A novel air conditioning system
with pure water as the refrigerant

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Vapor pressures of various refrigerants

![Graph showing vapor pressures of various refrigerants vs temperature in °C. The pressures are plotted on a logarithmic scale ranging from 0.001 to 100 bar. The graph includes lines for different refrigerants such as R744, R410A, R404A, R1270, R717, R290, R134a, R600a, and R718.](image-url)
R718 absorption chillers
R718 centrifugal chillers

- Integral
- IDE
- TI / Sabroe
- TI / JCI / Kobe Steel / TEPCO
- ILK
- Kawasaki Heavy Ind.
- Sasakura

Year

Refrigeration capacity in kW

Las Vegas, February 1st 2017, Slide 4
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Below ambient pressure
eChiller - Efficient waste heat rejection

Main system features:

- 35 kW nominal refrigeration capacity
- Capacity modulation capability
- Water - R718 as refrigerant
- Process pressures between 10 and 100 mbar
- Free cooling, free cooling+ 1 & 2 stage operational mode
- Heat sink & source decoupled by BPHX
Field test: air conditioning of a data center

Key application data:

- Location: Bremen, Germany
- Cooling capacity: 25 kW constantly
- Air temperature in aisles: 25 °C constantly
- Outside heat exchanger: Air cooled dry cooler
Operation of the eChiller – first generation

- Ambient temperature distribution at the location of the unit
Operation of the eChiller – first generation

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- Cooling capacity 25 kW all year
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- Power consumption of unit rising from 1.1 kW (free cooling mode) to 17 kW (two stage operation)
Operation of the eChiller – first generation

- Ambient temperature distribution at the location of the unit
- Cooling capacity 25 kW all year
- Power consumption of unit rising from 1.1 kW (free cooling mode) to 17 kW (two stage operation)
- COP is 1.4 to 22 depending on operational mode
Performance results full year 2015

- Cooling capacity: 170 MWh
- Annual COP: 14
  - 4 times higher than R410A system COP
  - Electricity savings: 50,000 kWh
  - Electricity cost reduction: 7000 €
  - CO₂ emission reduction: 31 t CO₂-eq.
The perfect application…

…has the following characteristics:

- Constant cooling capacity requirement over the entire year
- Cooling temperature above the heat sink temperature for 70-80% of the time and the remaining time below

(Data for chilled water in / out @ 22 °C / 16 °C, present eChiller model)
Efficiency, cost and application hit list

<table>
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<th>Chilled water in / out [°C]</th>
<th>22 / 16</th>
<th>24 / 18</th>
<th>26 / 20</th>
<th>28 / 22</th>
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Applications:

- Data centers (New and refurbishment)
- Plastics industry
- Chemical industry
- Commercial refrigeration (Cascade e.g. with CO₂)
- Heat pumps (especially high temperature)
- Commercial air conditioning

The amount and sort of required materials to make an eChiller results in lower cost than the state of the art @ same capacity.
100 % Water

80 % Energy Savings

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