Central Solar Heating Plants with Seasonal Thermal Energy Storage in Germany

H. Drück, R. Marx, D. Bauer, J. Nußbicker-Lux

Institute of Thermodynamics and Thermal Engineering (ITW)
Research and Testing Centre for Thermal Solar Systems (TZS)
University of Stuttgart, Pfaffenwaldring 6, 70550 Stuttgart, Germany
Internet: www.itw.uni-stuttgart.de
Email: drueck@itw.uni-stuttgart.de

TZS *the largest test centre for thermal solar systems in Europe*

Deutscher Akkreditierungs Rat
DAP-PL-3158.00

research & development

education & knowledge transfer

testing & inspection

SWT TECHNOLOGIE

Demonstration projects with STES (Solarthermie2000 plus) 1/2

Hamburg (1996)

3.000 m²
flat plate coll.,
4.500 m³
Water tank

Friedrichshafen (1996)

4.050m²
flat plate coll.,
12.000 m³
Water tank

Neckarsulm (1997)

5.670 m²
flat plate coll.,
63.300 m³
Borehole Thermal Energy Storage (BTES)

Steinfurt (1998)

510 m²
flat plate coll.,
1.500 m³
Pit TES
(gravel / water)

Rostock (2000)

980 m²
Solar-Roof,
20.000 m³
Aquifer Thermal Energy Storage (ATES)

Hannover (2000)

1.350 m²
flat plate coll.,
2.750 m³
Water tank

Demonstration projects with STES (Solarthermie2000 plus) 2/2

Chemnitz, 1. phase (2000)

540 m²
Vacuum tubes,
8.000 m³
Pit TES
(gravel / water)

Attenkirchen (2002)

800 m²
Solar-Roof
9.850 m³
Water tank and Boreholes

Munich (2007)

2.900 m²
flat plate coll.,
5.700 m³
Water tank

Crailsheim (2007)

7.500 m²
flat plate coll.,
39.000 m³
Borehole Thermal Energy Storage (BTES)

Eggenstein (2008)

1.600 m²
flat plate coll.,
4.500 m³
Pit TES
(gravel / water)

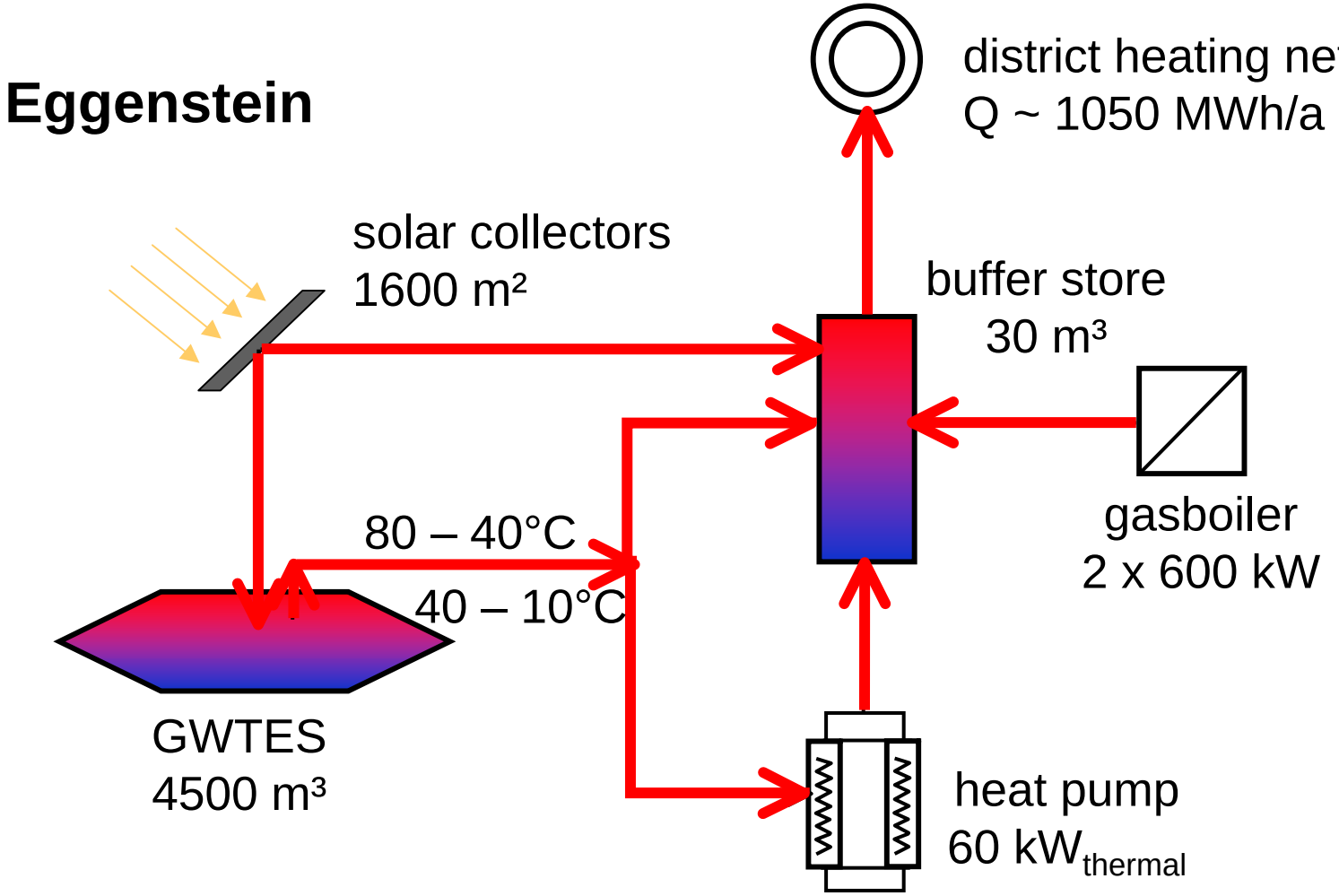
STES:
Seasonal Thermal Energy Storage

Central Solar Heating Plants with Seasonal Thermal Energy Storage under scientific accompaniment of ITW

	collector area [m²]	backup heating	heat pump [kW_{th}]	buffer store [m³]	STES [m³]	f_{sol} (designed) [%]
Friedrichshafen	4 050	gas boilers 720 + 900 kW	-	-	HTES 12 000	50
Neckarsulm	6 570	gas boiler 2 000 kW	500	2x 100	BTES 63 300	50
Rostock	980	gas boiler 250 kW	110	30	ATES 20 000	62
Crailsheim	5 710 (March 2011)	district heating	485	100 + 480	BTES 39 000	50
Eggenstein	1 600	gas boilers 2x 600 kW	60	30	GWTES 4 500	35-40

Latest Central Solar Heating Plants with Seasonal Thermal Energy Storage (CSHPSS)

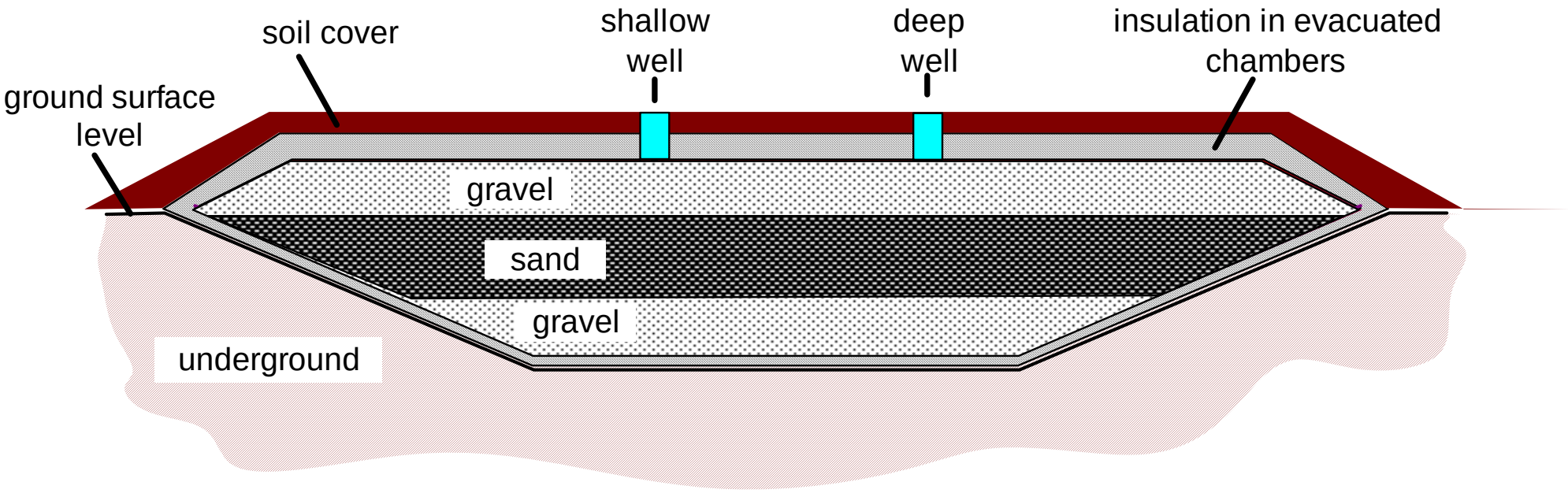
---> First CSHPSS integrated into existing buildings in Germany



CSHPSS Eggenstein

1600 m² solar collectors and 4500 m³ gravel/water store

Newest generation of gravel/water TES in Eggenstein



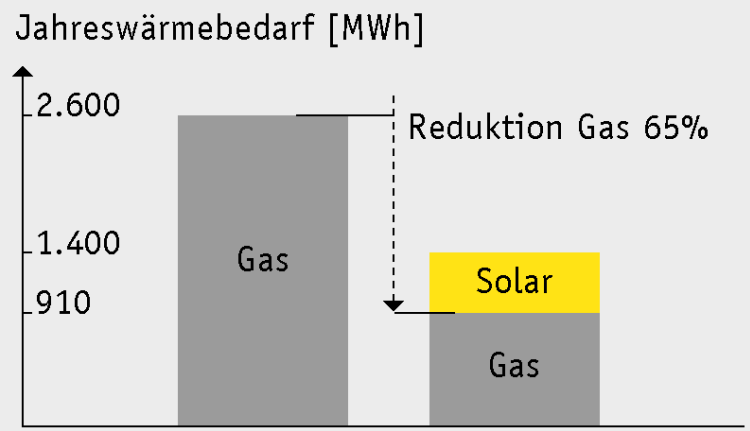
- full surface insulated (even bottom)
- 30 evacuated chambers filled with insulation (expanded glass granules and foam glass gravel)
- HDPE-liner restricted to temperature of 80°C
- bottom layer washed gravel
- middle layer sand (excavation)
- top layer washed gravel
- charging and discharging through out 2 wells

before → Renovation + Solar → after


Quelle: PKi


Quelle: PKi


Quelle: PKi



Quelle: PKi


Quelle: PKi

Summary

- 11 CSHPSS have been built in Germany in the last 15 years
- four seasonal storage concepts are successfully demonstrated; each concept is in operation in at least one CSHPSS plant
- experiences from the first pilot plants led to technical improvement, higher efficiencies and cost reduction in next generation plants
- there is no optimum storage concept for all applications – concepts have to be chosen individually according to local ground conditions and application

main experiences (STES):

- no serious failures (leakages …) have been observed by now
- moisture protection of the insulation is important
- system (integration) is crucial: e.g. the system temperatures fix the storage capacity!

Outlook - What we needed in the future

- numerous advanced demo-systems
- development of systems-concepts designed for retrofit-applications
- development of “intelligent” concepts of integration of other renewable energy sources such as biomass and heat pumps
- further development of seasonal heat storage technology also taking into account advanced technologies such as thermo-chemical heat stores
- development of standardised sub-system concepts / modules (e.g. heat distribution systems)
- advanced system concepts (e.g. “low-ex”; Systems operated on low temperatures combined with decentralised heat pumps
- cost reduction
- know-how transfer to planners and engineers
- awareness raising
- .....