

DIFFERENT TECHNOLOGIES AND AN OPTIMAL INTEGRATION TO COMBINED HEAT AND POWER

BY FLEMMING ULBJERG, RAMBOLL

SILKEBORG, AN EXAMPLE



PRESENT SITUATION

- Annual heat demand: 400.000 MWh.
 - CHP: 180.000 MWh
 - Boilers: 220.000 MWh. (Mainly natural gas)
- CHP. Combined cycle gas turbines.
 - 2 x 44 MW gas turbines.
 - 20 MW steam turbine.
- Fuel, 218 MW natural gas.
- Electricity: 108 MW. 49% efficiency.
- Heat: 83 MW. 38%
- Total efficiency: 87%.

OPTIMIZATION OF CHP.

- Present is flue gas 67 degrees C.
 - No condensation possible. (only < 36 degrees it is possible. (Λ : ~ 4))
- By active cooling of flue gas, 20 – 23 degrees flue gas is possible.
- Results if 23 degrees flue gas:
 - Total efficiency is 102% !
 - Heat production goes up with 32 MW.

PROPOSAL, CHP

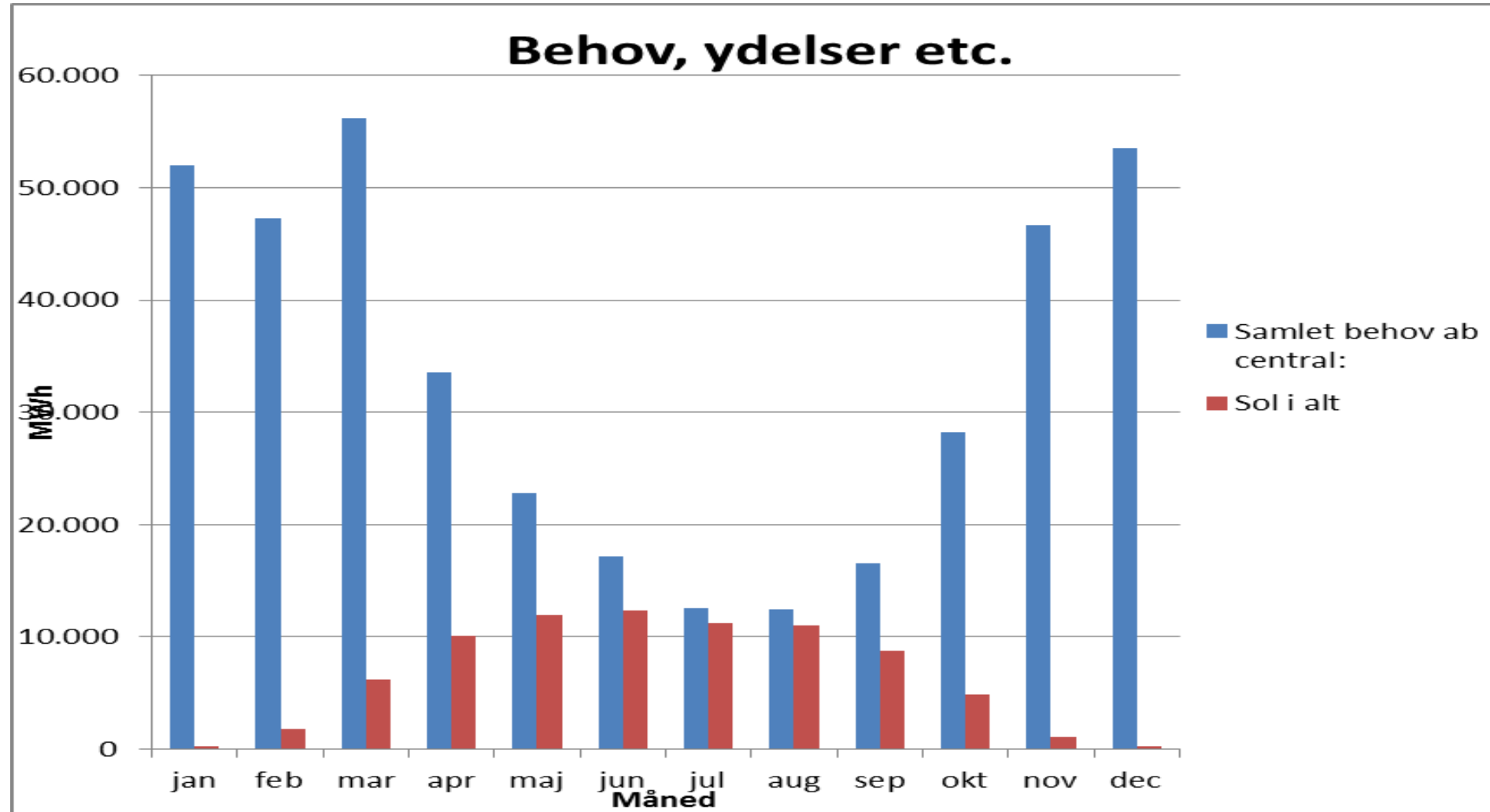
- Absorption heat pumps.
 - LP steam as driving heat. (Super heated water circuit)
 - Chilled water for cooling flue gas.
 - “Cooling water” to the dist. Network.
- Using double effect absorption, COP=2,3.
- Using LP steam, means **2 MW electricity less.**

The gain is 32 MW heat.

SOLAR

- Summer load to be solar.
 - Use the existing high temp. heat store. (Exist 2 x 16.000 m² steel tanks)
 - Extra 16.000 m³ steel tank for lower temperatures.
- Flat plate collectors.
 - The lower temperatures, the better.
- CSP:
 - Any temperatures are ~ same performance.
- Use absorption heat pumps for CSP – flat plate combination.
 - CSP to supply high driving temperatures.
 - Chilled water to increase performance of flat plate collectors.

DEMAND – SOLAR, MONTH BY MONTH.



PROPOSAL

- 135.000 m² flat plate collectors. (70.000 MWh / year)
 - ~ 17.000 m² CSP collectors. (~10.000 MWh / year)
 - Total 20 % solar fraction.
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- OR:
 - 155.000 m² flat plate collectors. Explanation follows.

INTEGRATING HEAT PUMPS.

- COP of the heat pump – for example 3,4.
- Electricity: 1.200 MWh / year.
- Low temp heat input: 2.880 MWh.

- BUT, what is the EXTRA production from the panels.?
 - Is it ALSO 2.880 MWh / year. ? If yes, COP (system) is 3,4
 - If it is only 1.200 MWh extra / year. COP (system) is ONLY 2,0. Giving a complete different economy, compared to COP 3,4.

SILKEBORG

- CSP is ~ 2 x price for flat plate. (price/performance)
- If CSP, in combination with absorption heat pumps, producing double, the proposal is OK.
- If less. Flat plate solution, is more feasible.

RESULTS.

- NO heat to be produced by boilers.
- Electricity production INCREASED from 226.000 MWh to 360.000 MWh / year.
- Feasible WITHOUT any support.
 - Optimization ~ 4 years to pay back.
 - Solar ~ 8 years to pay back.
- Socio-economic FEASIBLE.

All in all: solar in combination with optimization replaces all boiler heat.

THANK YOU