Integration of different renewables in Solar Heating Plants

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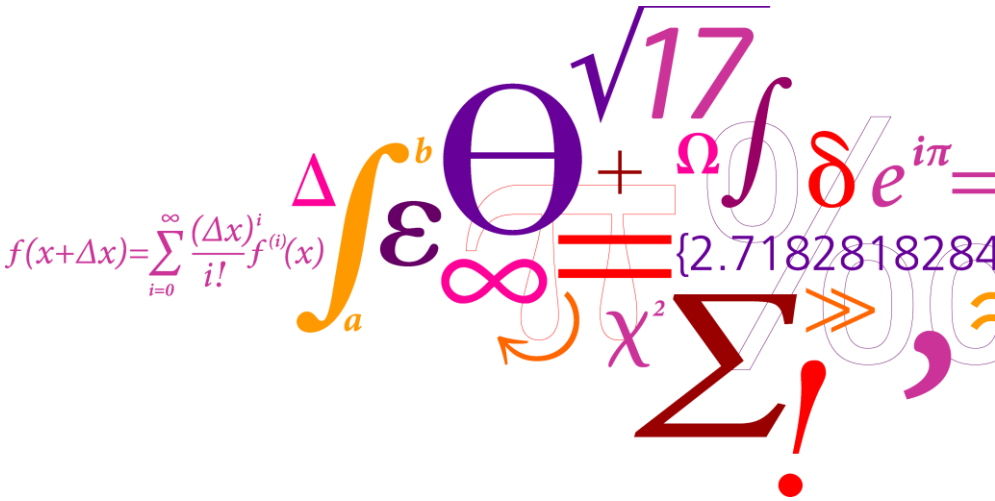

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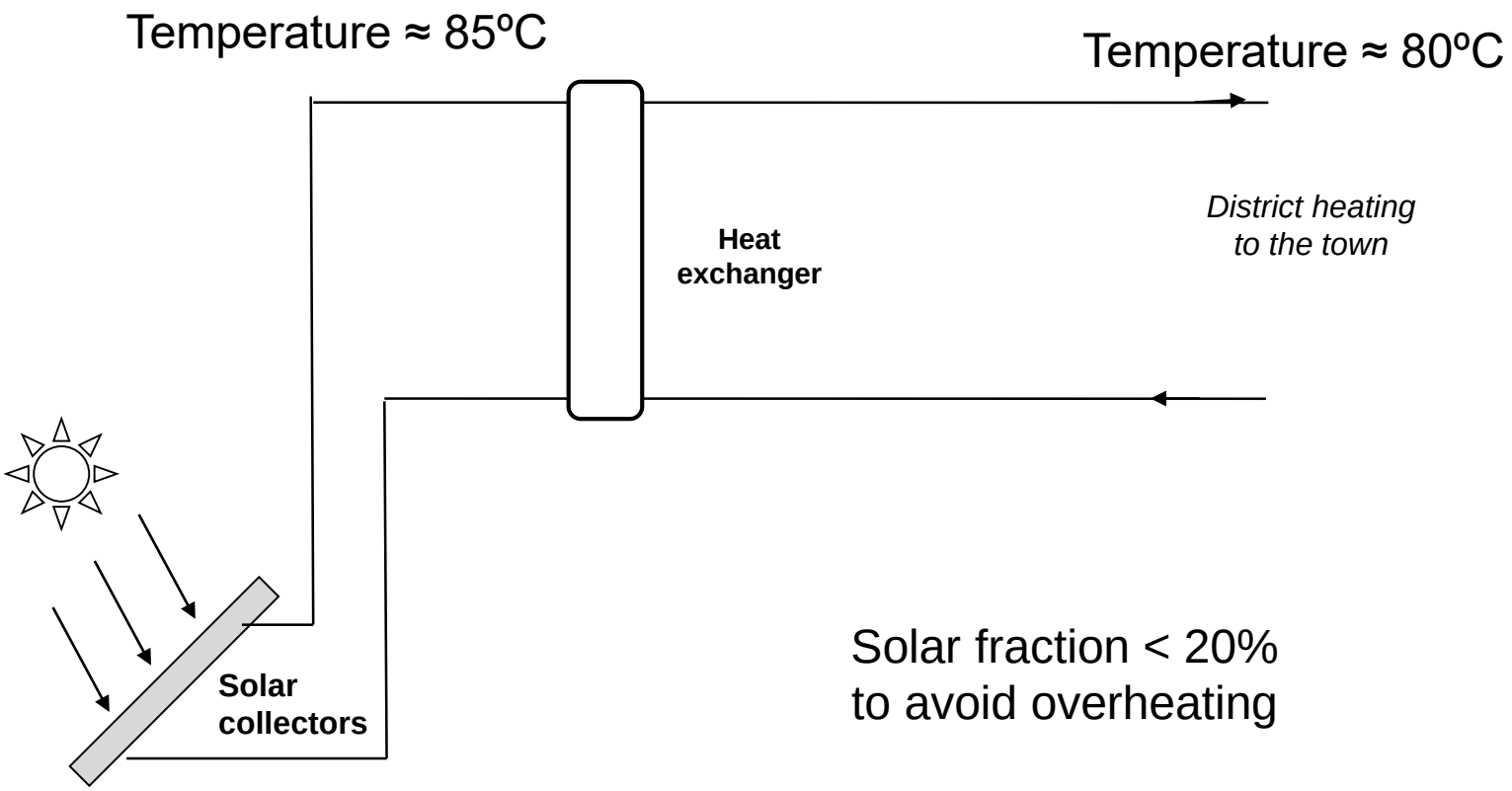
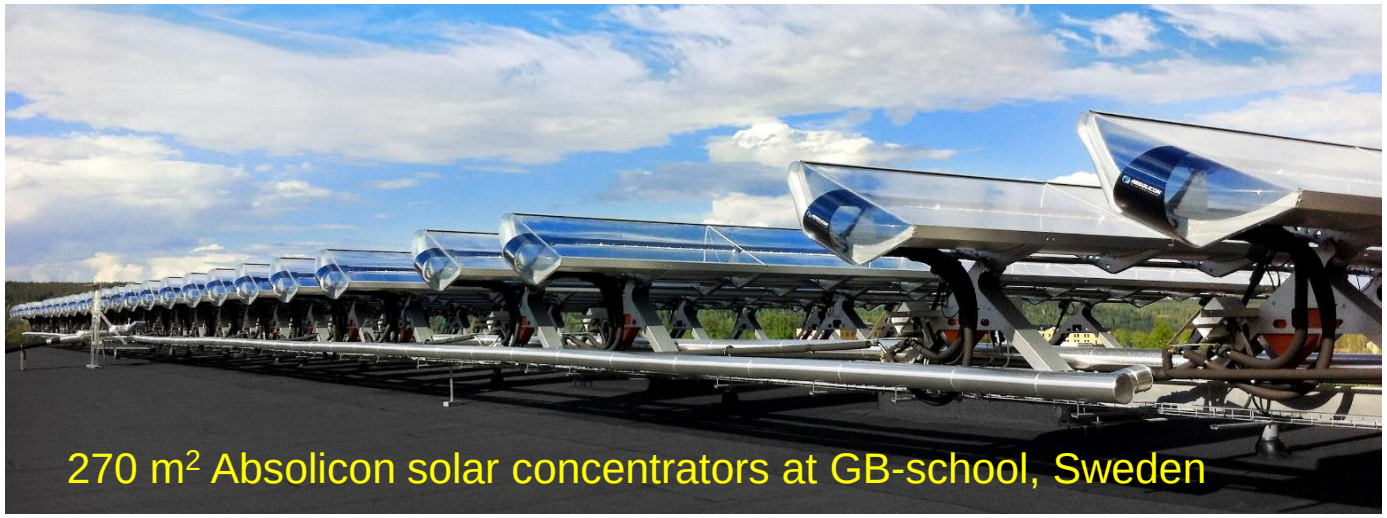
Integration of solar into a district heating system
Solution 1: direct feedin

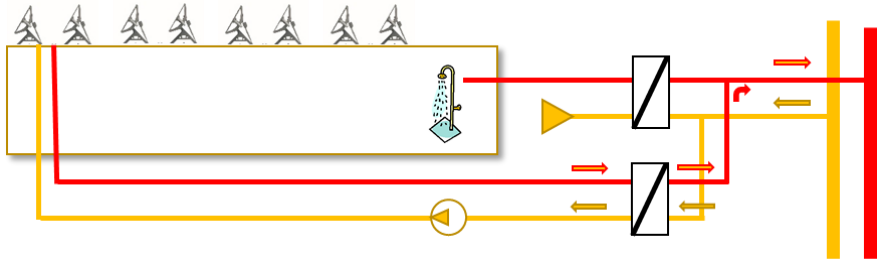


Operation temperature of the district heating system could vary from system to system

Solution 1 example: the solar heating project in Sweden

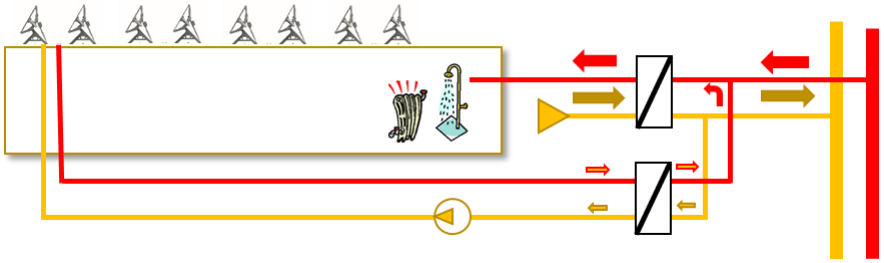


Summer

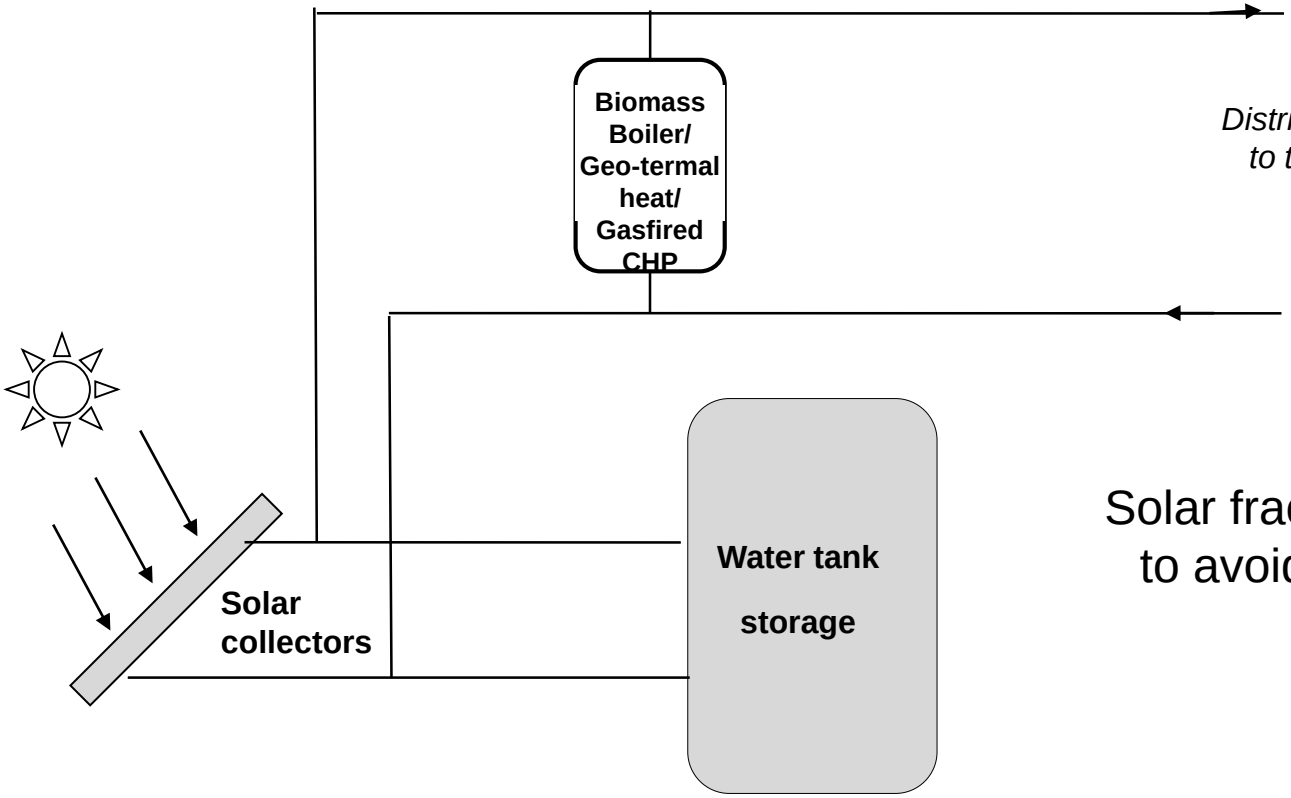


District heating

The other seasons



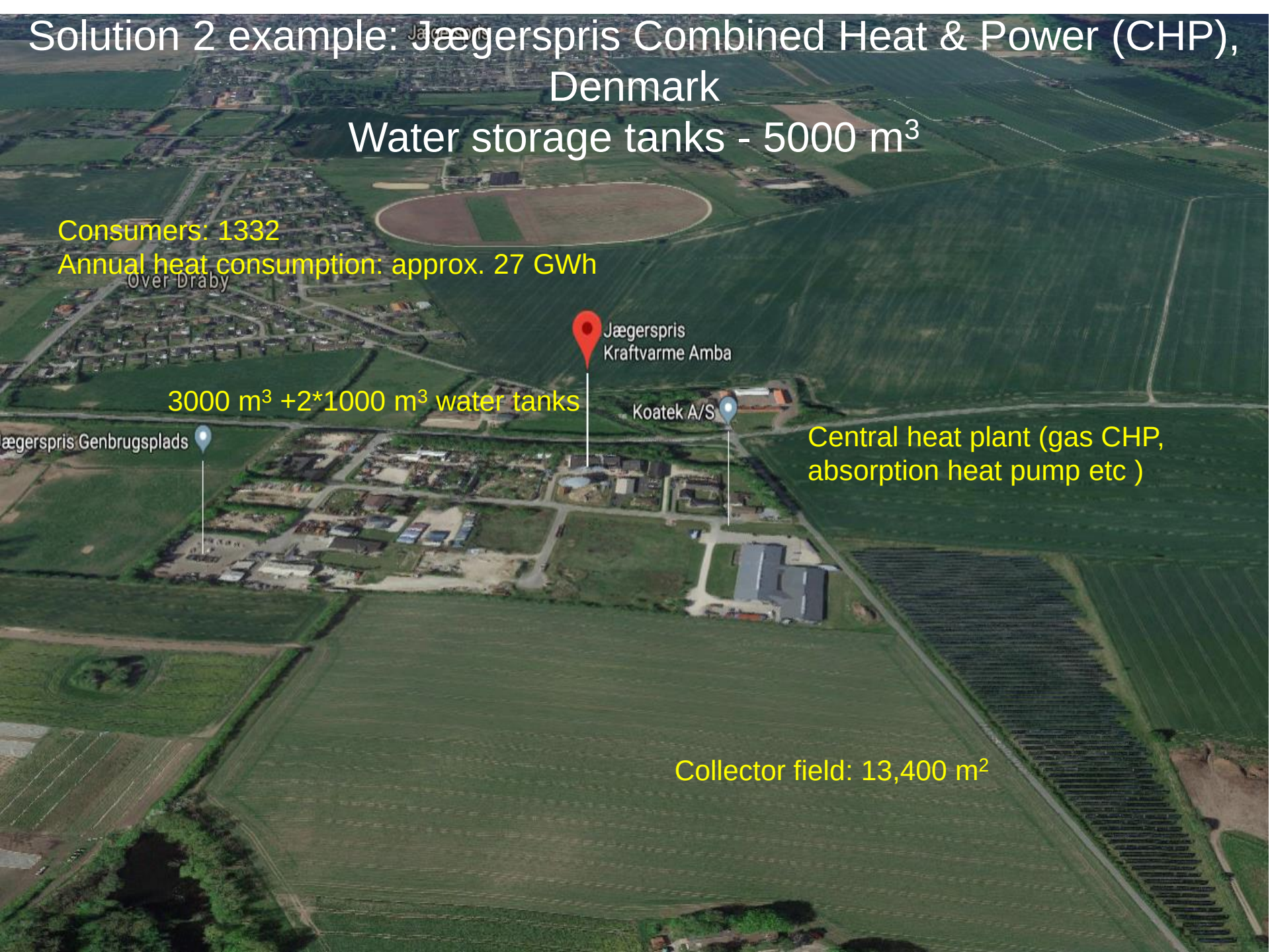
Integration of solar into a district heating system
Solution 2: short term heat storage



Solar fraction < 20-30% to avoid overheating

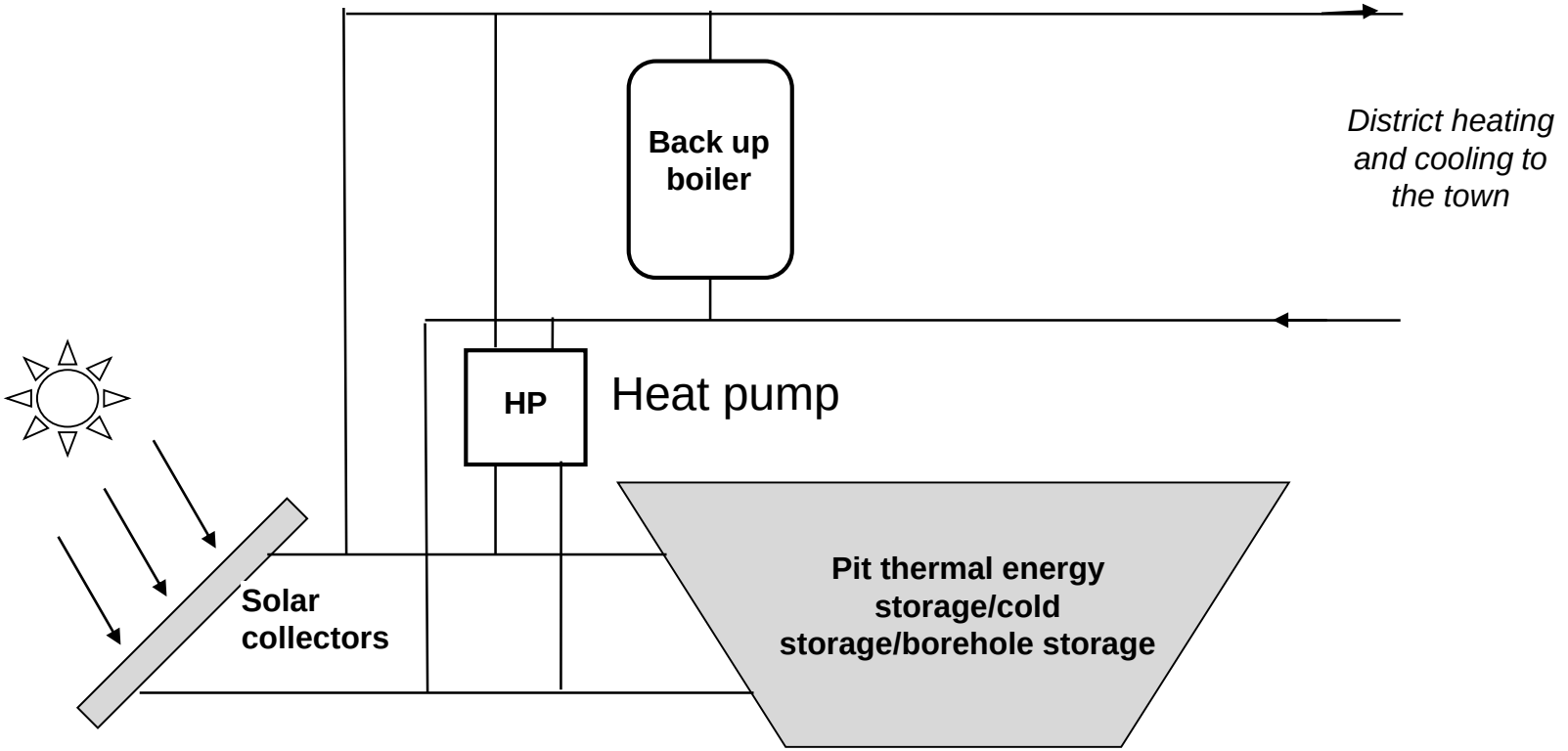
Typically volume < 7000 m^3

Solution 2 example: Jægerspris Combined Heat & Power (CHP), Denmark
Water storage tanks - 5000 m^3



Integration of solar into a district heating system
Solution 3: long term heat storage

Solar fraction up to 50%



Typically volume > 10000 m^3

Solution 3 Examples: Solar district heating systems in China

3.1 Project Progress

日出东方 ARCON SUNMARK

✓ Solar field:
√ 1620 collectors
√ Pipeline & valves
√ Signal lines

✓ HX station and technical room
√ HX station
√ Charge/discharge unit
√ Water treatment
Control system (To be completed)

√ Equipment house
√ High&low voltage supply
√ Electrical boiler
√ Diesel generator

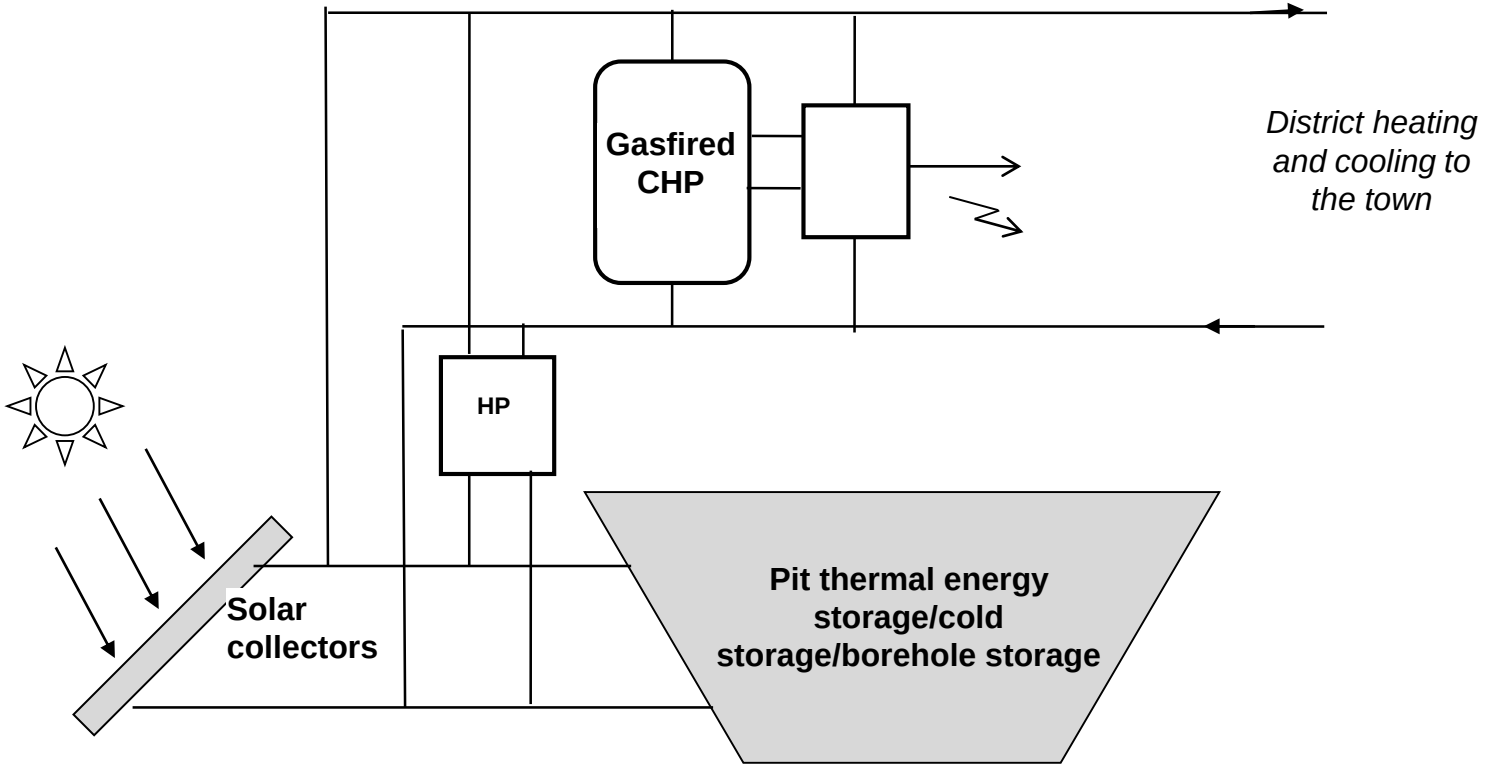
✓ Storage:
√ Main body
√ Protection slope and fence (To be completed)

✓ DH-grid & heating terminals

√ 82,600 m^2 covering 26 residential communities

Heat only, no electricity production

Integration of solar into a district heating system
Solution 4: solar+CHP



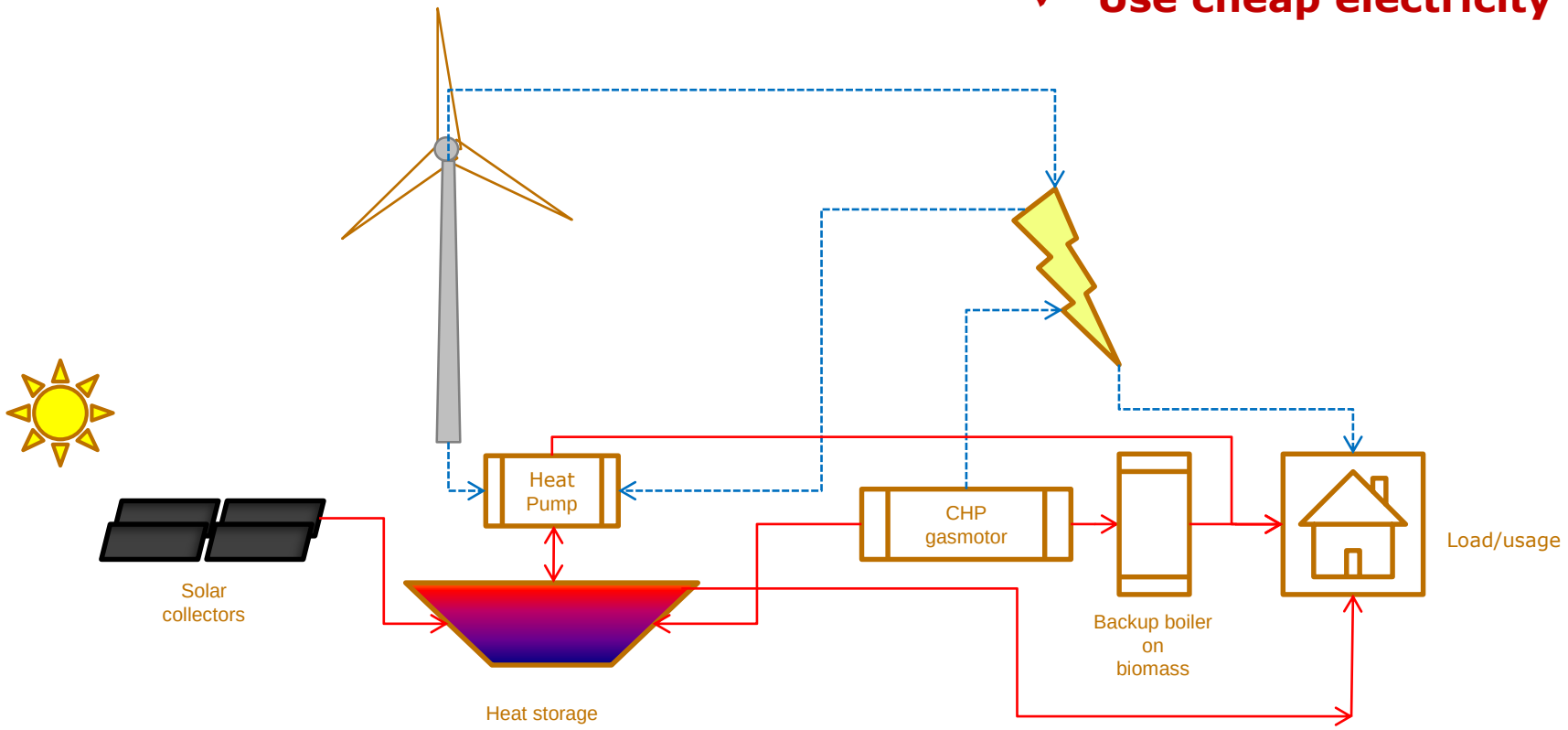
CHP: Combined heat and power production
Fuel: gas, diesel, woodchip or other biomass

The benefit of a smart heat storage

Combined renewable technologies and smart heat storage interacting with the electricity grid …

Smart heat storage:

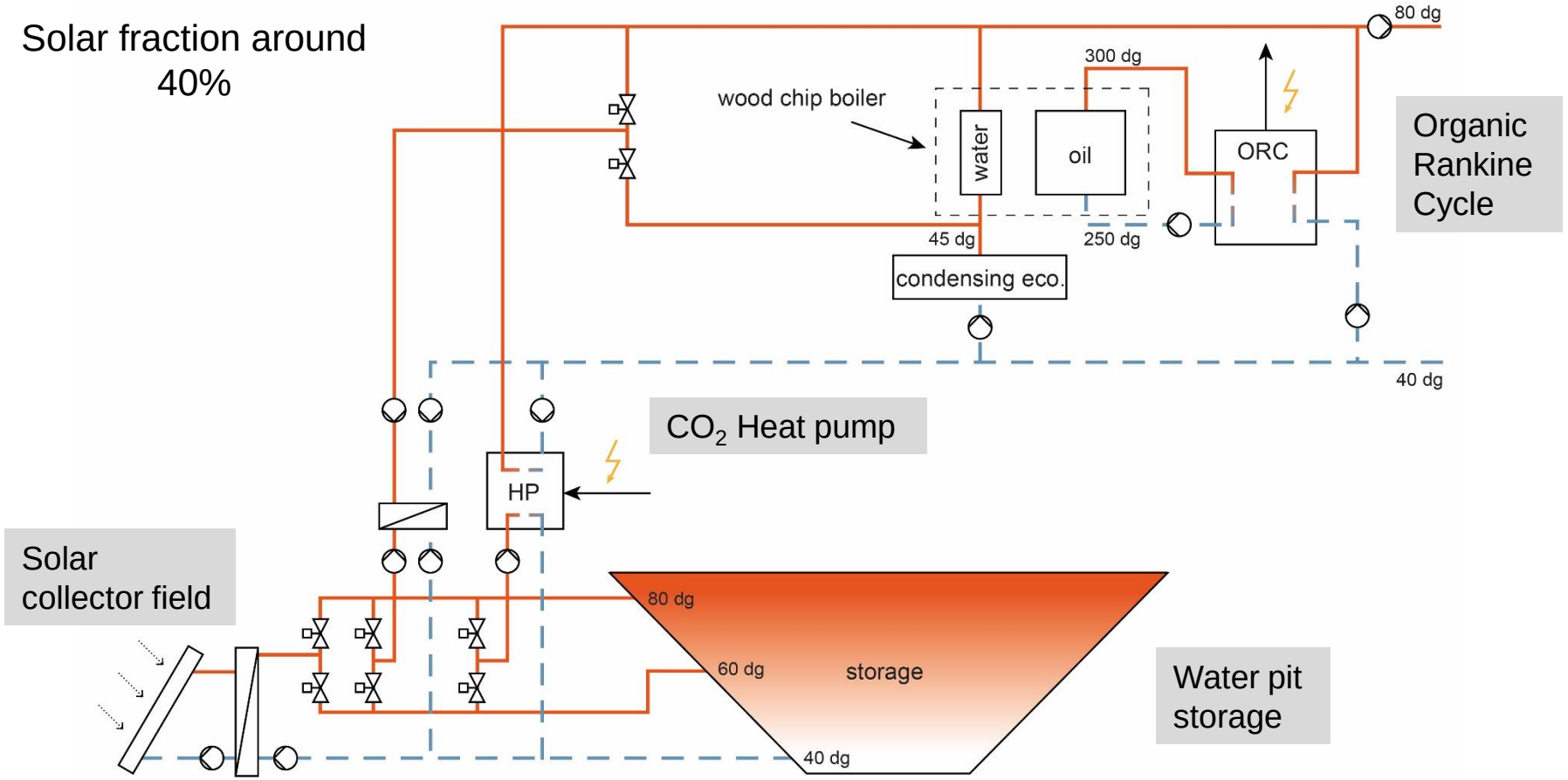
- ✓ Gives flexibility
- ✓ Makes combinations of technologies possible
- ✓ Use cheap electricity



A typical example: Marstal solar heating plant

Well integration and interplay of different renewable technologies are essential for success of a solar heating plant. One example is the Marstal Solar heating plant.

Solar fraction around 40%



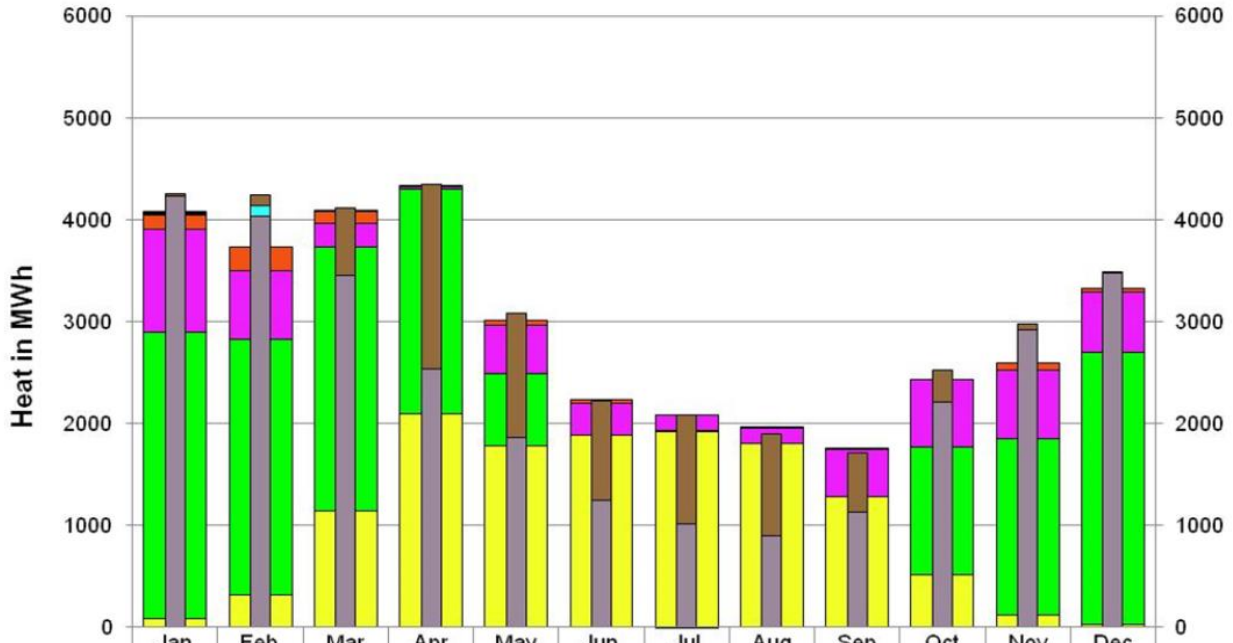
A schematic drawing of the Marstal solar heating plant

Marstal Solar heating plant
Seasonal heat storage - 75000 m^3 PTES

CO_2 heat pump

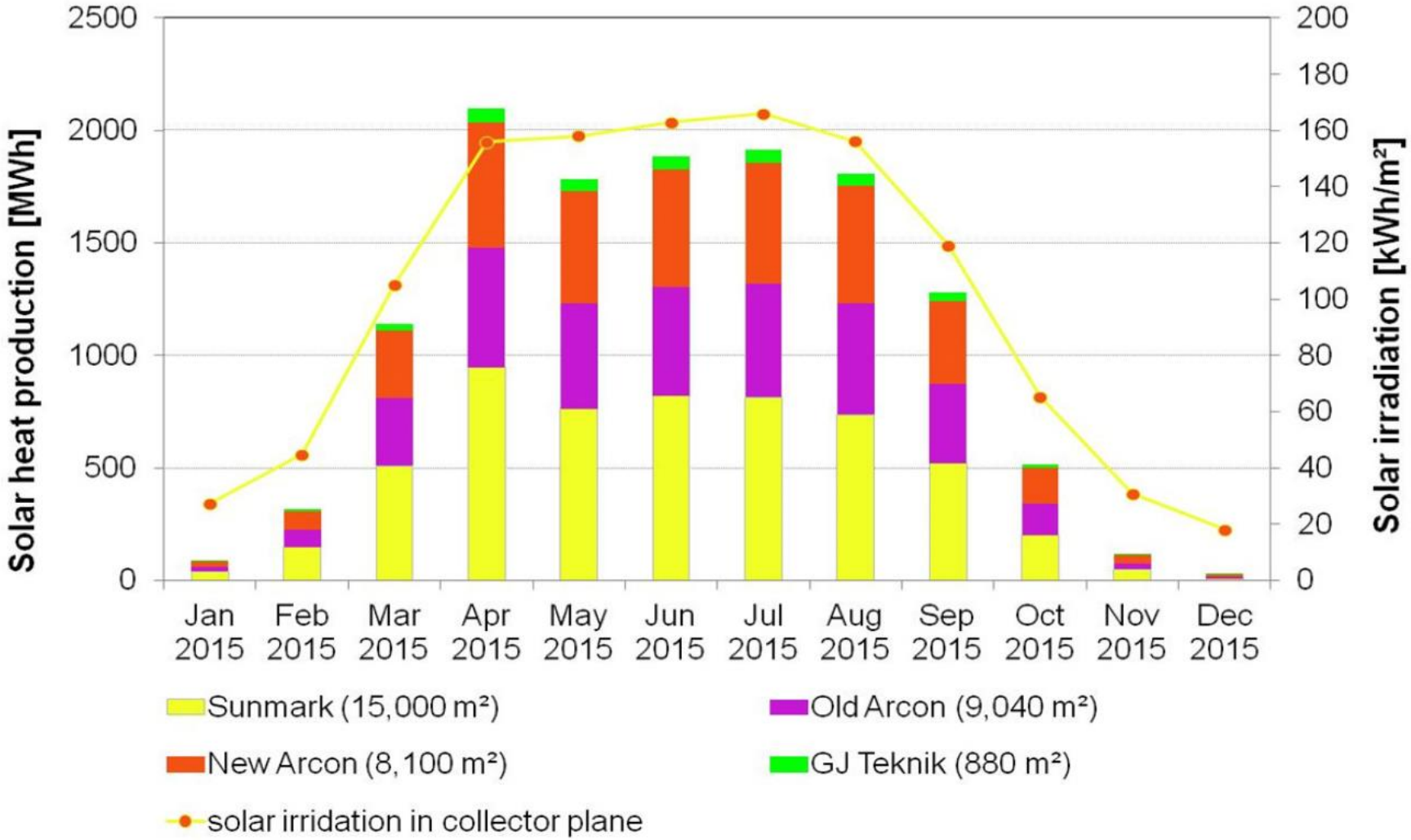
Technical Specifications:
Heat output: 1500 kW
No. of compressors: 16
Heat absorbed: 1000 kW
Temperature district heating forward: 75˚ C
Temperature district heating return: 35˚ C
Cooling of brine: 10 K
COP heat: 3,4

Monthly heat balance in Marstal SDH 2015

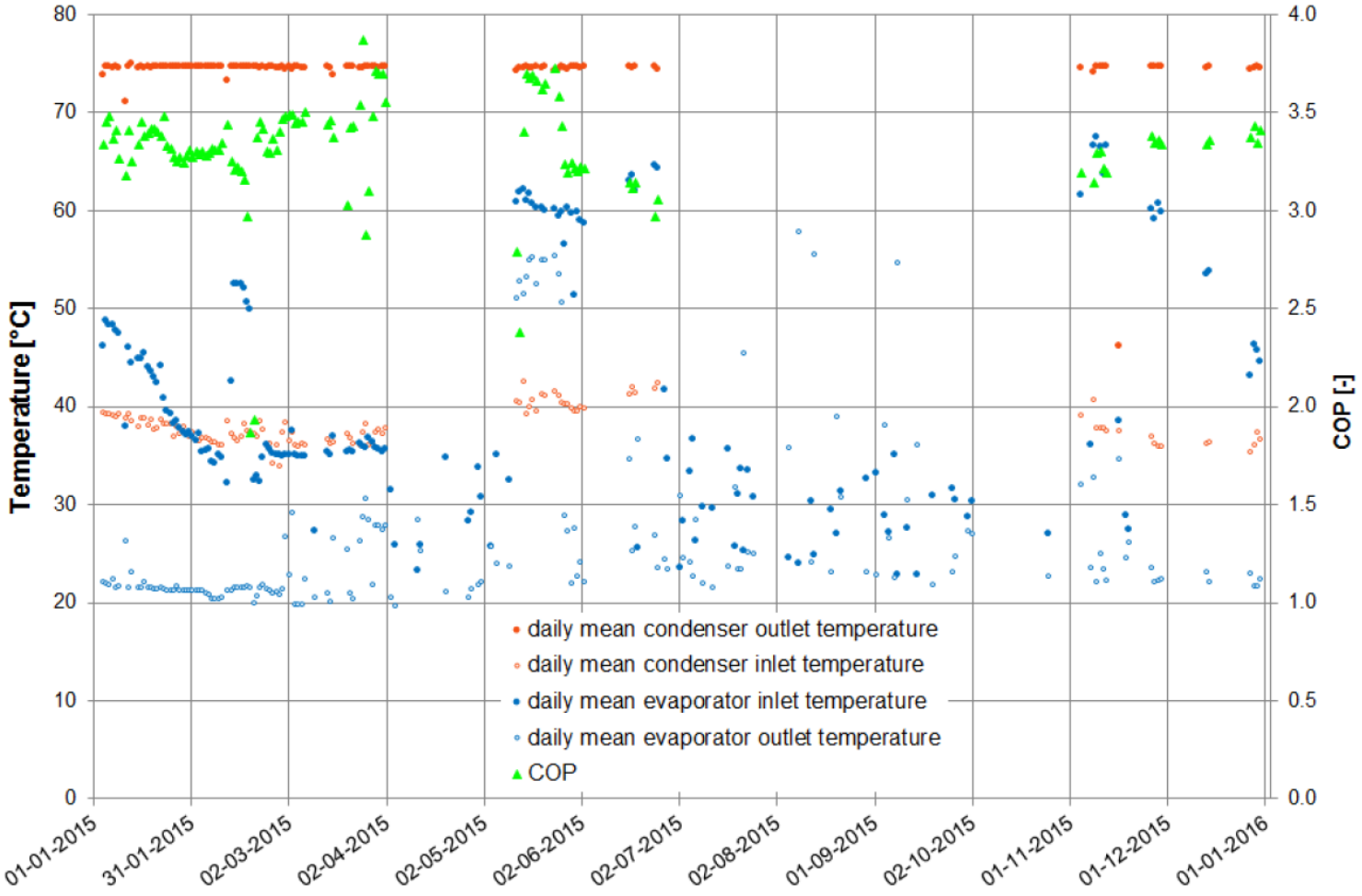


	Jan 2015	Feb 2015	Mar 2015	Apr 2015	May 2015	Jun 2015	Jul 2015	Aug 2015	Sep 2015	Oct 2015	Nov 2015	Dec 2015
Oil Boilers	32	0	3	0	0	0	0	0	0	0	0	0
Electricity consumption Heat Pump	140	232	113	7	41	33	0	0	0	0	70	36
Discharging S4 PTES	1018	672	230	20	485	314	159	140	469	660	678	589
Biomass Boiler + ORC	2804	2513	2595	2210	703	0	9	0	0	1251	1737	2678
Solar Collectors	89	317	1144	2098	1784	1886	1919	1811	1282	518	116	26
Charging S4 PTES	22	111	659	1813	1214	974	1074	995	584	312	52	2
Sunmark cooling	0	103	0	0	0	0	0	0	0	0	7	0
Total heat supply	4239	4035	3456	2535	1868	1253	1013	900	1134	2215	2919	3475

Monthly solar heat production in Marstal SDH 2015

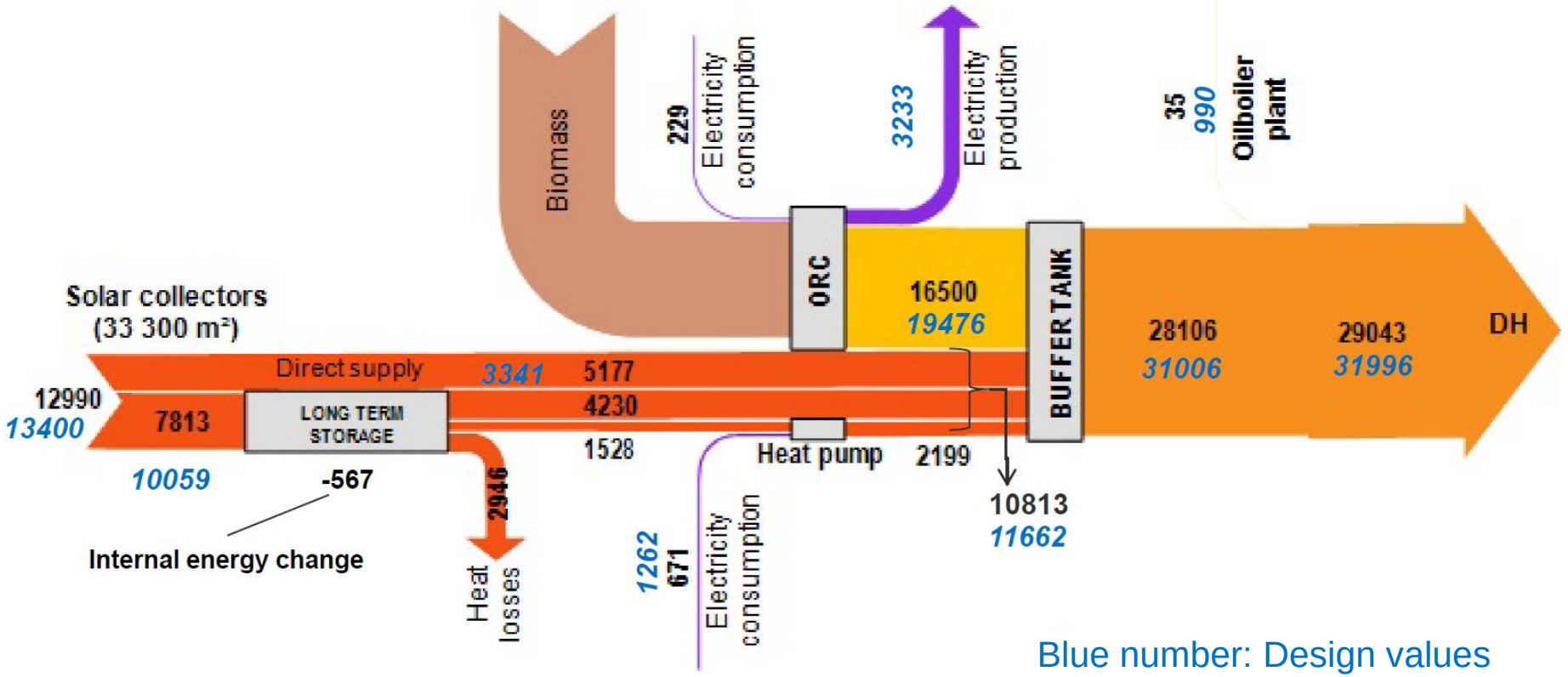


Heat pump operation conditions in Marstal SDH 2015



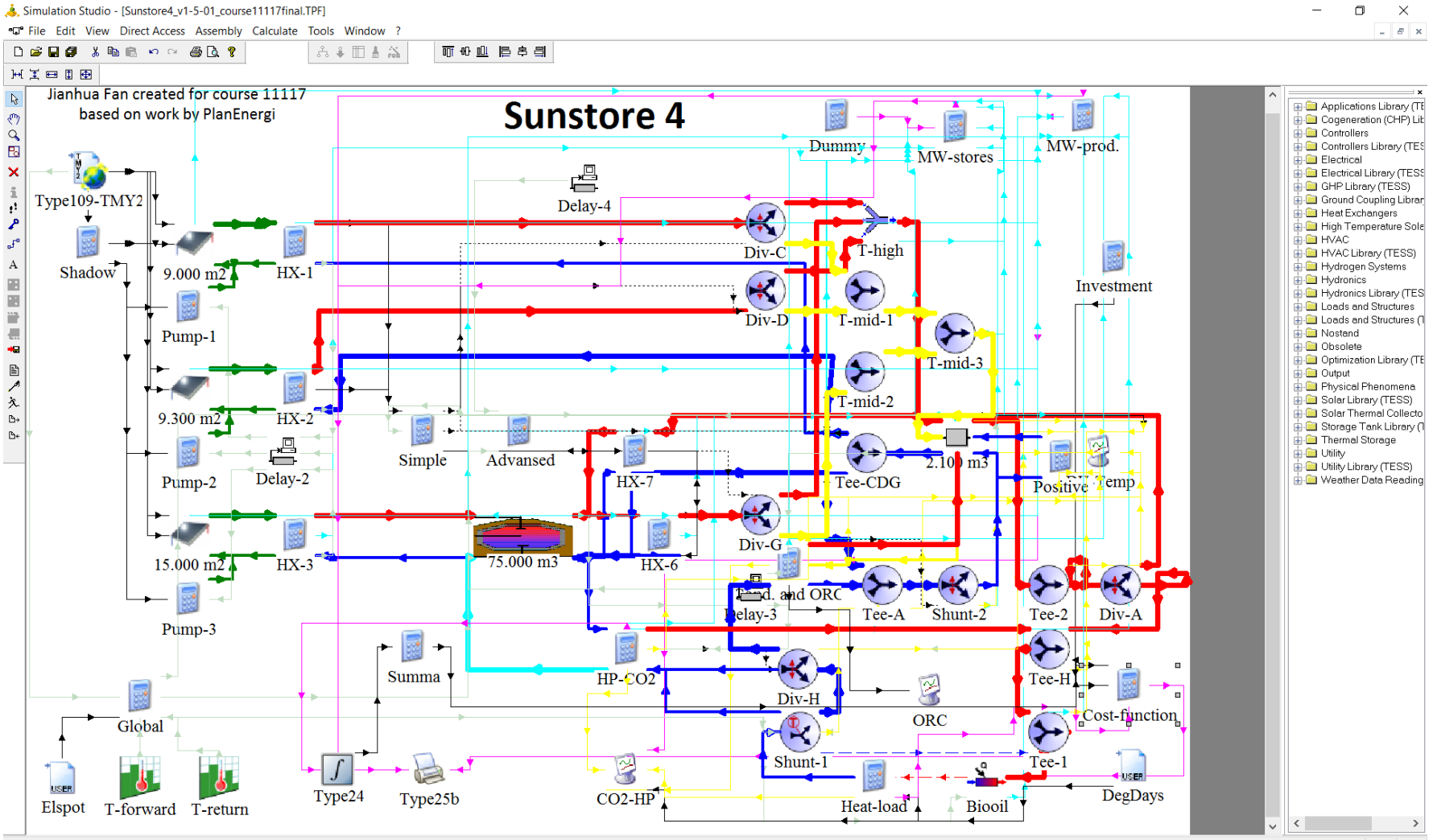
Energy flow diagram for the Marstal solar heating plant

Monitored year: 2015
Solar fraction: 41%
RES fraction: 100%
Solar gain: 395 kWh/m^2/year



Blue number: Design values
Black number: monitored values in MWh/year

Design and optimization of a solar heating plant by Trnsys



Thanks for your attention!