Monitoring results and performance of seasonal heat storage

Thomas Schmidt

Steinbeis
Research Institute
for Solar and
Sustainable
Thermal
Energy Systems
www.solites.de

Meitnerstr. 8
70563 Stuttgart, Germany
www.solites.de

solites

Outline

- Introduction
- SDH*) with **pit thermal energy storage** in Dronninglund, Denmark
- SDH*) with **borehole thermal energy storage** in Crailsheim, Germany
- Summary

*) SDH: Solar district heating

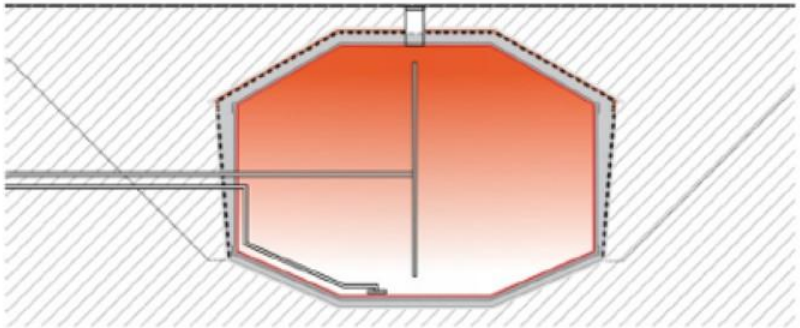
Steinbeis Research Institute
for Solar and Sustainable
Thermal Energy Systems
www.solites.de

solites

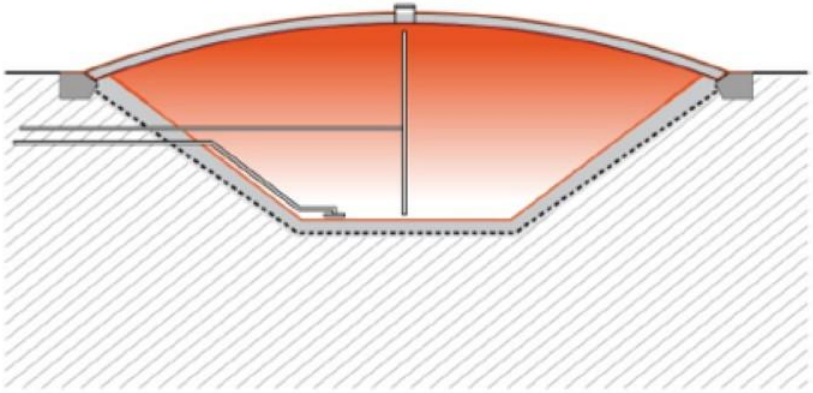
photo: Dronninglund Fjernvarme

Large-scale seasonal heat storage – concepts

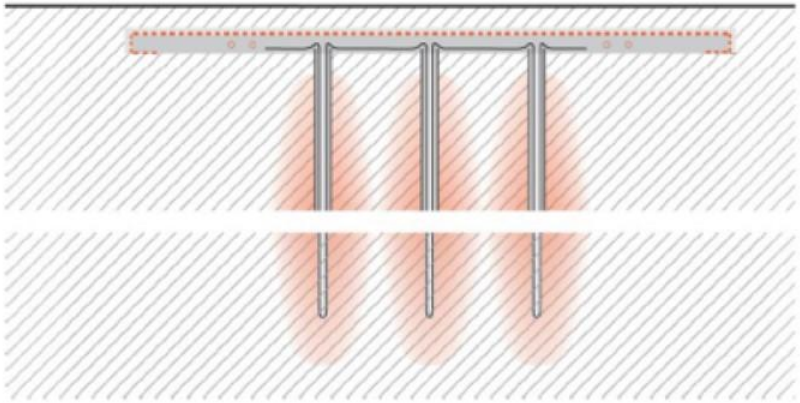
Tank thermal energy storage (TTES)
(60 to 80 kWh/m³)



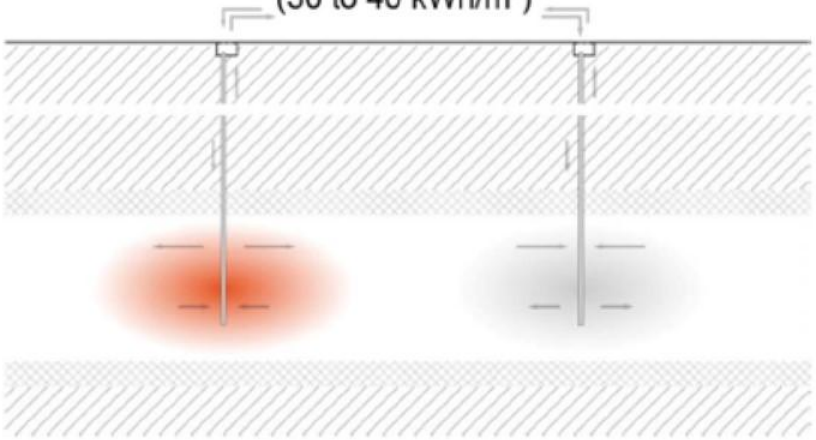
Pit thermal energy storage (PTES)
(60 to 80 kWh/m³)



Borehole thermal energy storage (BTES)
(15 to 30 kWh/m³)



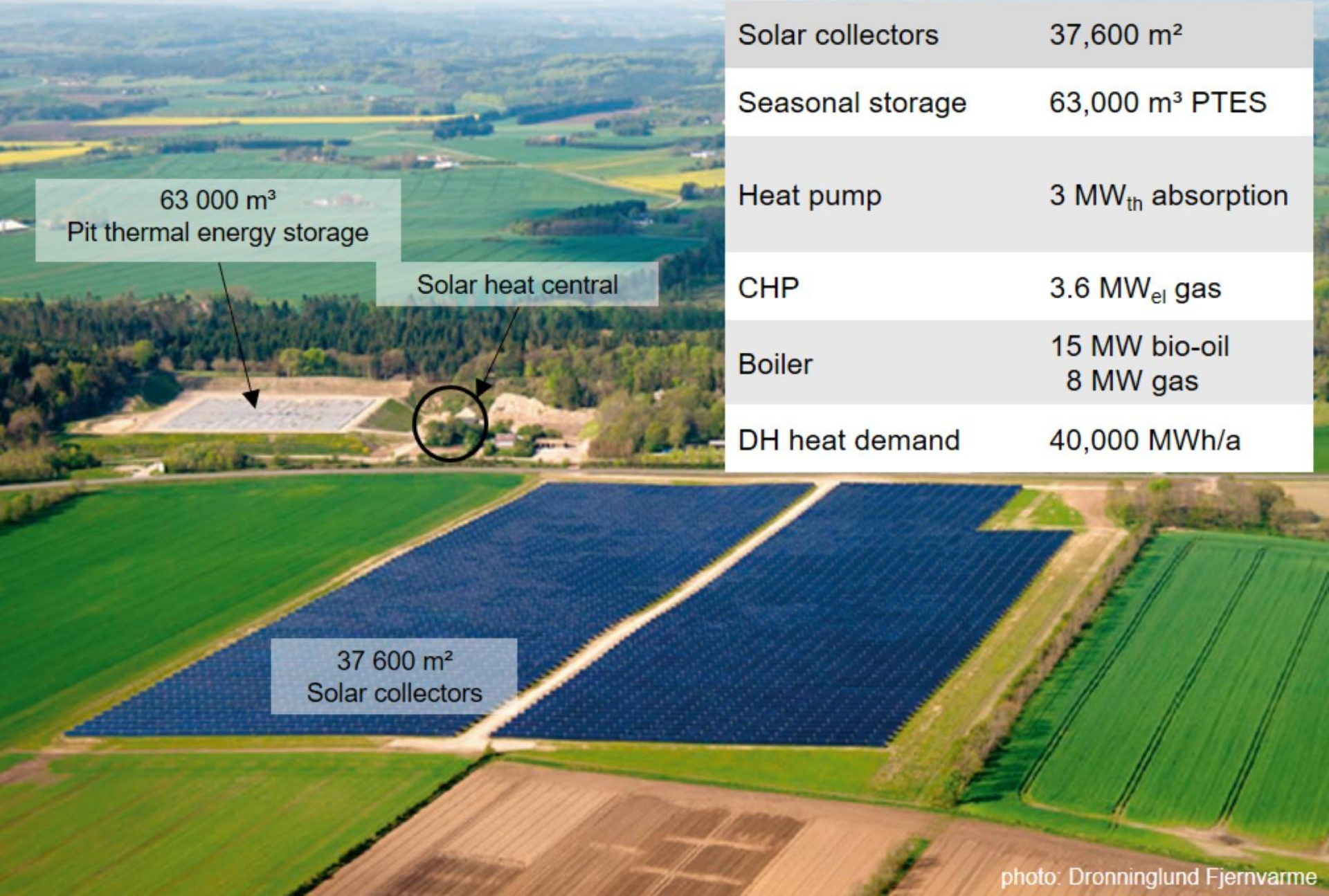
Aquifer thermal energy storage (ATES)
(30 to 40 kWh/m³)



Steinbeis Research Institute
for Solar and Sustainable
Thermal Energy Systems
www.solites.de

solites

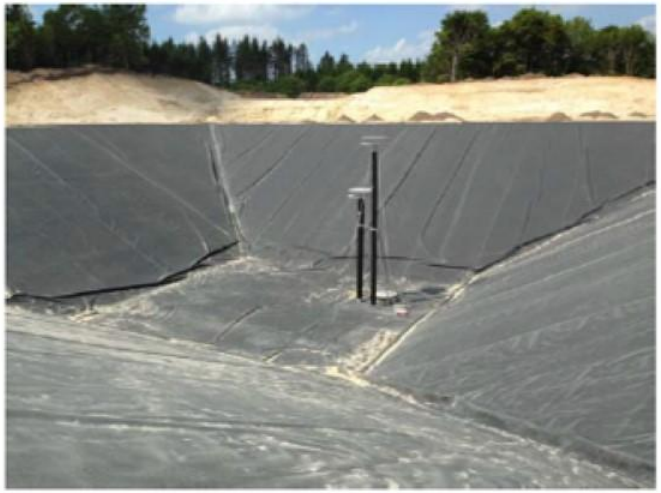
Pit thermal energy storage in Dronninglund, Denmark



Solar collectors	37,600 m²
Seasonal storage	63,000 m³ PTES
Heat pump	3 MW_{th} absorption
CHP	3.6 MW_{el} gas
Boiler	15 MW bio-oil 8 MW gas
DH heat demand	40,000 MWh/a

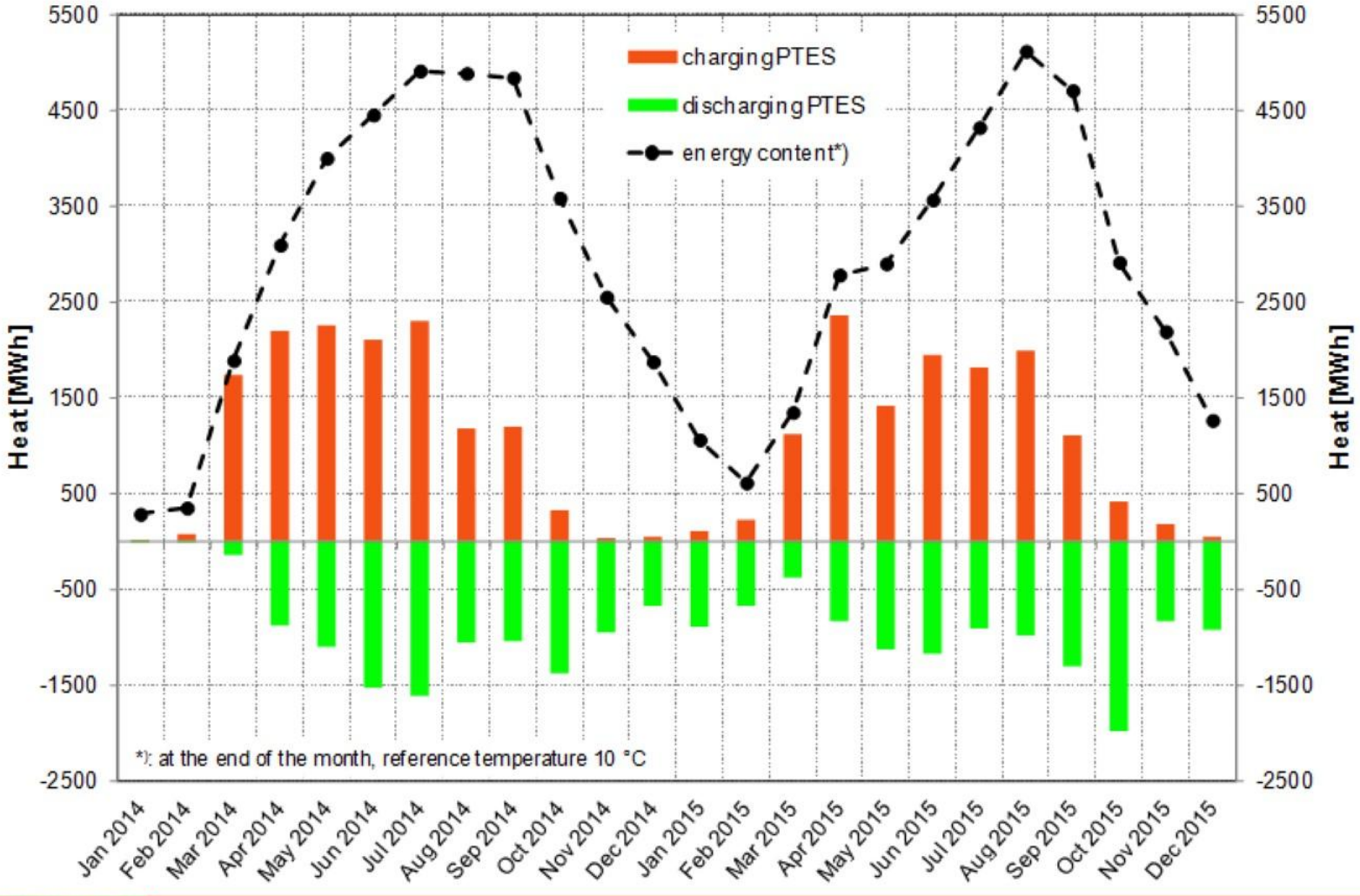
photo: Dronninglund Fjernvarme

PTES in Dronninglund, 63 000 m³, 2013



photos: Dronninglund Fjernvarme

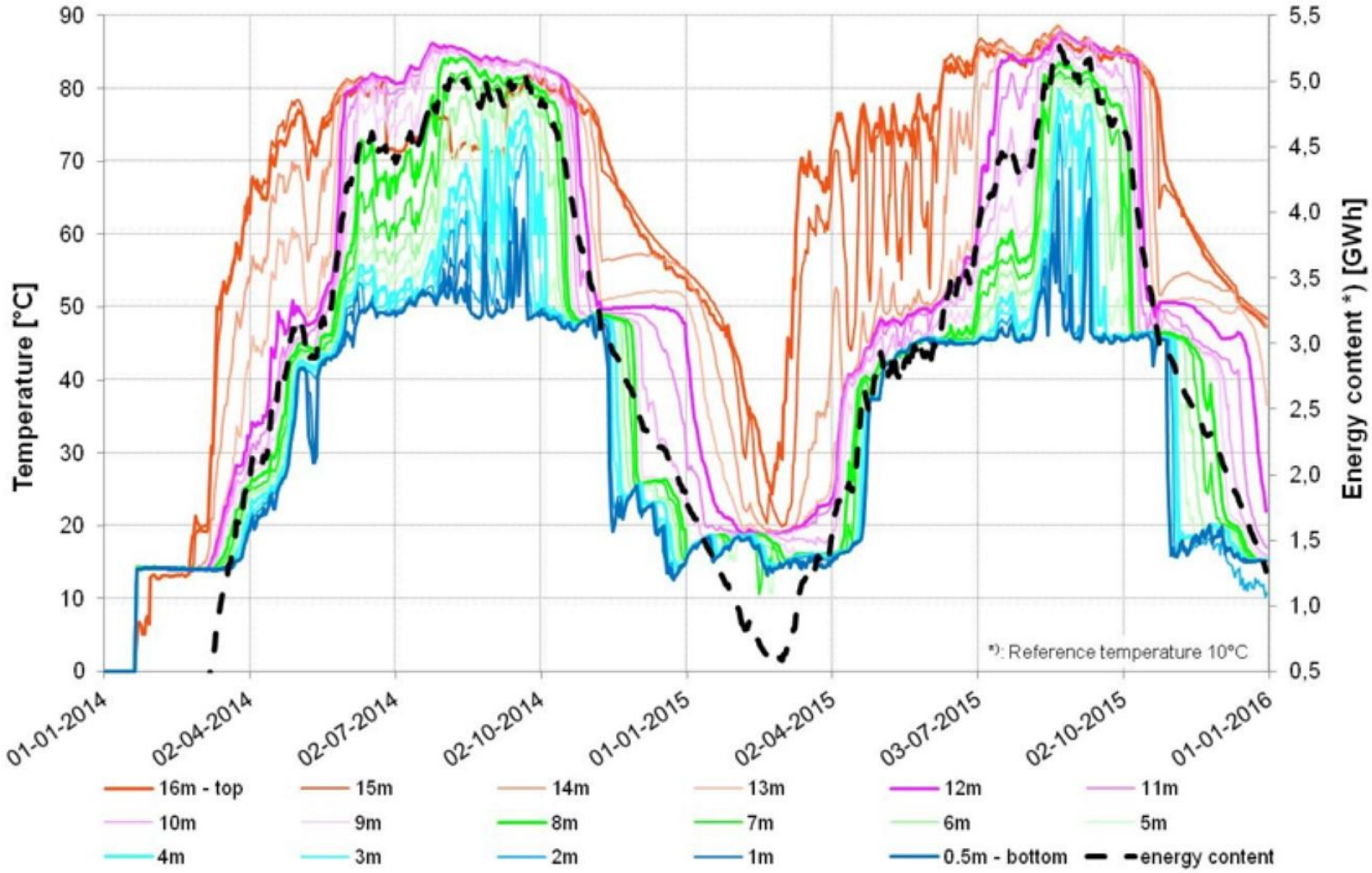
Dronninglund pit storage energy balance 2014 + 2015



Steinbeis Research Institute
for Solar and Sustainable
Thermal Energy Systems
www.solites.de

solites

Dronninglund pit storage temperature development

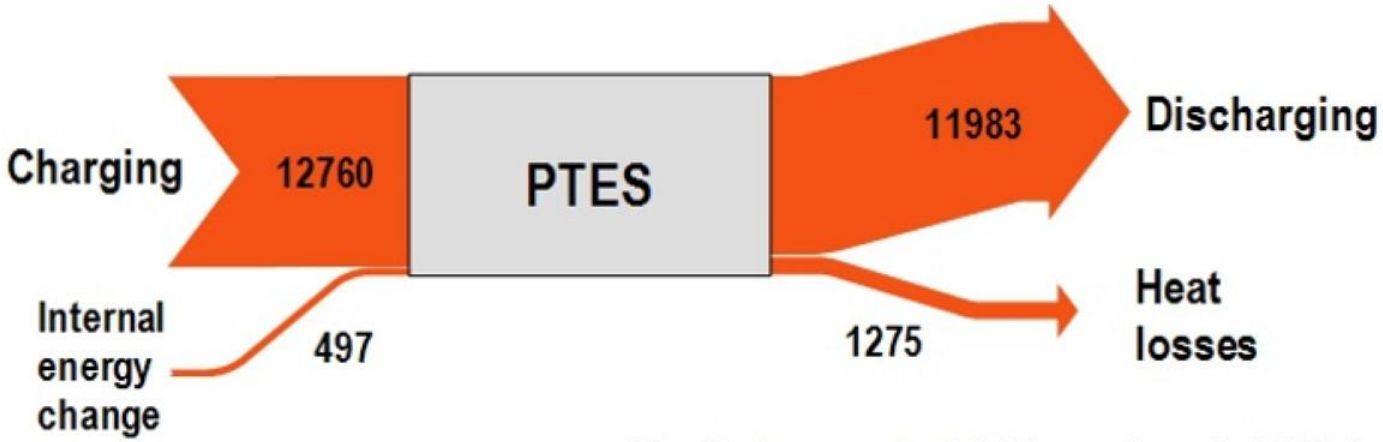


Steinbeis Research Institute
for Solar and Sustainable
Thermal Energy Systems
www.solites.de

solites

Dronninglund pit storage energy flow 2015

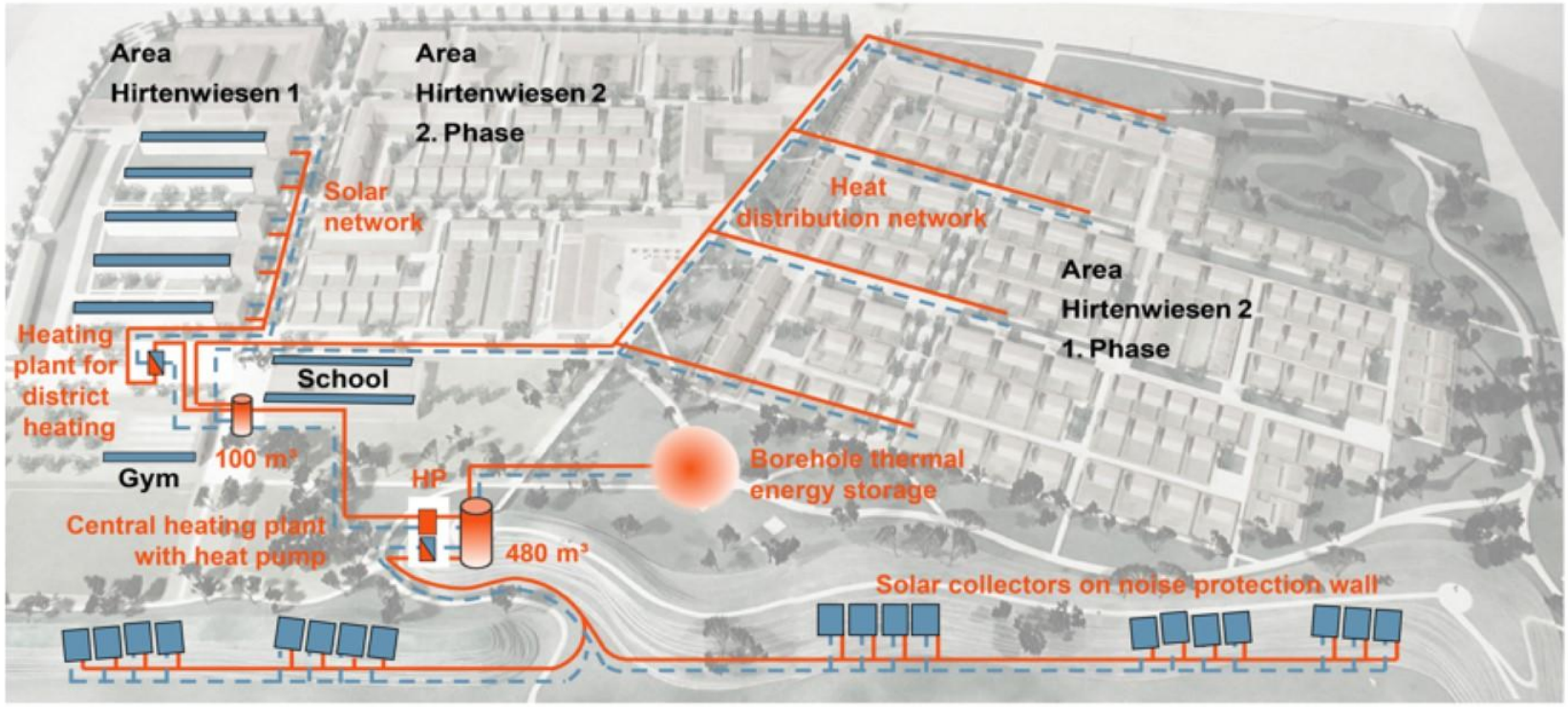
Storage efficiency:	**90 %**	**T-max:**	**89 °C**
No. of storage cycles:	**2.2**	**T-min:**	**10 °C**
Heat capacity (64 K):	**5 500 MWh**		



Monitoring results 2015, numbers in MWh/a

No se puede mostrar la imagen en este momento.

SDH with seasonal heat storage in Crailsheim, Germany



- service area: 260 apart., school, gym.
- heat demand: 4 100 MWh/year
- solar collectors: 7 300 m² (aperture)
- buffer storage: 100 + 480 m³ (water tank)
- STES: 37 500 m³ (BTES)
- el. heat pump: 480 kW_{th}
- solar fraction: 50 % (design)

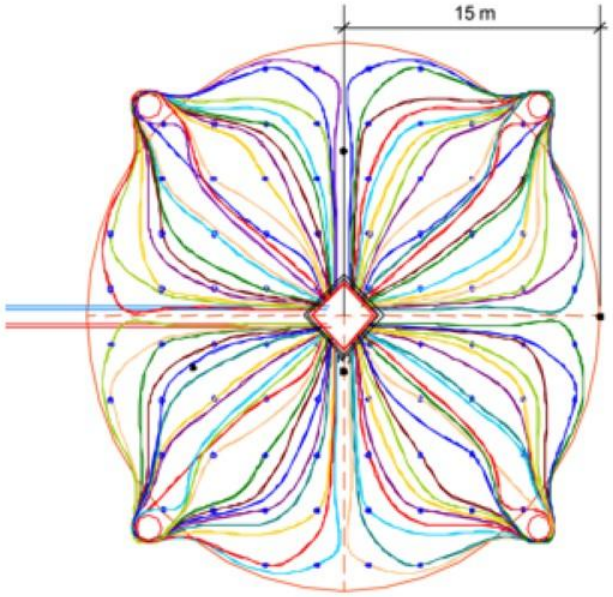
Steinbeis Research Institute
for Solar and Sustainable
Thermal Energy Systems
www.solites.de

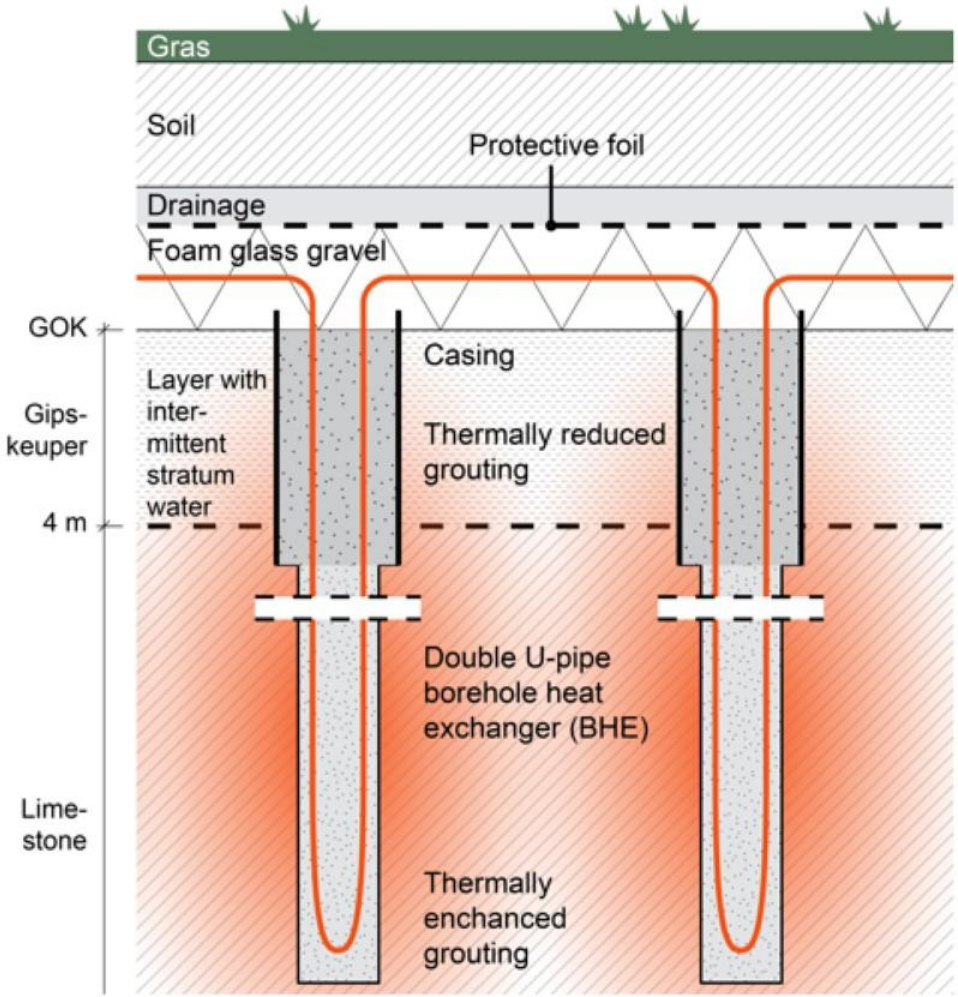
solites

No se puede mostrar la imagen en este momento.

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





Steinbeis Research Institute
for Solar and Sustainable
Thermal Energy Systems
www.solites.de

solites

No se puede mostrar la imagen en este momento.

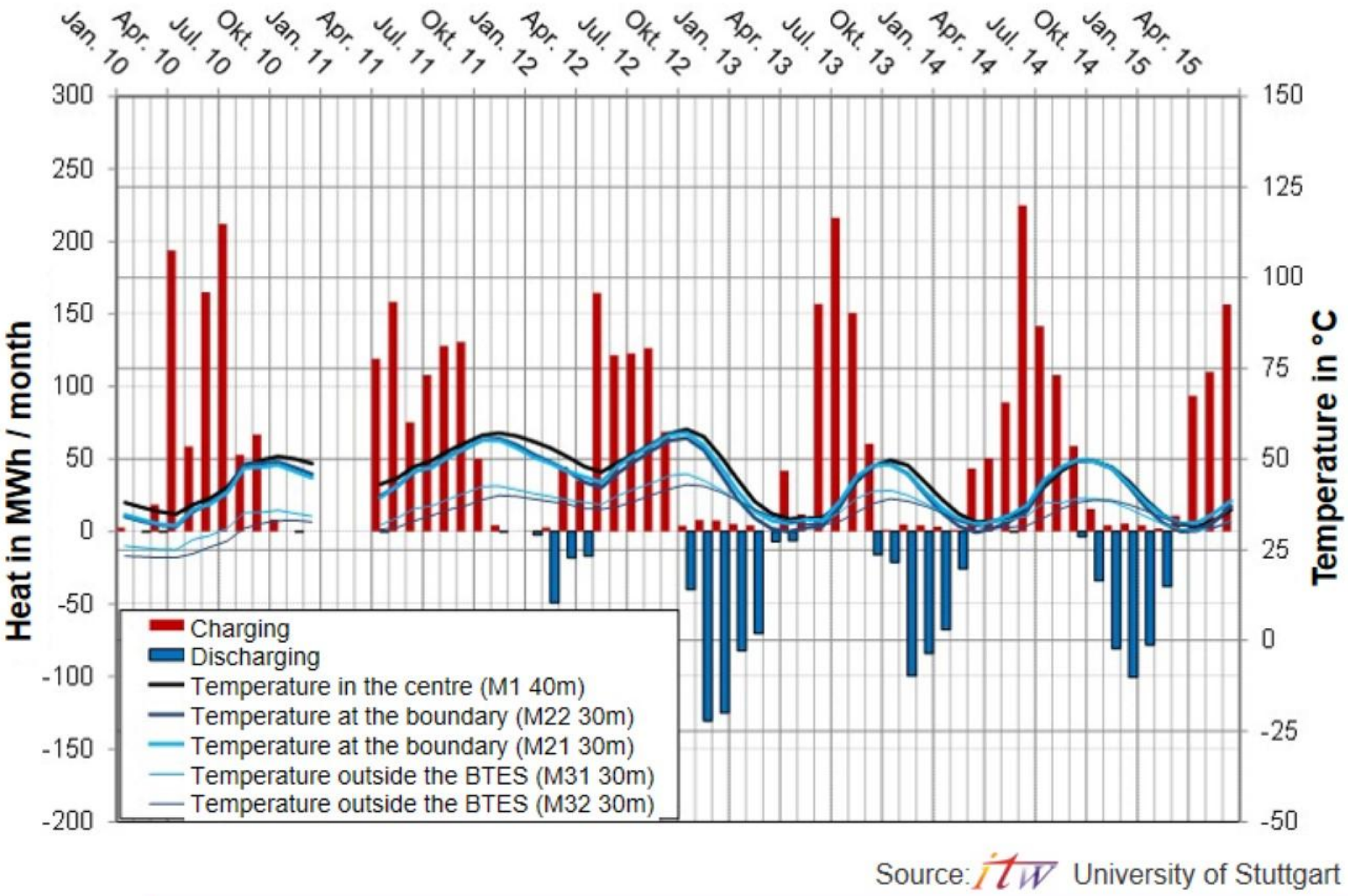
BTES in Crailsheim, 37.500 m³, 2007

Steinbeis Research Institute
for Solar and Sustainable
Thermal Energy Systems
www.solites.de

solites

No se puede mostrar la imagen en este momento.

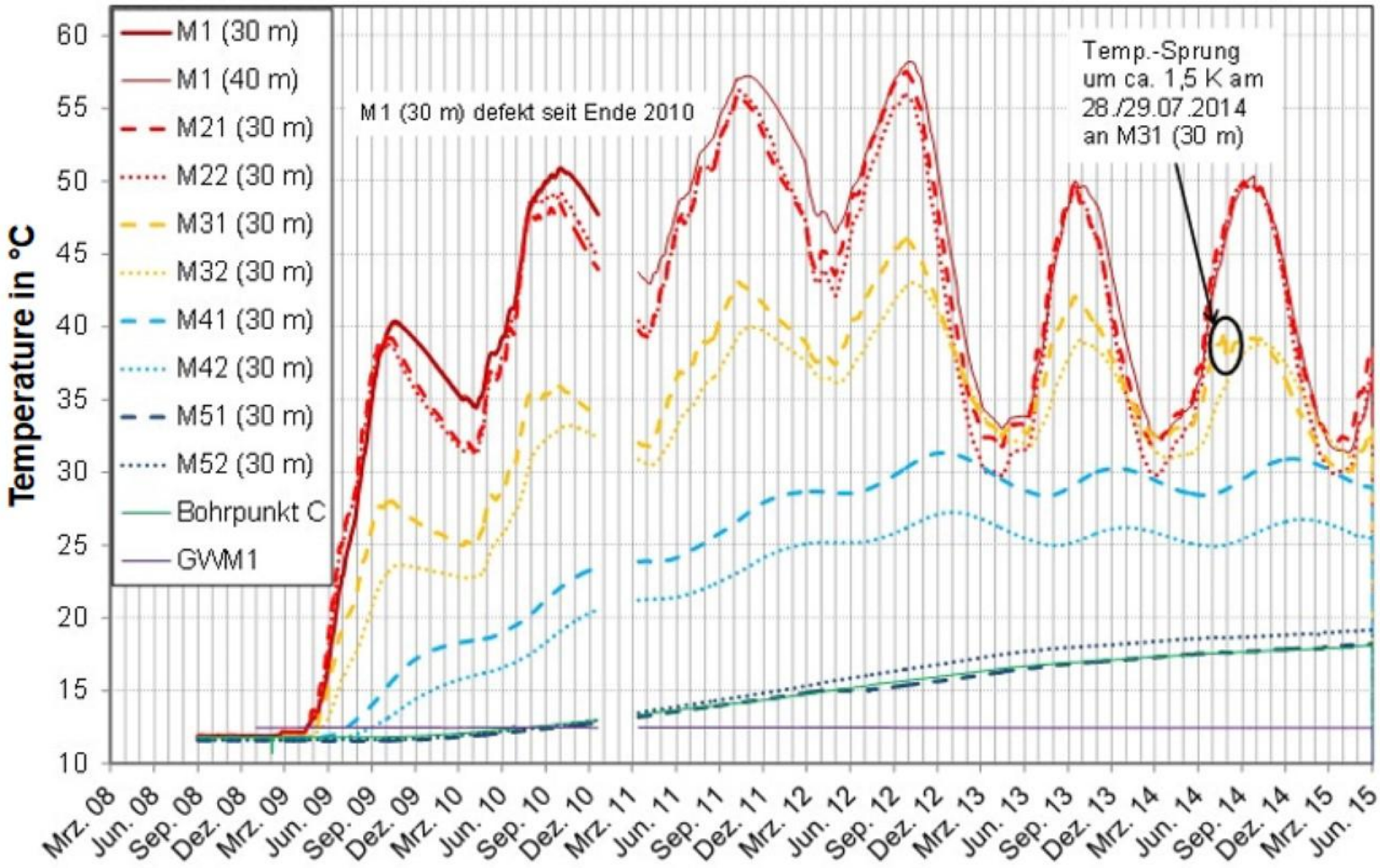
Crailsheim BTES monthly heat balance



Source: itw University of Stuttgart

No se puede mostrar la imagen en este momento.

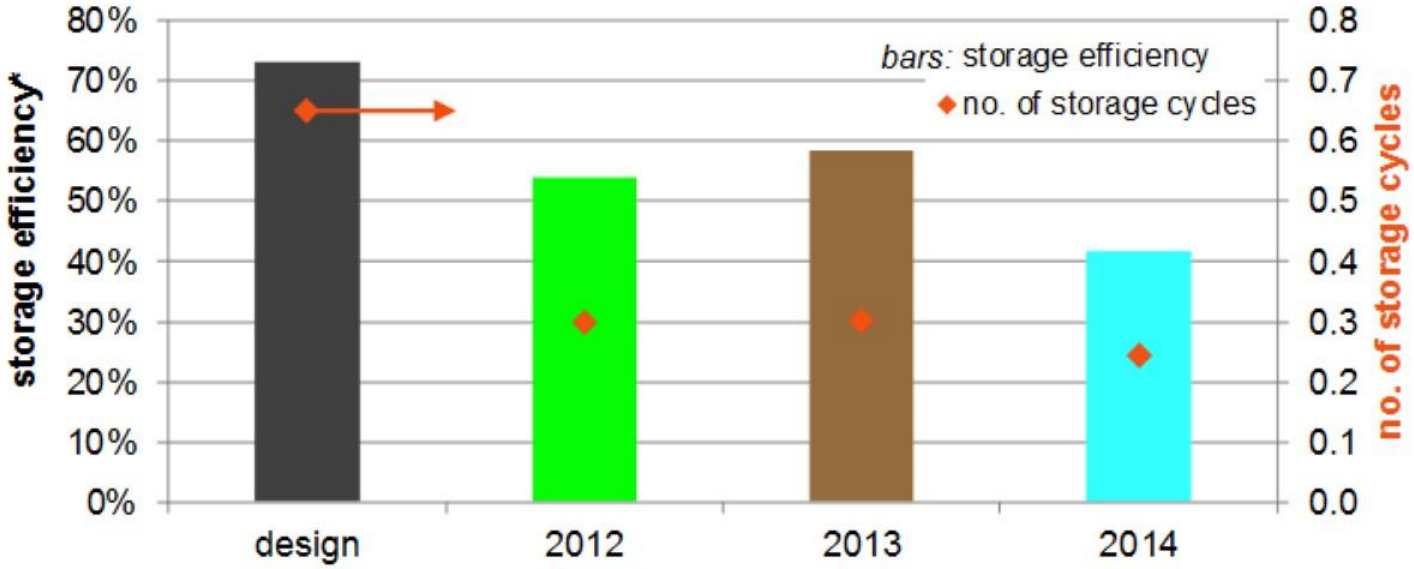
Crailsheim BTES temperature development



Source: itw University of Stuttgart

No se puede mostrar la imagen en este momento.

Crailsheim BTES efficiency

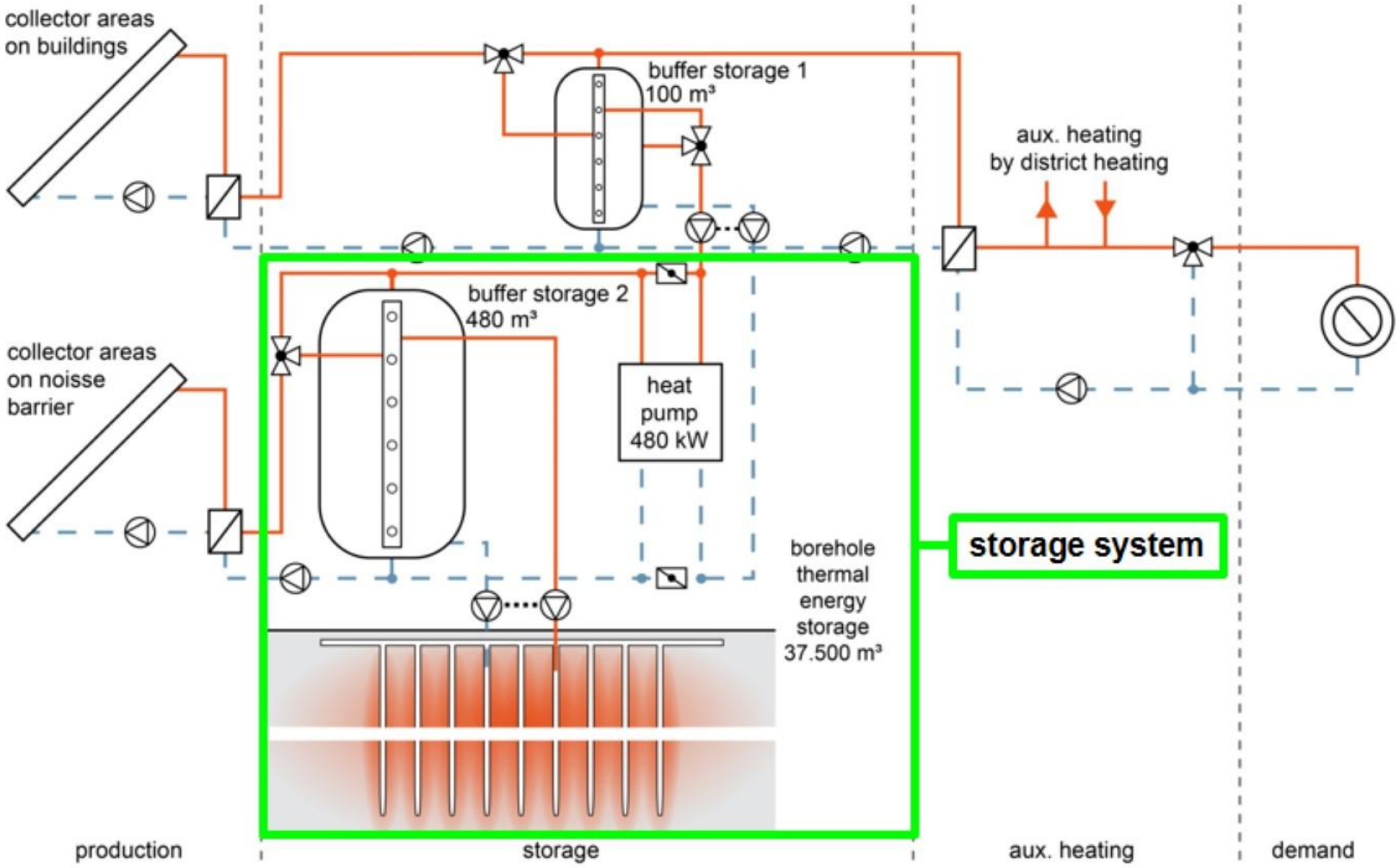


- Utilisation of the storage is less than designed (yearly charging and discharging)
- Charging temperatures are less than designed (70°C instead of 80°C)
- Heat pump for BTES discharging is smaller than designed (80 kW_{el} instead of 258 kW_{el})
- Larger share of direct solar thermal usage -> less solar heat for charging BTES available
- Buffer tank smaller than designed (480 m^3 instead of 600 m^3)

*) Data source: itw University of Stuttgart

No se puede mostrar la imagen en este momento.

System concept of the solar district heating plant in Crailsheim



Steinbeis Research Institute
for Solar and Sustainable
Thermal Energy Systems
www.solites.de

solites

Summary

- Seasonal heat storage allows for high RES shares in district heating systems (40 – 50% in the presented examples)
- High storage efficiencies are proved e.g. in Dronninglund
- Efficiency of a seasonal heat storage is strongly depending on
  - system integration
  - utilisation of the storage by the system

Steinbeis Research Institute
for Solar and Sustainable
Thermal Energy Systems
www.solites.de

solites

photo: Dronninglund Fjernvarme

Thank you for your attention!

More information:

www.saisonalspeicher.de

www.solar-district-heating.eu

www.solites.com

Energiteknologisk udvikling og demonstration

The presented work was financially supported by the German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMU) and eudp, Denmark. The authors gratefully acknowledge this support.

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

photo: Dronninglund Fjernvarme

Investment cost of seasonal thermal energy storages