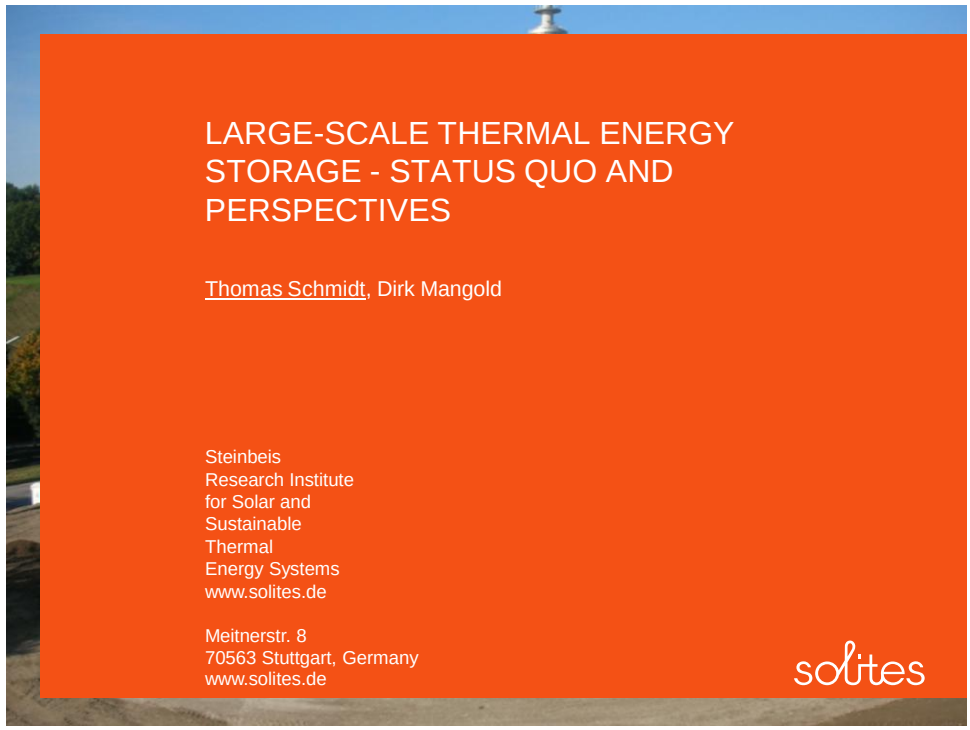

LARGE-SCALE THERMAL ENERGY STORAGE - STATUS QUO AND PERSPECTIVES

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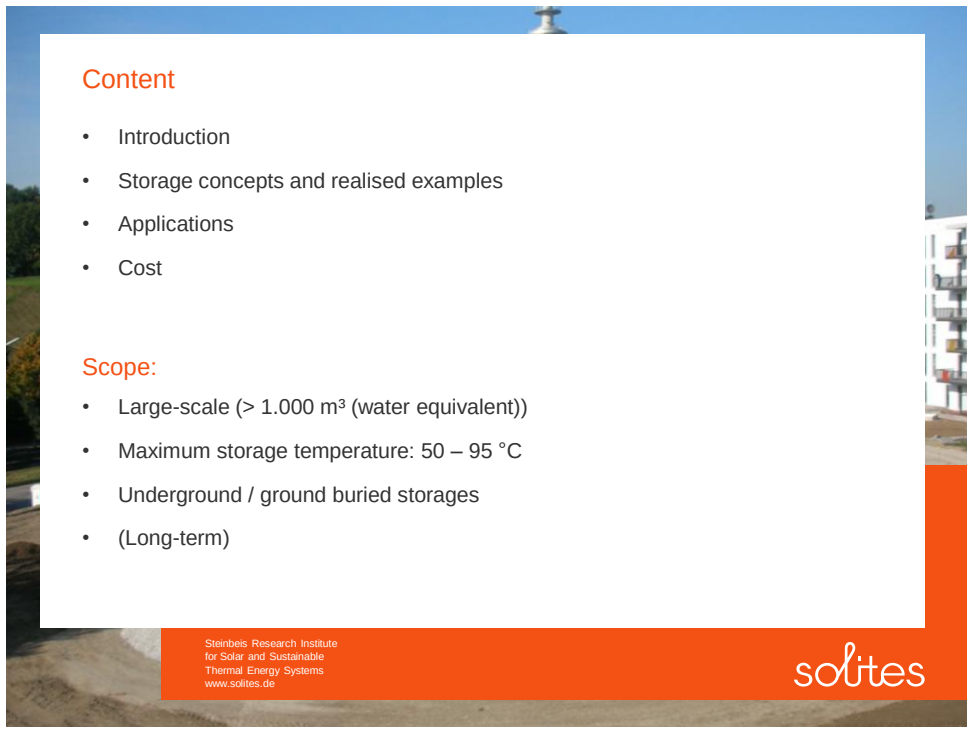

Content

- Introduction
- Storage concepts and realised examples
- Applications
- Cost

Scope:

- Large-scale (> 1.000 m³ (water equivalent))
- Maximum storage temperature: 50 – 95 °C
- Underground / ground buried storages
- (Long-term)

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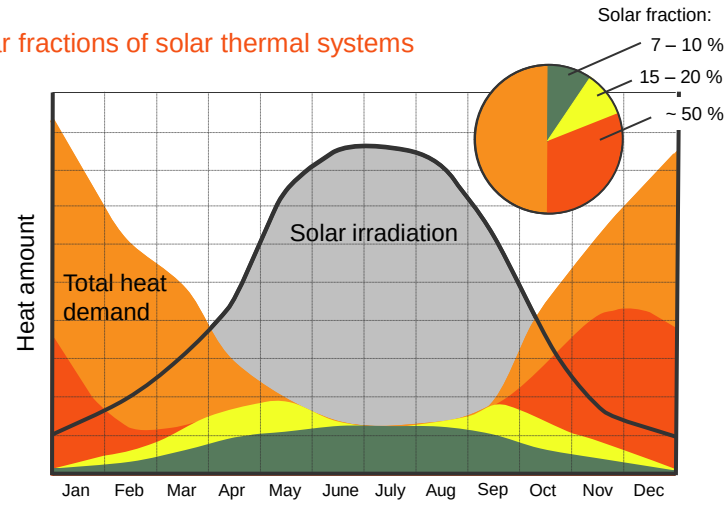
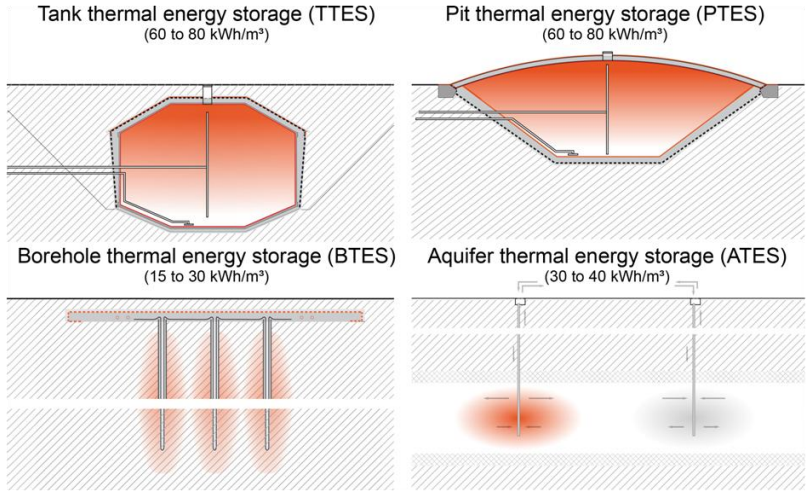
Solar fractions of solar thermal systems



- Domestic hot water system (100 % solar in summer)
- Solar combisystem (hot water and space heating)
- Solar district heating (SDH) with seasonal storage

Seasonal Thermal Energy Storage (STES) – Concepts



Solar district heating with concrete water tank in Munich

Start of operation: 2007

24.800 m² heated area (2.300 MWh/a)

2.900 m² solar collectors

5.700 m³ tank

Solar fraction: 47 %*

*simulation results ZAE

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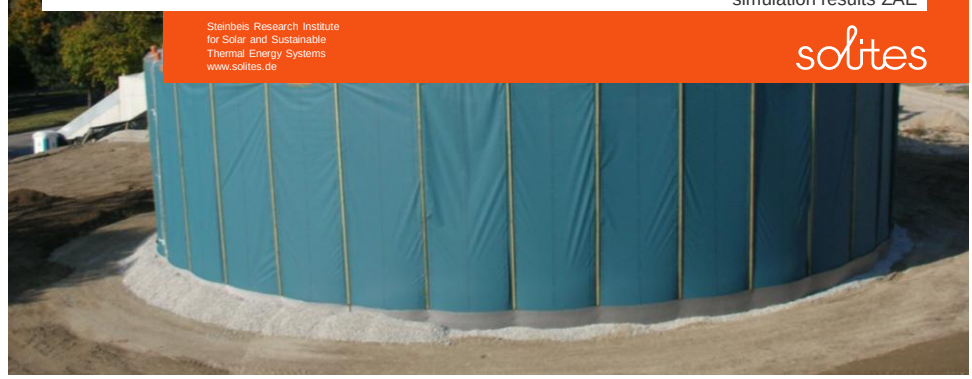
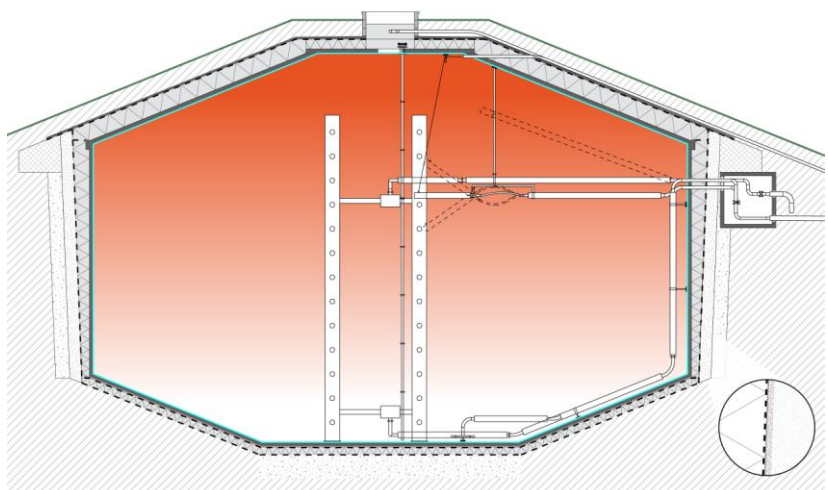


Concept of the TTES in Munich, 5700 m³, 2007



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Construction of the seasonal TTES in Munich , 5700 m³, 2007




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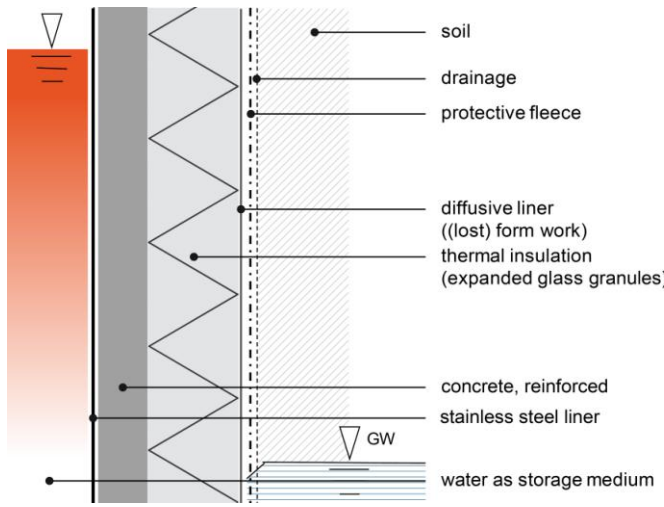
Wall construction of TTES in Munich , 5700 m³, 2007



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TTES Project examples

Location	Water volume [m³]	Year of construction
Friedrichshafen, DE	12,000	1996
Hamburg, DE	4,500 / 4,100*	1996 / 2010*
Hanover, DE	2,750	2000
Munich, DE	5,700	2007

*: reconstruction

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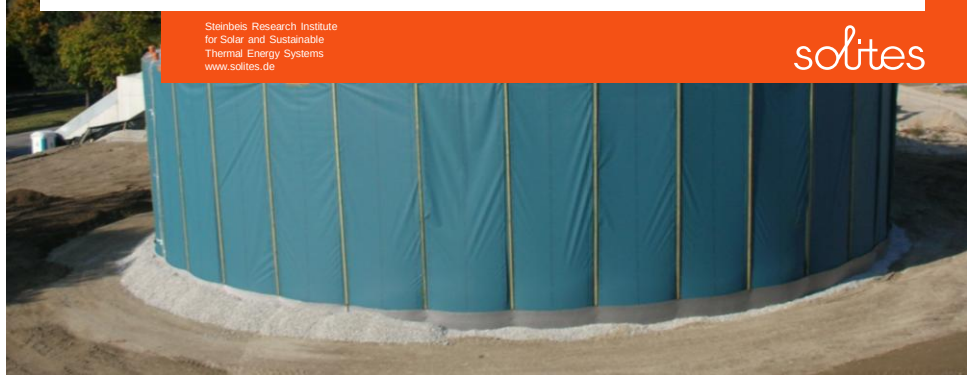
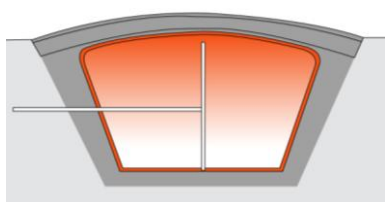


Pit thermal energy storage (PTES) in Eggenstein, 2008



12.000 m² heated area (1.150 MWh/a)

1.600 m² solar collectors

4.500 m³ pit storage

Solar fraction (design): 37 %

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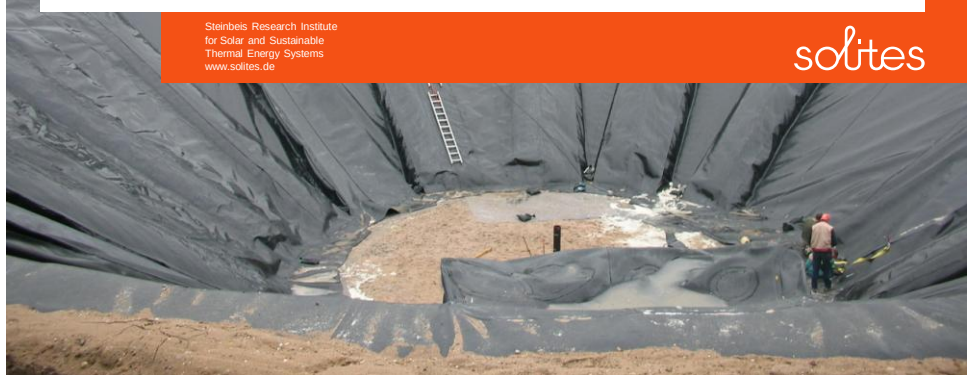
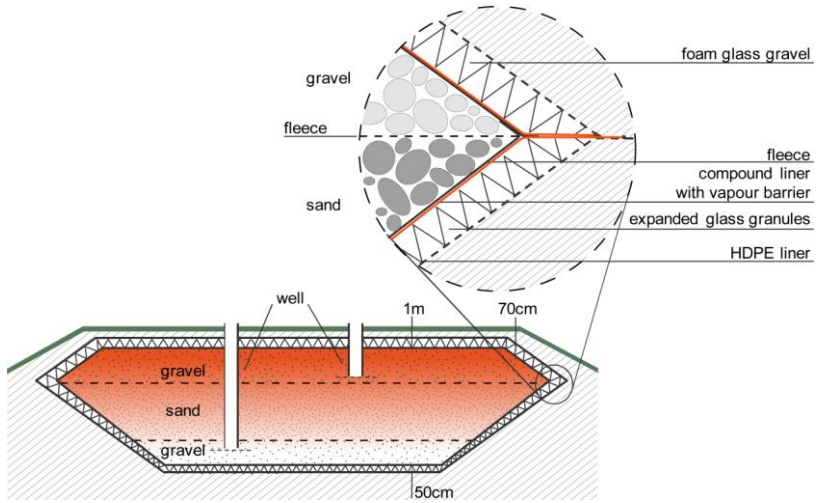


Concept of the PTES in Eggenstein, 4500 m³, 2007



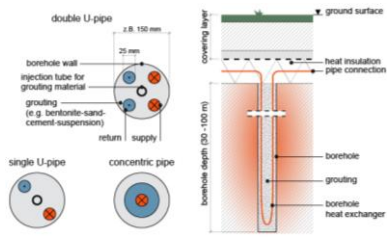
Pit storage in Eggenstein, 4500 m³, 2008




PTES Project examples

Location	Storage volume [m³]	Year of construction
Chemnitz, DE	8,000 (gravel/water)	1997
Augsburg, DE	6,500 (gravel/water)	1997
Steinfurt, DE	1,500 (gravel/water)	1999
Eggenstein, DE	4,500 (sand/gravel/water)	2008
Ottrupgaard, DK	1,500 (water)	1995
Marstal-1, DK	10,000 (water)	2003
Marstal-2, DK	75,000 (water)	2012

Borehole thermal energy storage (BTES) in Crailsheim, 2008



40.000 m²	heated area (4.100 MWh/a)
7.300 m²	solar collectors
100 + 480 m³	buffer tanks
37.500 m³	BTES
Solar fraction:	50 % (design)

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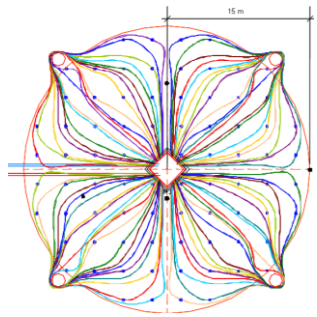
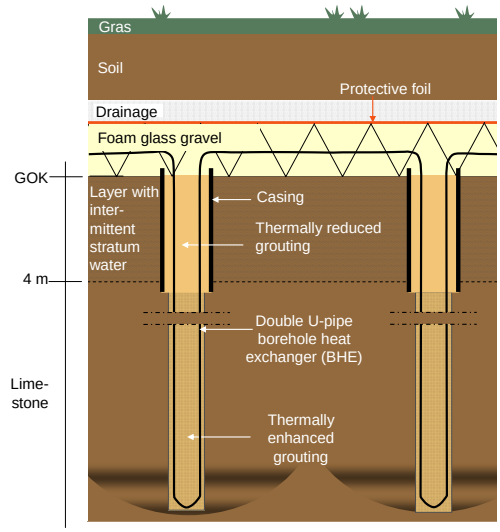
BTES in Crailsheim

No. of Boreholes:	80
Depth:	55 m
Volume:	37 500 m³
BHE:	2xU (PEX)
Insulation:	40 cm foam
(to the surface)	glass gravel





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BTES in Crailsheim, 37.500 m³, 2007

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BTES Project examples

Location	Ground volume [m³]	Year of construction
Neckarsulm, DE	63,400	1997+1998+2001
Attenkirchen	9,850*	2002
Crailsheim, DE	37,500	2008
Okotoks, CA	34,000	2007
Braedstrup, DK	17,000	2011

*: 500 m³ water + 9,350 m³ ground volume

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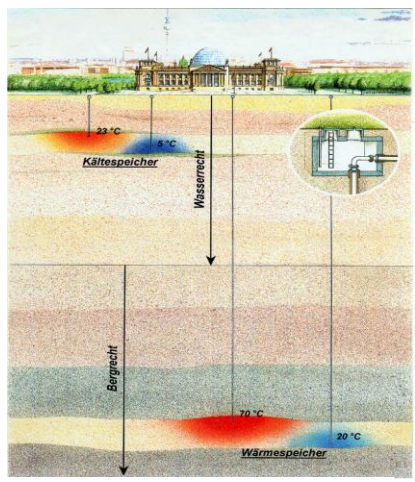
ATES in Berlin, heat and cold storage,1999



Source: Geothermie Neubrandenburg GmbH

Cold storage

- upper aquifer, 60 m below surface
- temperatures 5-28 °C
- cold from ambient and heat pumps
- 2 x 5 wells, 60 m
- max. flowrate: 300 m³/h
- distance between wells: 300 m

Heat storage

- lower aquifer, 285-315 m below surface
- temperatures up to 70 °C
- heat from CHP
- 2 wells, 320 m deep
- max. flowrate 100 m³/h
- distance between wells: 300 m

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ATES Project examples

Location	Max. temp.[°C]	Year of construction
Utrecht, NL	90	1991
Gouda, NL	90	1998
Berlin, DE	70	1999
Rostock, DE	50	2000
Neubrandenburg, DE	70	2004

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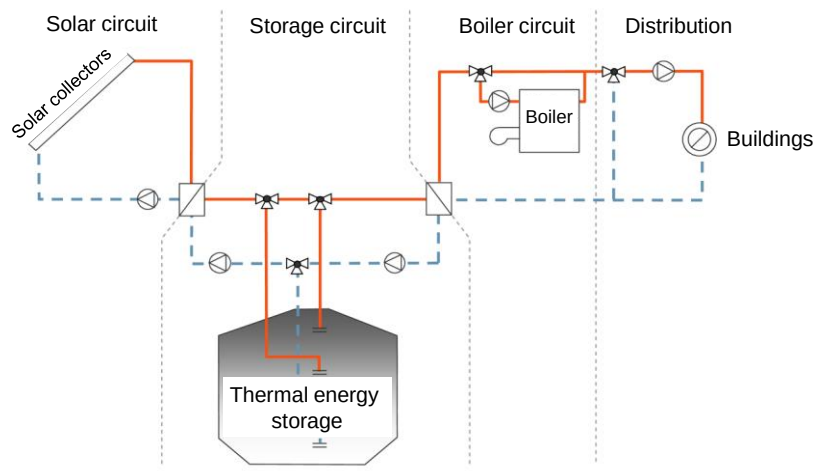
Solar district heating with (seasonal) thermal energy storage



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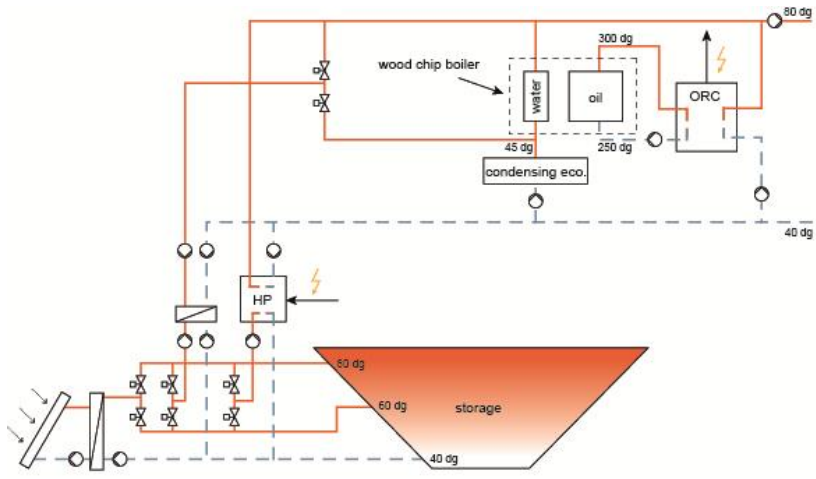
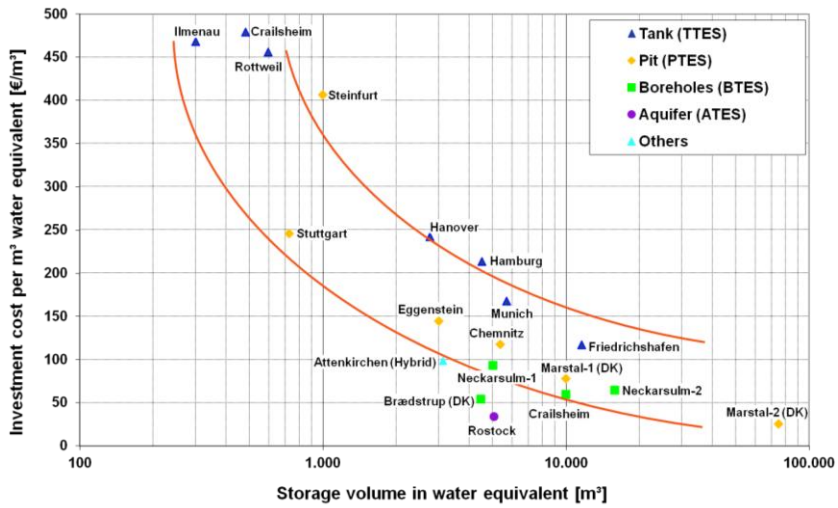
Smart district heating in Marstal, Denmark (EU FP7 - SUNSTORE 4)



Investment cost of large-scale thermal energy storages



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