Integration of Solar District Heating and Seasonal Thermal Energy Storage (STES) – Examples from European Districts

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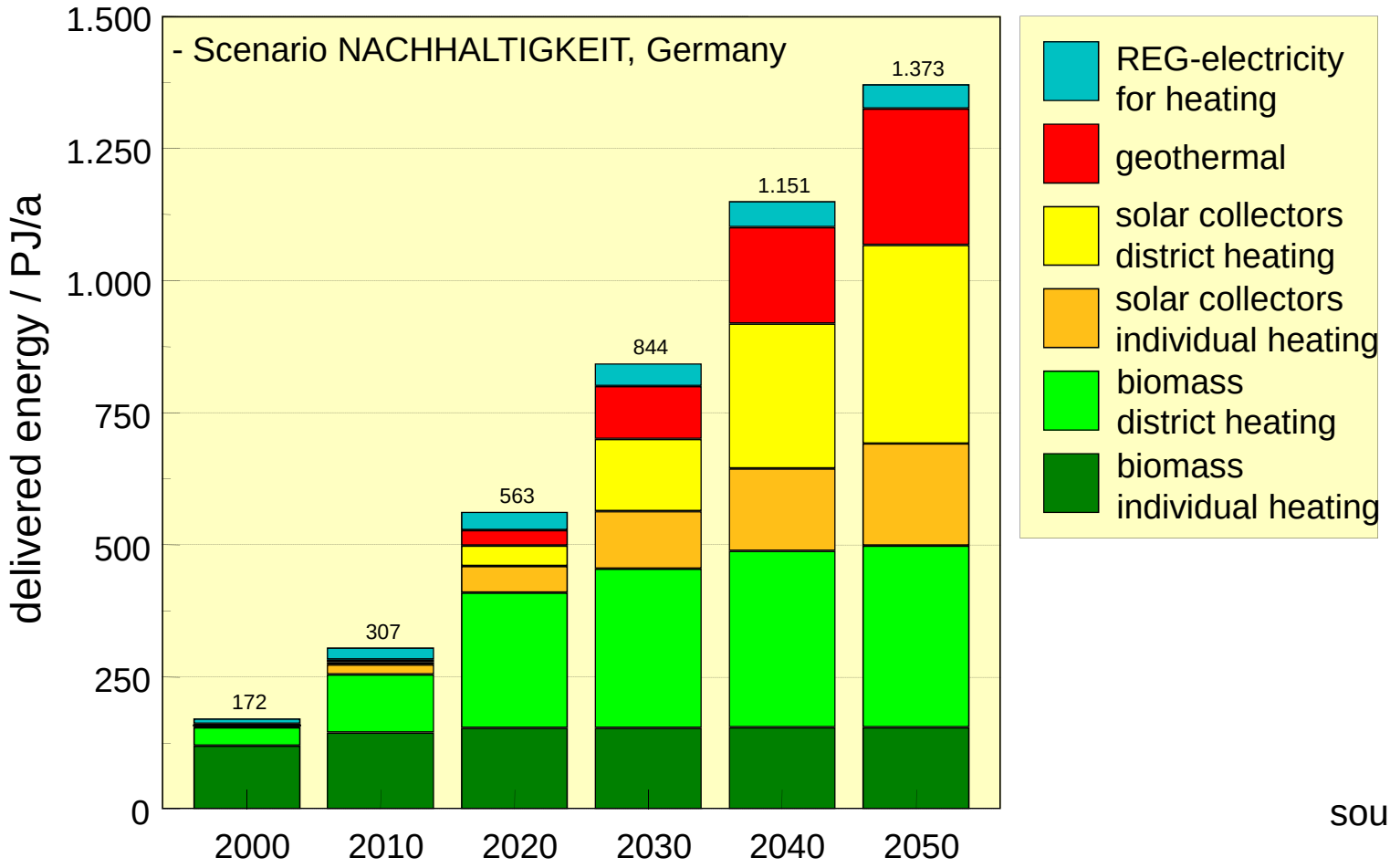
Content

- Solar District Heating
- Seasonal Thermal Energy Storage (STES)
- European Examples
- Conclusions

District Heating

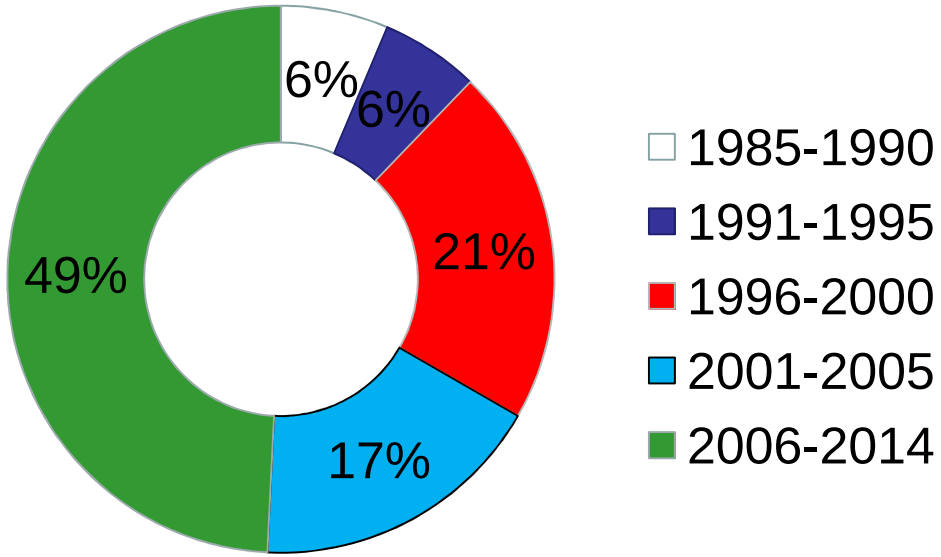
(One) Energy Scenario for Germany



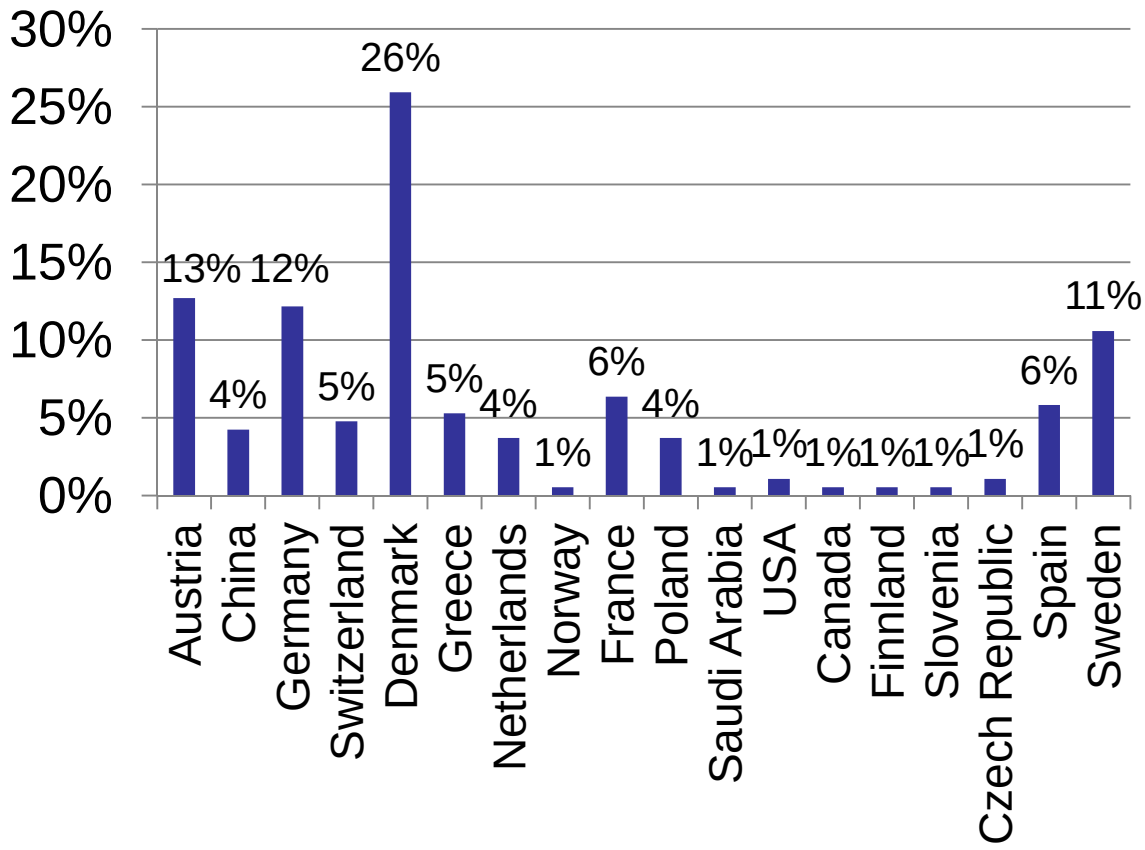
source: DLR, ITT

Solar District Heating Worldwide

Installed Solar District Heating Plants per Periode (> 0.5 MW)



Solar District Heating Plants Worldwide in %

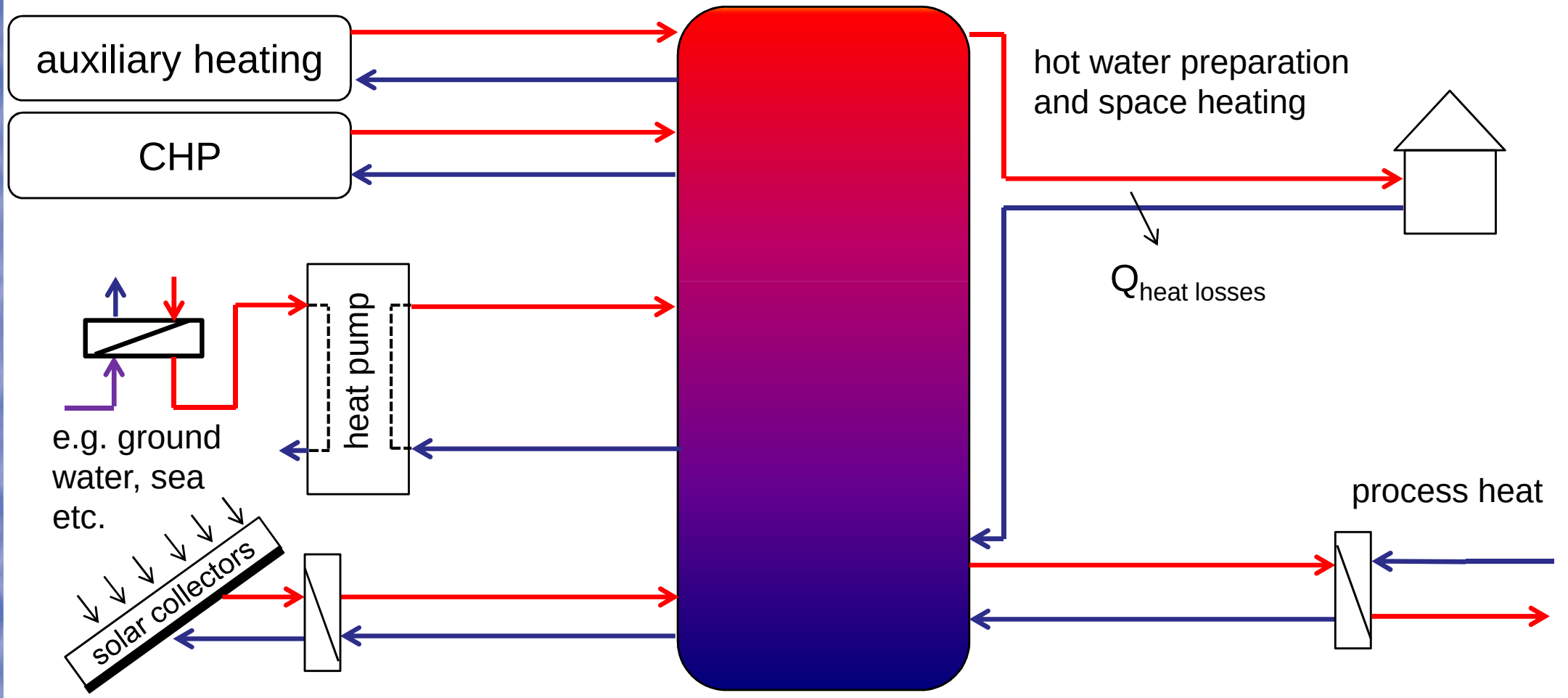


Total plants: 189 (in 2014)
~ 6 Mio m² collector area
90 % in Europe (60 % in Denmark)

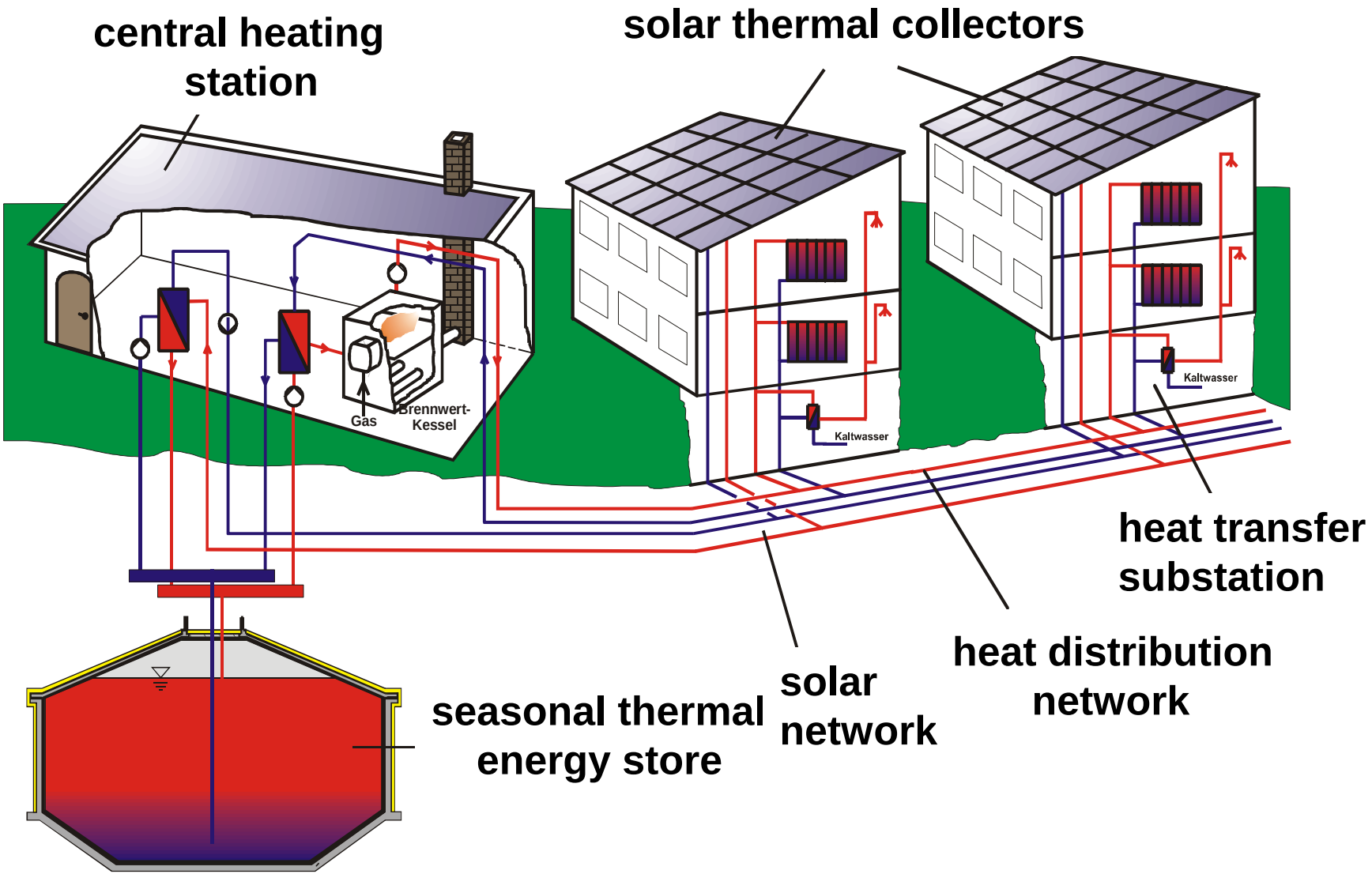
source: IEA-SHC Task 45

District Heating

Holistic approach for a district heating network



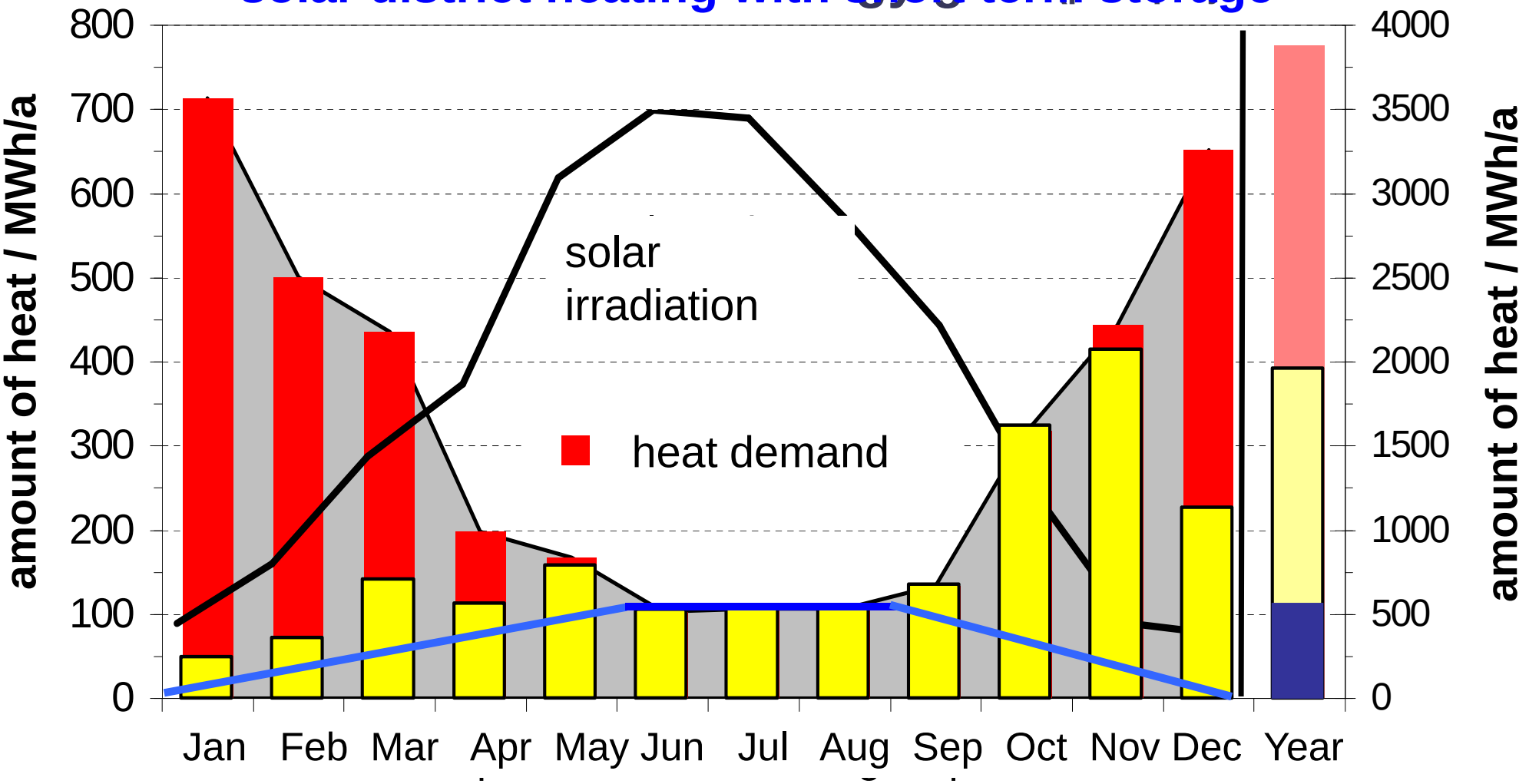
Solar District Heating with STES



Why STES?

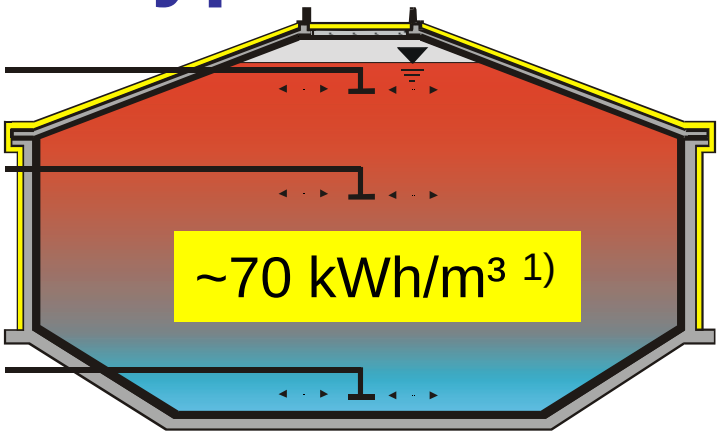
heat demand and solar energy gain

solar district heating with short term storage (pilot project in Friedrichshafen)

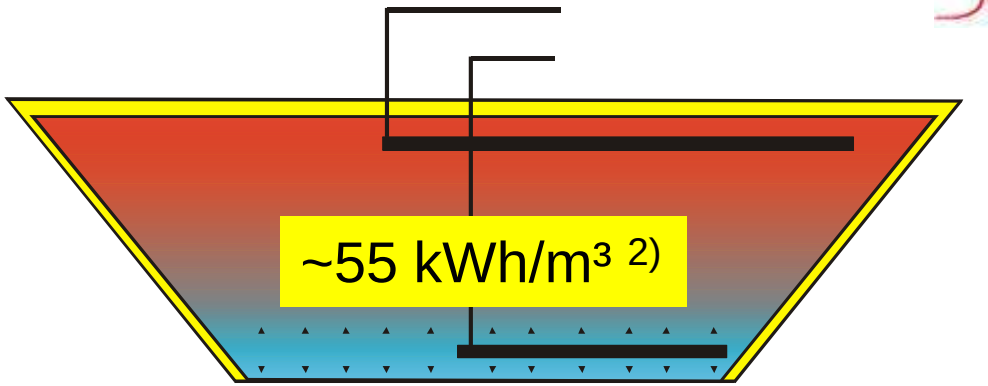


solar district heating with STES

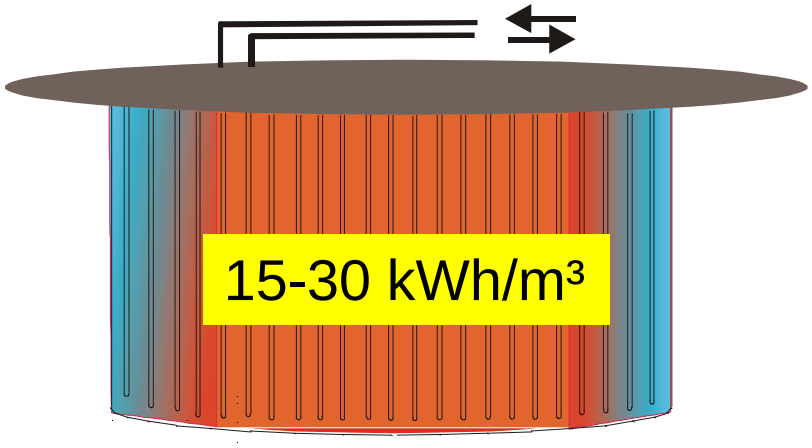
Types of STES



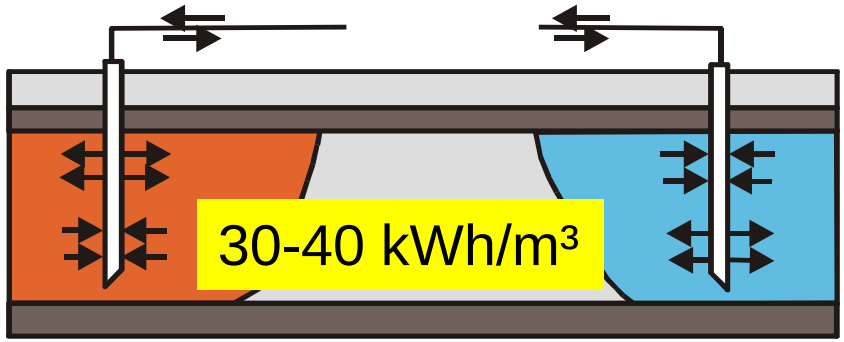
hot water tank thermal energy store (HW)



pit thermal energy store (PTES)



borehole thermal energy store (BTES)



aquifer thermal energy store (ATES)

[1] ϑ_{max}=90 °C, ϑ_{min}=30 °C without heat pump [2] ϑ_{max}=80 °C, ϑ_{min}=10 °C gravel-water TES with heat pump

Demonstration Projects with STES in Germany

Hamburg (1996)

3.000 m²
flat plate coll.,
4.500 m³
Water tank

Friedrichshafen (1996)

4.050 m²
flat plate coll.,
12.000 m³
Water tank

Neckarsulm (1997)

5.300 m²
flat plate coll.,
63.300 m³
BTES

Steinfurt (1998)

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

Rostock (2000)

1.000 m²
Solar-Roof,
20.000 m³
ATES

Hannover (2000)

1.350 m²
flat plate coll.,
2.750 m³
Water tank

Demonstration Projects with STES in Germany

Chemnitz, 1. phase (2000)

540 m²
Vacuum tubes,
8.000 m³
PTES (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.,
37.500 m³
BTES

Eggenstein (2008)

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

Projects without STES in Austria

Graz (2006)

4.960 m²
flat plate coll.
(high temperature)
enlarged to
7.450 m² in 2015

Graz, Andritz (2010)

3.855 m²
flat plate coll.
(high temperature)

UPC-Arena, Graz (2002)

1.407 m²
flat plate coll.

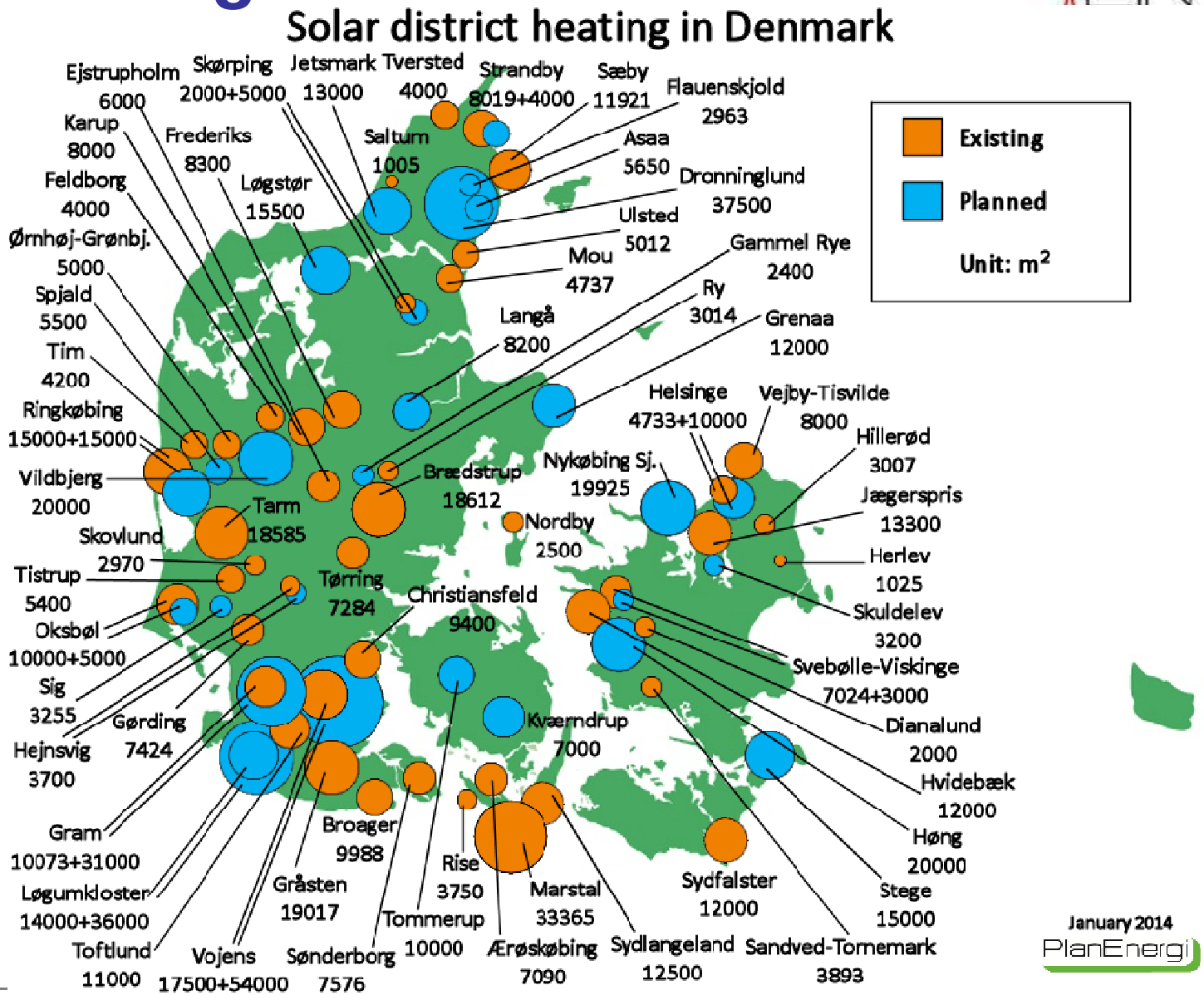
all thermal energy used in district heating network Graz without STES

Lienz (2001)

690 m²
flat plate coll.

sources: S.O.L.I.D.

Solar District Heating in Denmark



Solar District Heating in Denmark

- SDH in Denmark economically competitive technology to assure a security of supply
- Solar Thermal Smart Grids a important measure to balance fluctuating renewable energies incl. electricity
- Adaption of Danish examples to improve the share of renewable energy in other European markets

Definition: Solar Thermal Smart Grids

- District heating systems
- Central components that are integrated with a sophisticated control strategy:
  - Solar thermal collector fields
  - Large (seasonal) thermal energy stores
  - Combined heat and power plants
  - Intelligent use of heat pump
- Goals:
  - High solar yields and solar fractions
  - Low heating costs (< 40 €/MWh)
  - Balancing fluctuating renewable powers

Favourable Boundary Conditions

	Denmark
District heating (residential buildings)	> 60 % → 80 %
Combined heat and power plants (share at total electricity production)	50 %
Share of renewables at electricity production (2012)	33 % (30 % wind)
Costs for collector area [€/m²]	200 (installed)
Political decisions	- Prohibition of gas and oil boilers in new residential buildings (2013) - High taxes on natural gas

EC Project: Sunstore IV

The SUNSTORE® concept can integrate renewable electricity in heat production. Examples Brædstrup and Marstal

35 – 40 000 m²

HP

CHP

Boiler

End use

50 – 100 000 m³ Very cost effective heat storage (demonstration)

PlanEnergi

EC Project: Sunstore IV in Marstal

- Solar collector field: 33 000 m²
- Pit STES volume: 75 000 m³
- Heat pump: 1.5 MW_{th} (CO_2)
- Wood chip boiler: 4 MW
- ORC: 750 kW_{el}
- Backup heating: 18.3 MW_{th} (Oil boiler)
- Annual heating demand: 28 GWh
- Planned solar fraction: 55 %
- Planned renewable fraction: 100 %

EC Project: Sunstore IV in Marstal

PlanEnergi

Conclusions

- SDH and STES are technologies that fit into renewable energy concepts
- Increasing numbers of SDH plants European wide
- Local boundary conditions influence size and type of system
- Economic competition achieved in some regions
- More research and demonstration necessary for deeper market penetration

Thank you!

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