Integration of different renewables in Solar Heating Plants

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Integration of solar into a district heating system

Solution 1: direct feedin

Temperature $\approx 85^\circ C$

Heat exchanger

Temperature $\approx 80^\circ C$

District heating to the town

Solar collectors

Solar fraction $< 20\%$ to avoid overheating

Operation temperature of the district heating system could vary from system to system
Solution 1 example: the solar heating project in Sweden

270 m² Absolicon solar concentrators at GB-school, Sweden

Summer

The other seasons

District heating
Integration of solar into a district heating system

Solution 2: short term heat storage

Solar fraction < 20-30% to avoid overheating

Typically volume < 7000 m³
Solution 2 example: Jægerspris Combined Heat & Power (CHP), Denmark

Water storage tanks - 5000 m³

Consumers: 1332
Annual heat consumption: approx. 27 GWh

3000 m³ + 2 * 1000 m³ water tanks

Central heat plant (gas CHP, absorption heat pump etc)

Collector field: 13,400 m²
Integration of solar into a district heating system

Solution 3: long term heat storage

Solar fraction up to 50%

Typically volume $> 10000 \text{ m}^3$
Solution 3 Examples: Solar district heating systems in China

3.1 Project Progress

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

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

✓ 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

✓ DH-grid & heating terminals

✓ 82,600 m² 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

Consumers: 1600
Annual heat consumption: approx. 30 GWh

Central heat plant (biomass boiler, ORC, heat pump etc.)

75000 m$^3$ water pit heat storage

Collector field 1: 9043 m$^2$
Collector field 2: 9124 m$^2$
Collector field 3: 15000 m$^2$
**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

![Graph showing monthly heat balance in Marstal SDH 2015](image)

- **Heat in MWh**
- **Months:** Jan 2015 to Dec 2015

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Monthly solar heat production in Marstal SDH 2015

Solar heat production [MWh]

Solar irradiation [kWh/m²]

- Sunmark (15,000 m²)
- Old Arcon (9,040 m²)
- New Arcon (8,100 m²)
- GJ Teknik (880 m²)
- solar irradiation in collector plane
Heat pump operation conditions in Marstal SDH 2015
Monitored year: 2015
Solar fraction: 41%
RES fraction: 100%
Solar gain: 395 kWh/m²/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!