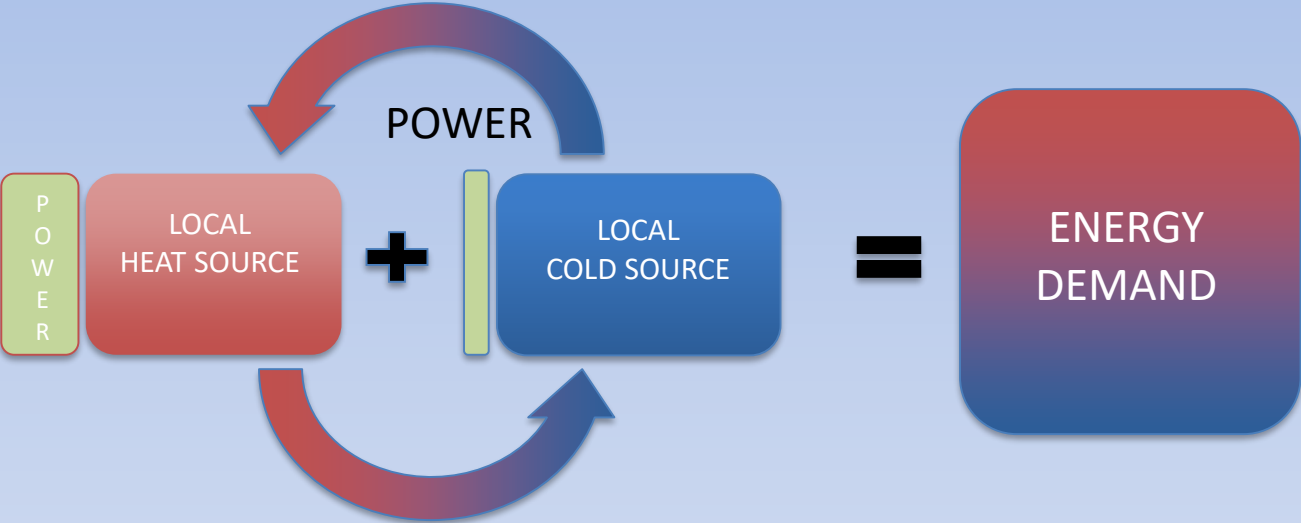
- Passive systems
- Active systems
- Active systems - balanced



Energy demand



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.

UTES is invisible, quiet and non-smelling.

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.

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

Thank you!