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Optimising the Low Temperature Cooling Energy Supply: Experimental Performance of an Absorption Chiller, a Compressor Chiller and Direct Cooling – a Comparison

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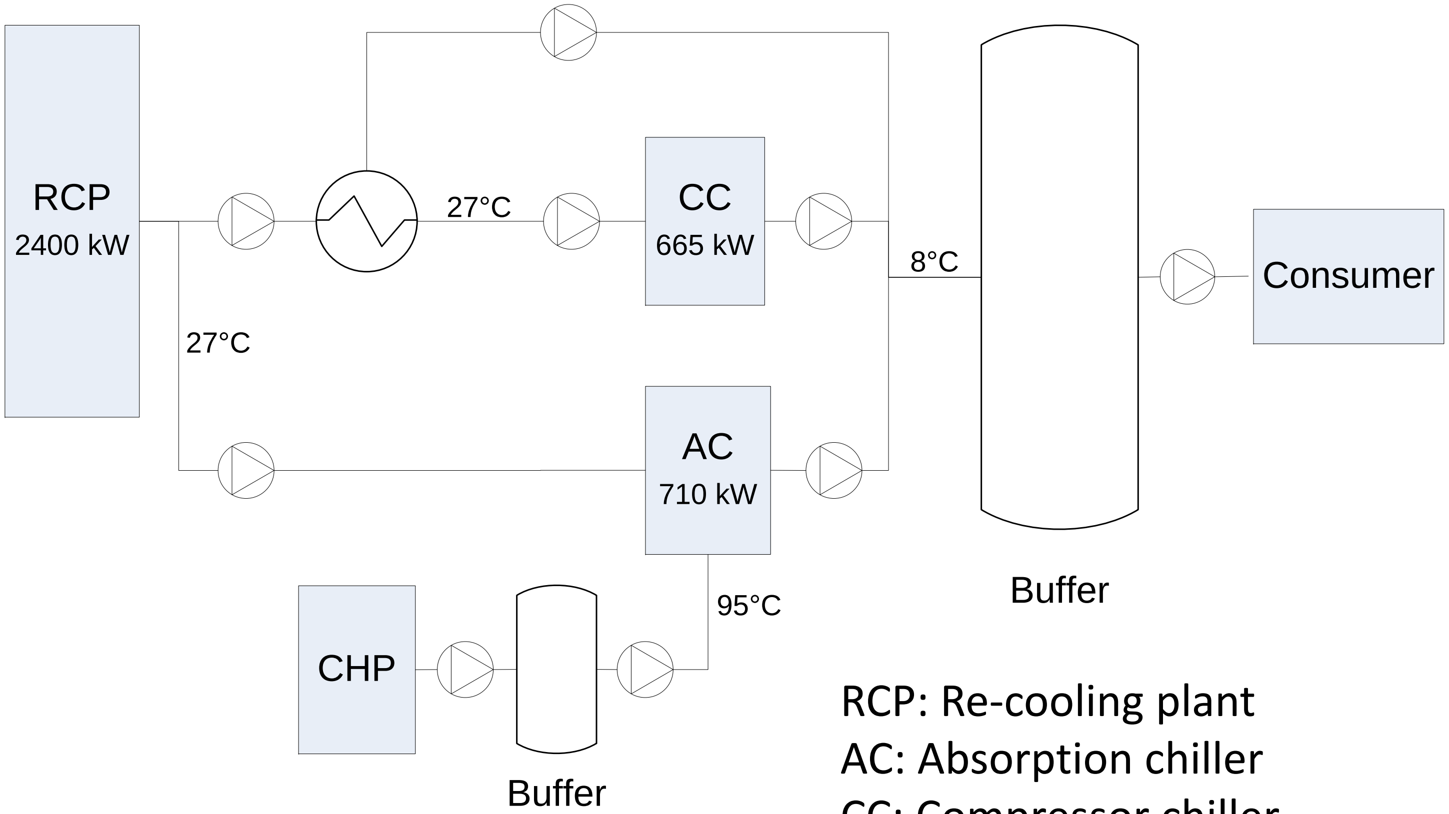
Overview

- The system
- Methodology
- Results
- Outlook
- Conclusion

The System



RCP: Re-cooling plant
AC: Absorption chiller
CC: Compressor chiller
CHP: Combined heat and power plant

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Methodology: Overview

Dependant variable:

Primary Energy Factor

System analysis:

Which part of the building‘s supply system has the biggest impact ?

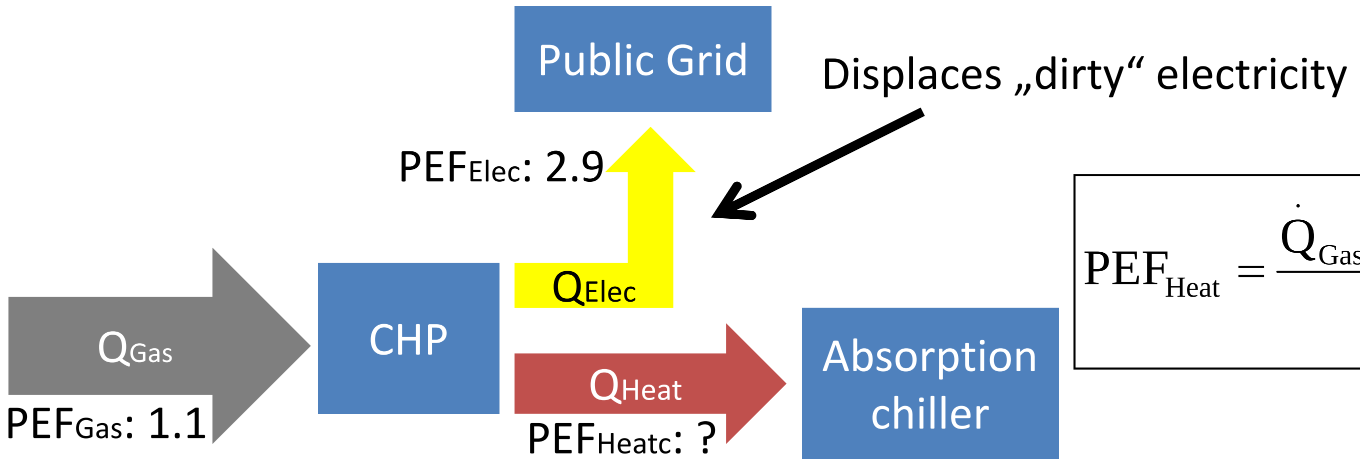
Component analysis:

What are the underlying conditions the results hold true for? Further savings possible?

Methodology: Primary Energy Factor (PEF)

Determine the PEF for all energy flows throughout the system using the causative principle:

- Direct cooling and the compressor chiller: PEF of their electricity consumption: 2.6
- Absorption chiller: Credit method to determine the PEF of its heat and electricity consumption:



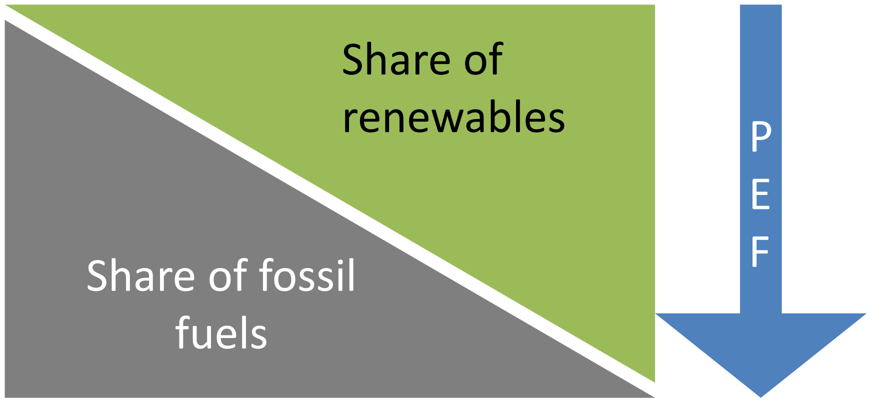
$$PEF_{Heat} = \frac{\dot{Q}_{Gas} \cdot PEF_{Gas} - \dot{Q}_{Elec} \cdot PEF_{Elec}}{\dot{Q}_{Heat}}$$

Methodology: Primary Energy Factors (PEF)

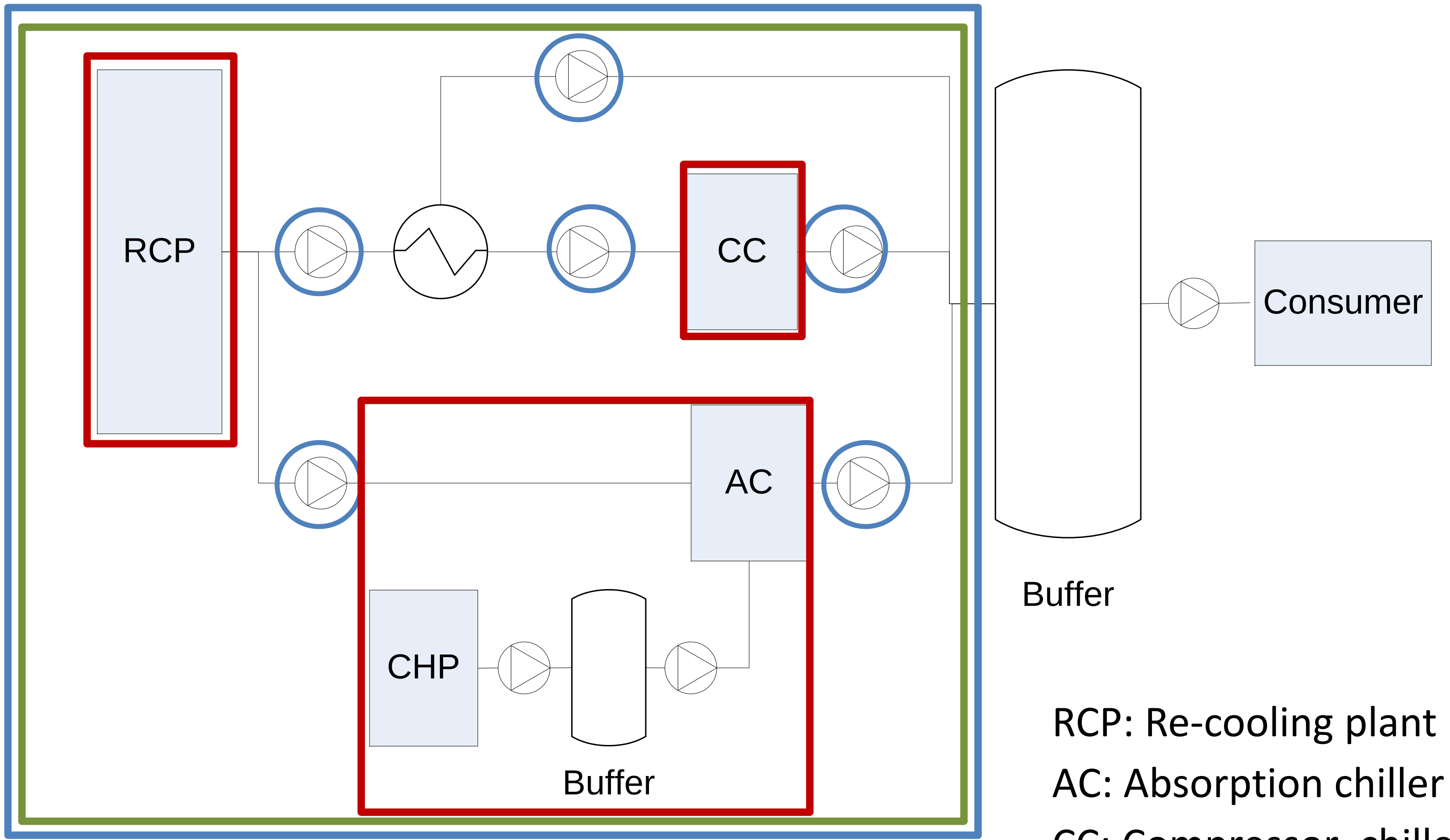
Reasons for choosing the Credit Method:

- It pays respect to the economical and technical circumstances: Absorption chiller arranges for the economic feasibility of the system with heat as its main product.
- It allows the evaluation against the background of the energy economic development:

$$PEF_{Heat} = \frac{\dot{Q}_{Gas} \cdot PEF_{Gas} - \dot{Q}_{Elec} \cdot PEF_{Elec}}{\dot{Q}_{Heat}}$$



Methodology: Energy Balance Levels



RCP: Re-cooling plant
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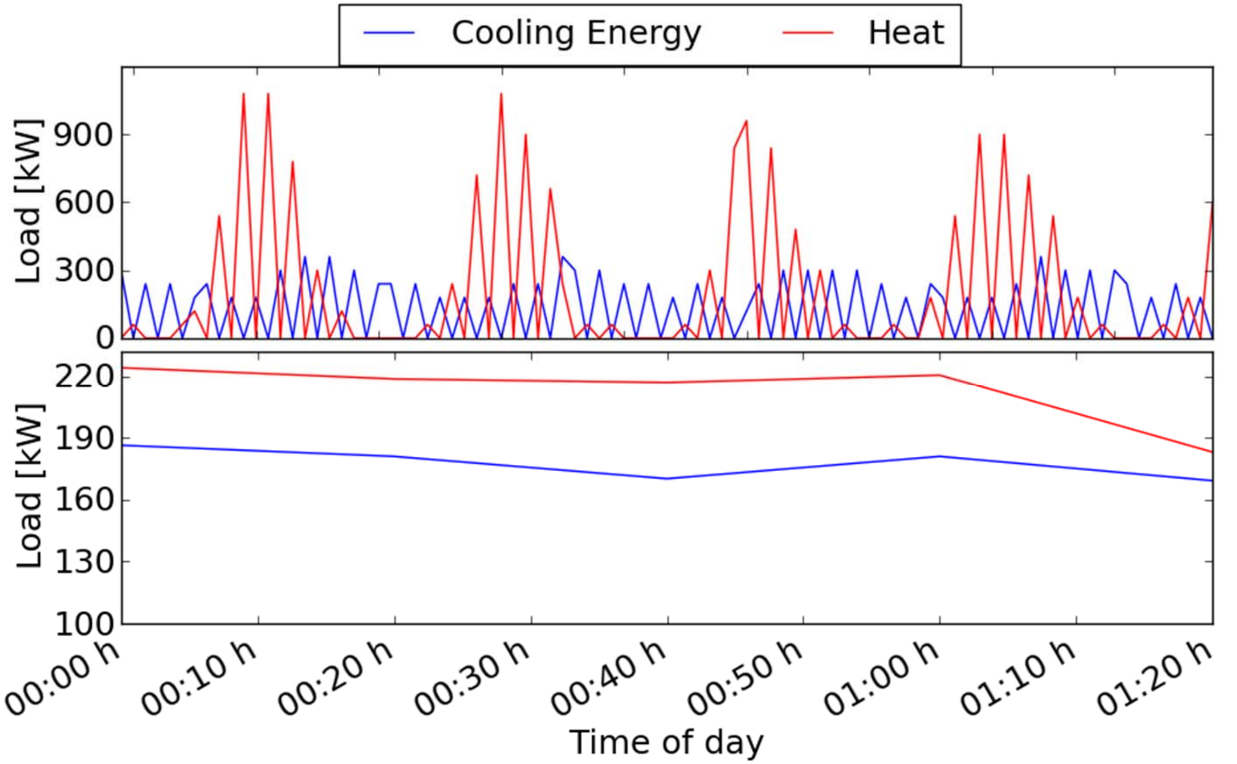
Methodology: Data Selection & Preparation



Obstacles to overcome:

- Incongruence of the meter update and the data logging
- System inertia
- No qausi-static state

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Methodology: Pumps & Buffers

Pumps

- No continuous measurement so far

Pumps	Load [kW]
Re-cooling water of the absorption chiller	18
Re-cooling water of the compressor chiller/direct cooling	13
Re-cooling water of thecompressor chiller	3.1
Cooling water of the absorption chiller	2.2
Cooling water of the compressor chiller	2.2
Cooling water of direct cooling	1.6

Buffers

- Hydraulic separators
- Obstacle: System dynamics
- Ten load cylces as an approximation

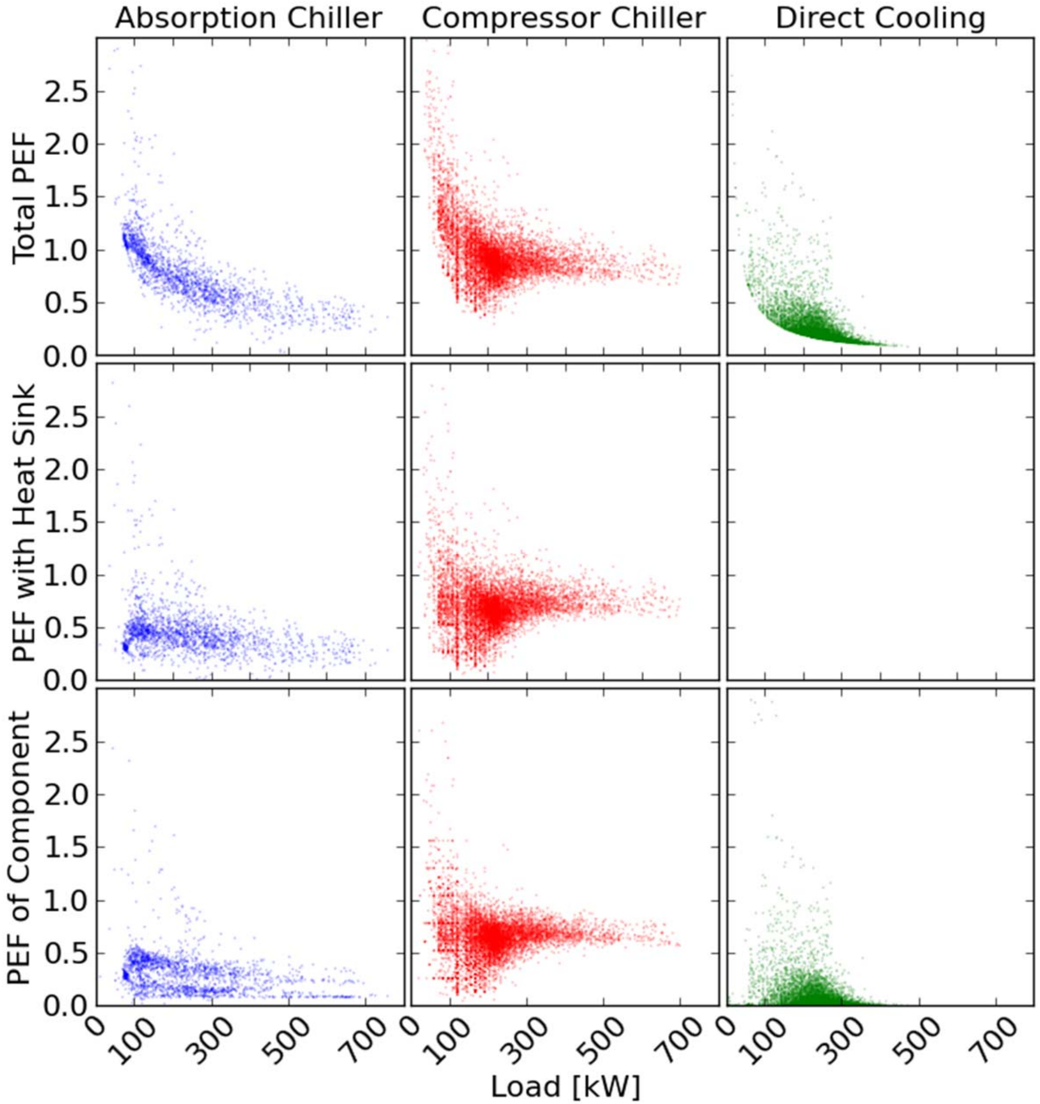
Results of the present PEF

•Direct cooling has the lowest PEF at most times.

•If direct cooling cannot be operated, the absorption chiller is the option to choose.

•The absorption chiller benefits from the low PEF of heat.

•Pumps impact the PEF to an essential extent, especially at lower load levels.



Results: Single Component Analysis

Component	Efficiency
Absorption chiller (AC)	0,69
Compressor chiller (CC)	4
Direct cooling	10
Re-cooling plant	18 (AC: 20, CC: 26)
CHP	85%
Buffer storage	96%

Underlying efficiencies within the boundaries of other comparable components

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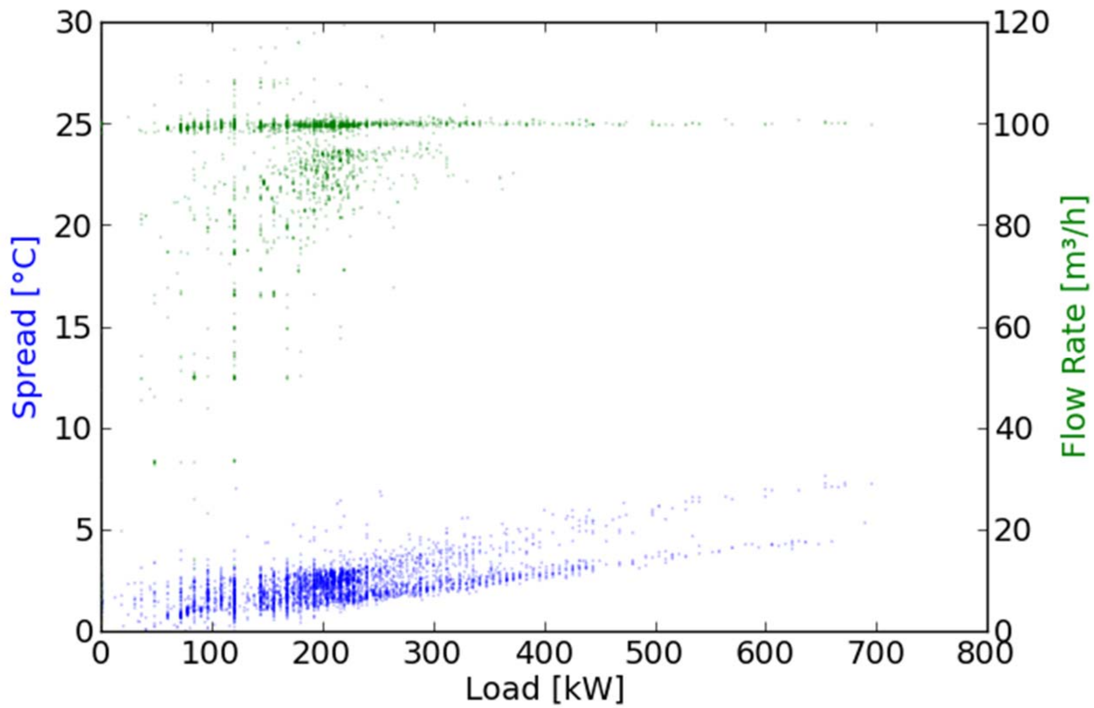
Reults: Single Component Analysis

•The pumps of the compressor chiller are operated at a constant flow rate at all load levels.

•Energy savings are possible by implementing flow control.



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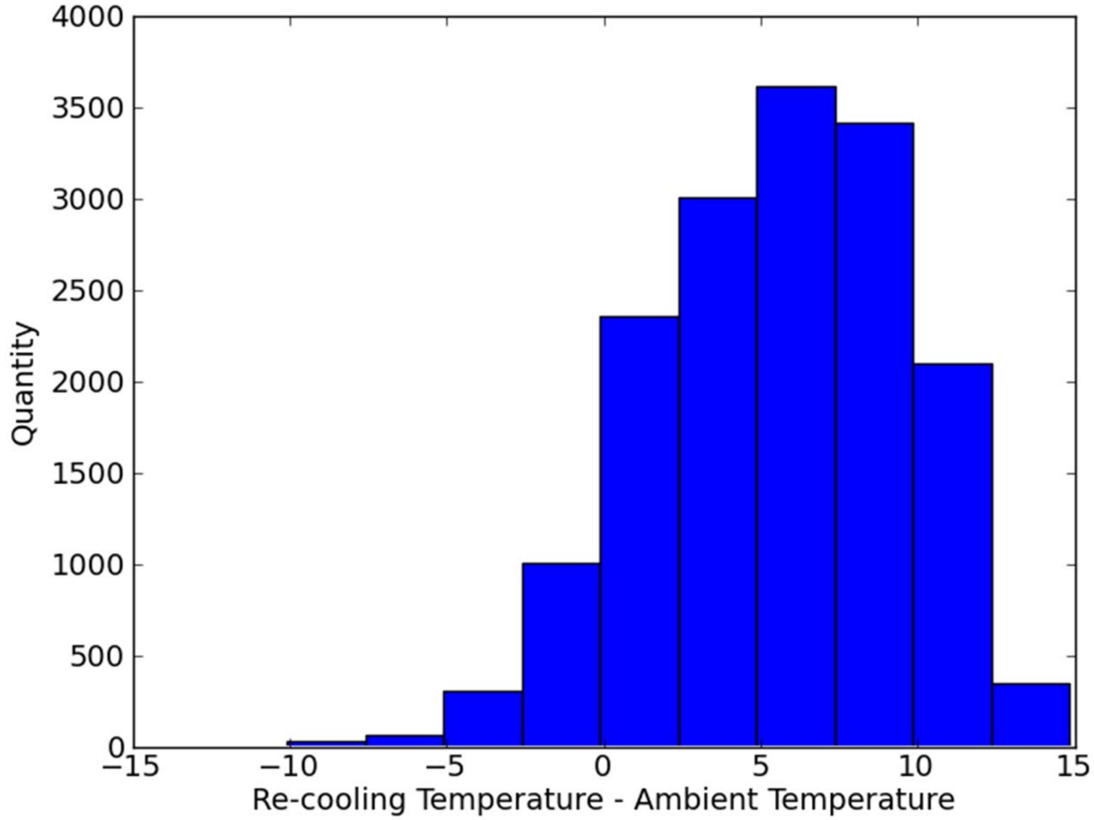
Reuslts: Single Component Analysis

•Despite the re-cooling plant‘s higher efficiency compared to that of the compressor chiller, its capacity is not completely used.

•Energy savings are possible by decreasing the re-cooling temperature.



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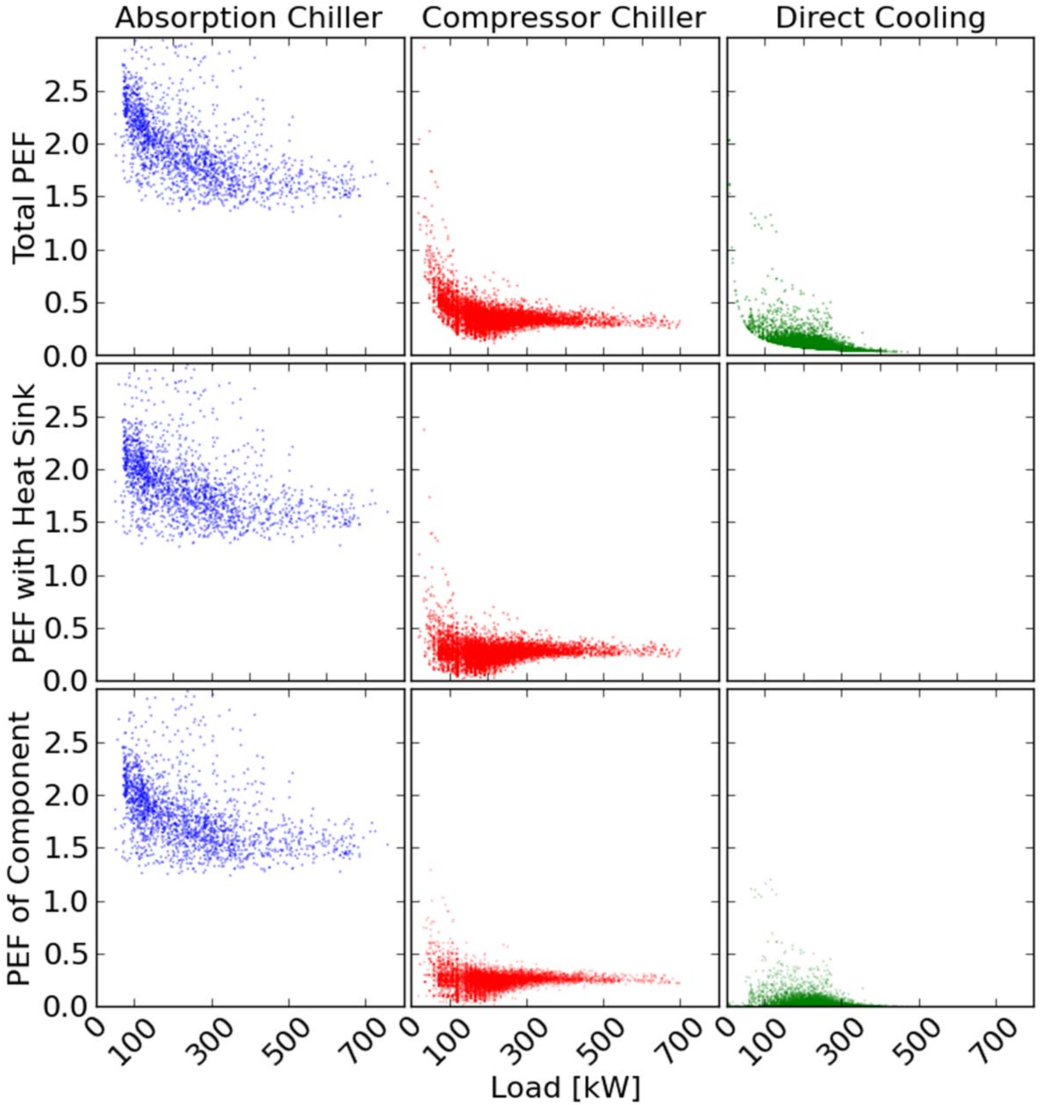
Outlook: The future PEF

•The increasing amount of renewables with a PEF of one will result in an augmenting importance of the efficiency of the sole system.

•In future the PEF of the compressor chiller will be lower than the one of the absorption chiller.

•Direct cooling will still have the lowest PEF.



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Conclusion

- Direct cooling is the most energy efficient option, though restricted by the ambient temperature.
- Based on the current efficiency, at present the absorption chiller is more energy efficient than the compressor chiller. However, in future the compressor chiller will be more efficient.
- Efficiency can be enhanced by reducing the re-cooling inlet temperatures of the absorption chiller and the compressor chiller. Furthermore electricity can be saved by implementing pump control. Results will be presented in further work.
- A comparison of three production ways of cooling energy in one building with similar sized components - an example that might provide a basis for designing further energy supply strategies.

Thank you for your attention!