BAVARIAN CENTER
FOR APPLIED
ENERGY RESEARCH

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Operational Performance Results of an Innovative Solar Thermal Cooling and Heating Plant

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Agenda

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1. Introduction and Motivation
2. System Concept and Pilot System
3. Operational Results
4. Conclusion and Recommendations

1 - Introduction & Motivation

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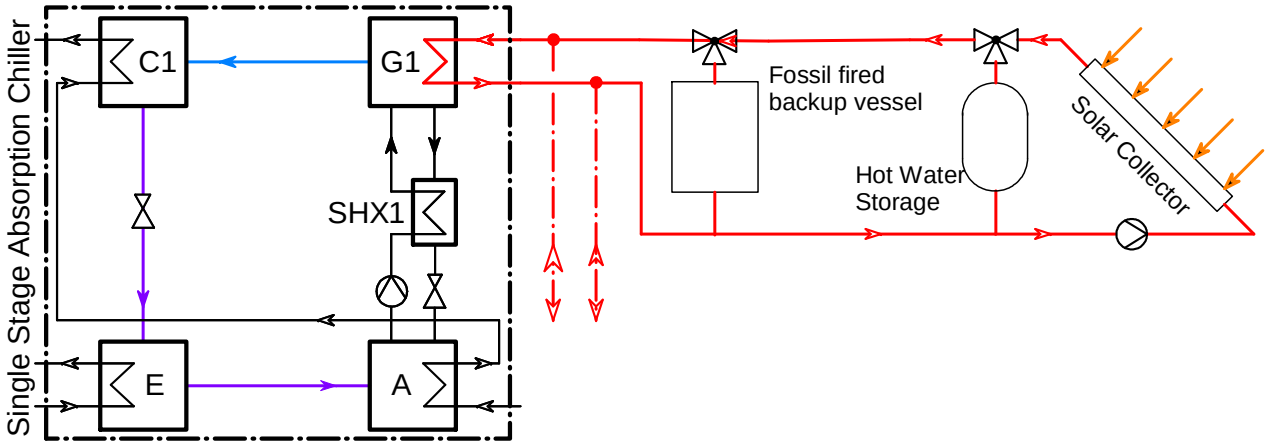
Solar Cooling

Conventional solar cooling system with single stage (single-effect, SE) absorption chiller

- Hot water driven single stage absorption chiller

  → hot water from solar collector (T_{HW} ~ 90°C)
- In case of insufficient solar radiation and parallel cooling demand a backup heat source is needed (mostly fossil fired hot water boilers)
- Rather poor utilization of primary energy of fossil fuel due to limited efficiency of the single-effect chiller (**COP_{SE} ~ 0,70**)

→ **Improved utilization of fossil fuel is imperatively essential for a positive primary energy ratio for such a solar-cooling system**



1 - Introduction & Motivation

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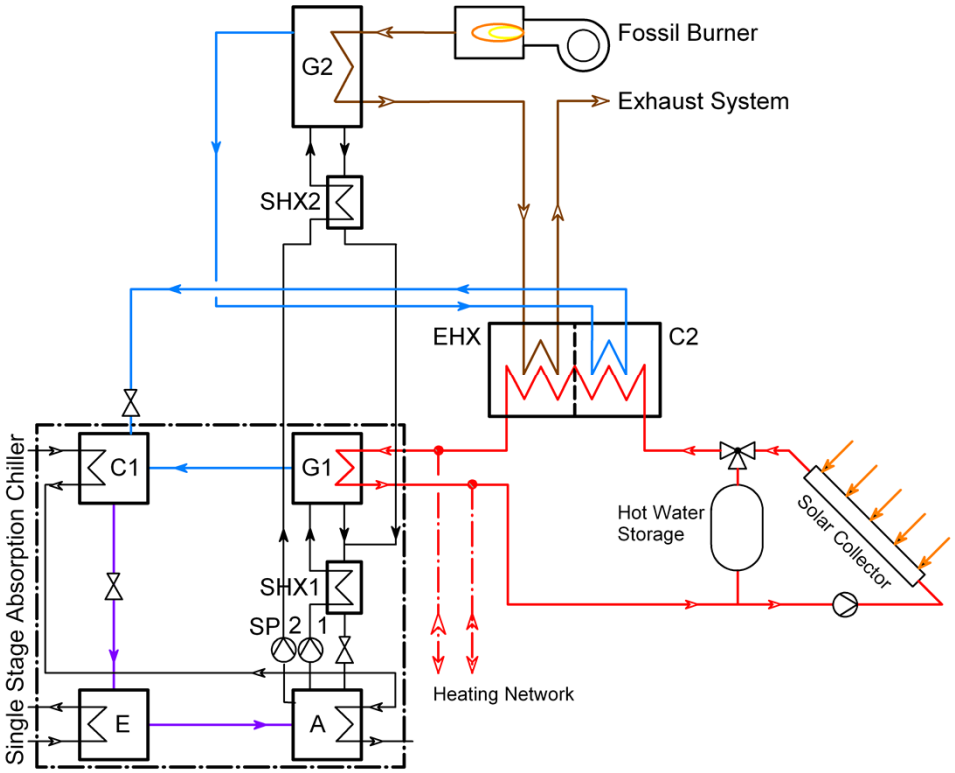
Approach:

Addition of a *high temperature stage* with a direct gas fired high temperature generator (G2)



- Usage of fossil driving heat (flue gas from a natural gas burner) in double effect (DE) absorption chiller offers higher efficiency

  COP_{DE} ~ 1,2

- Coupling of single- and double effect chiller (DE/SE) allows ***simultaneous usage*** of hot water (solar collectors) and fossil driving heat

  ($COP_{DE/SE}$ ~ 1,0)

  → **improvement of primary energy ratio as compared to a single-effect fossil backed-up system**

1 - Introduction & Motivation

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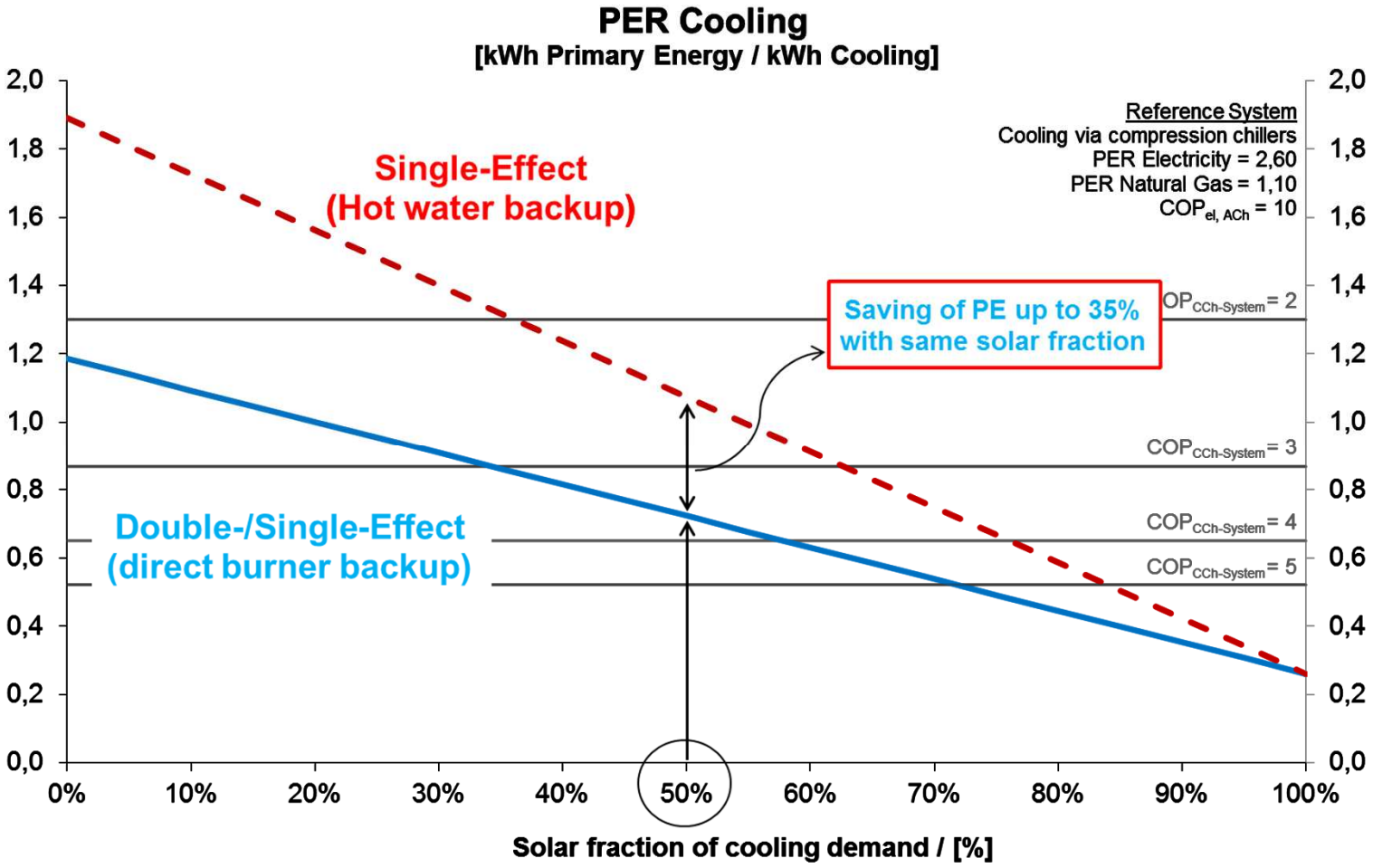

2 – System Concept

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Data of the pilot system @ Lindner, Arnstorf (D)

Absorption chiller	**90kW** cooling / **160 kW** heating cap. (LiBr/water, Thermax)
Solar field (STI):	265 m² flat plate collectors (nom. cap. ~ 90 kW @ 90°C)
Storage capacity (water):	**17 m³** -> specific storage : 56 l / m² solar collector
Building:	~ 3400 m² office building, activated ceilings moderate supply temperatures (cooling 15/18, heating 35/30 °C)
Annual demand (calc.)	*Cooling*: 10 kWh/m²a - *Heating*: 120 kWh/m²a

Lindner

2 – System Concept & Pilot System

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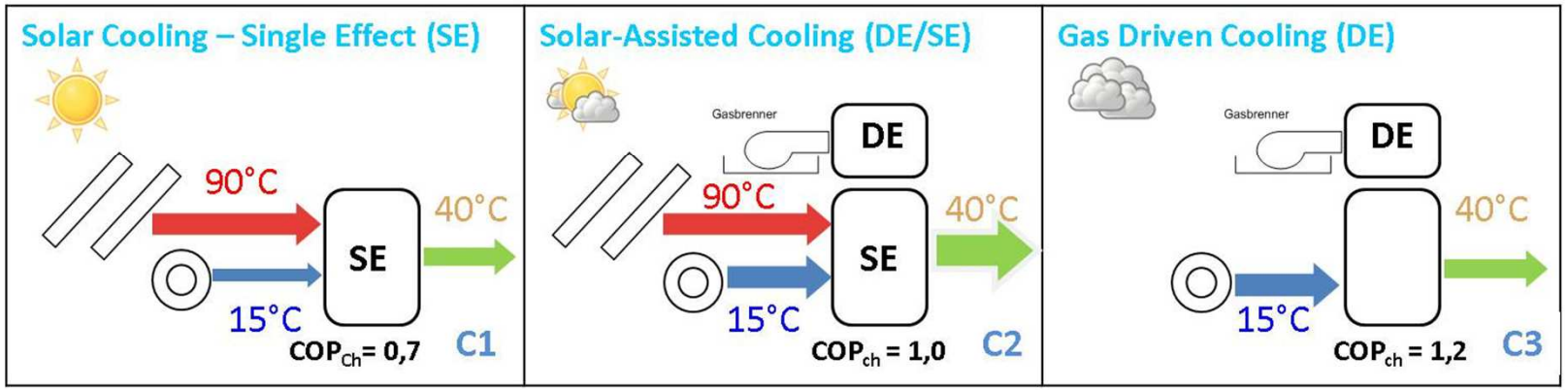
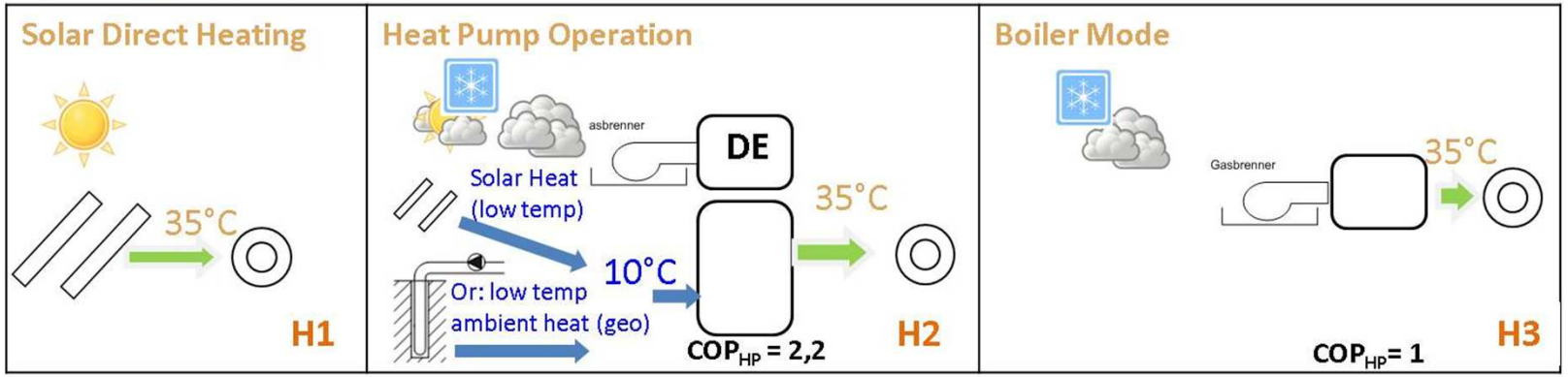
Flexible and simultaneous operational modes

Summer Cooling and DHW preparation



Spring/Autumn/Winter Heating and DHW preparation



3 – Operational Results

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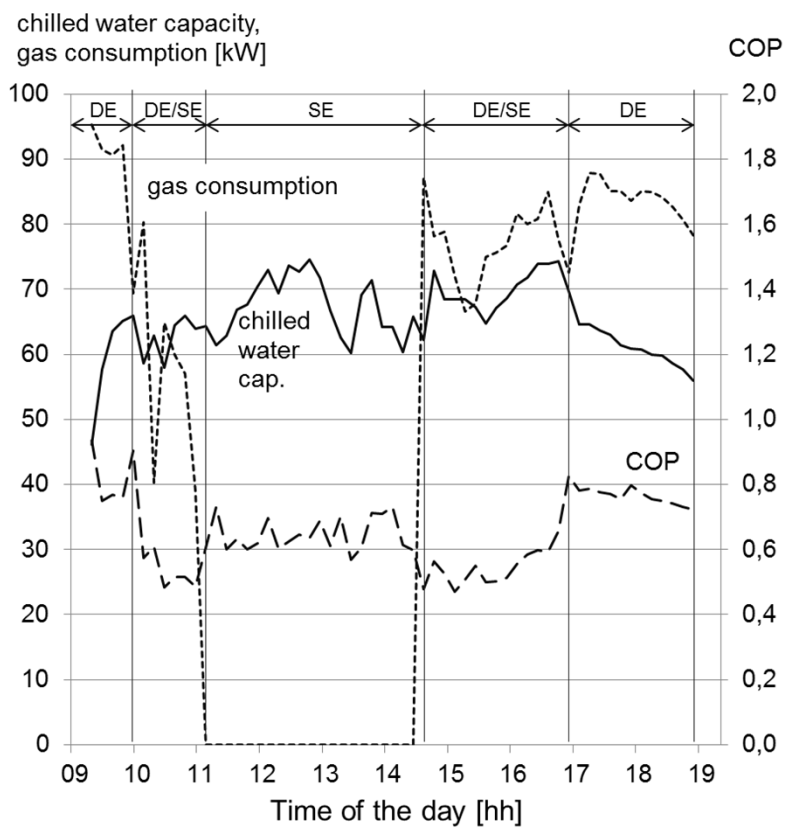
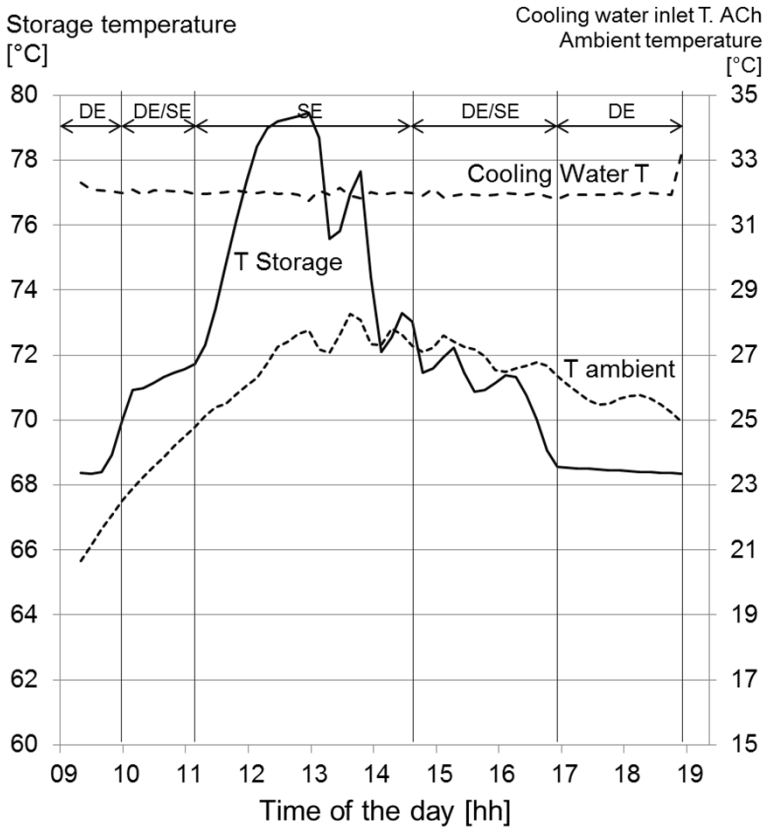
Cooling (typical day in Sept. 2011)





3 – Operational Results

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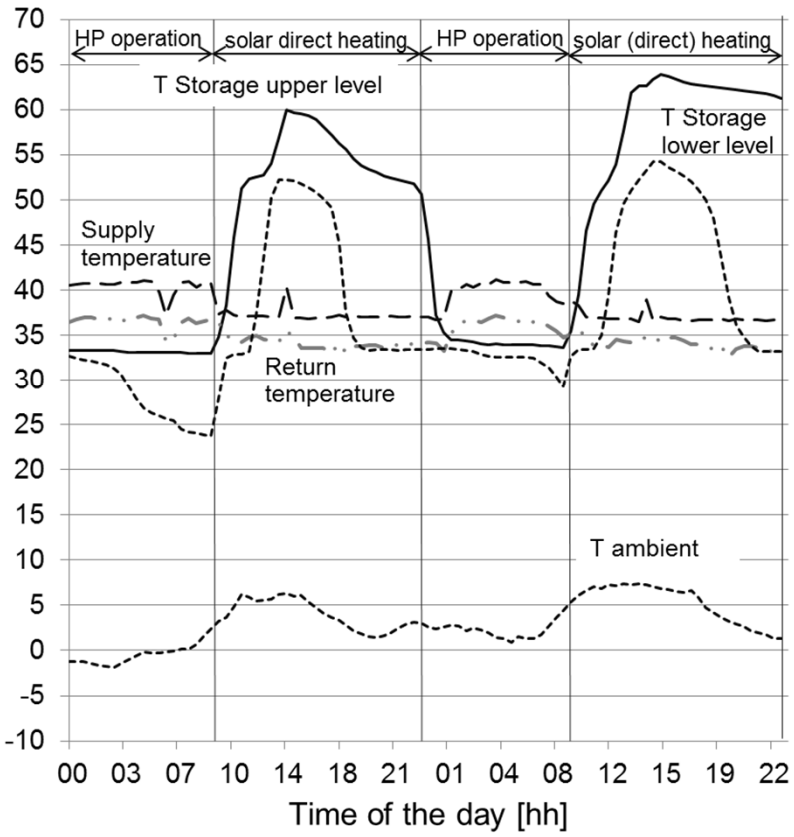
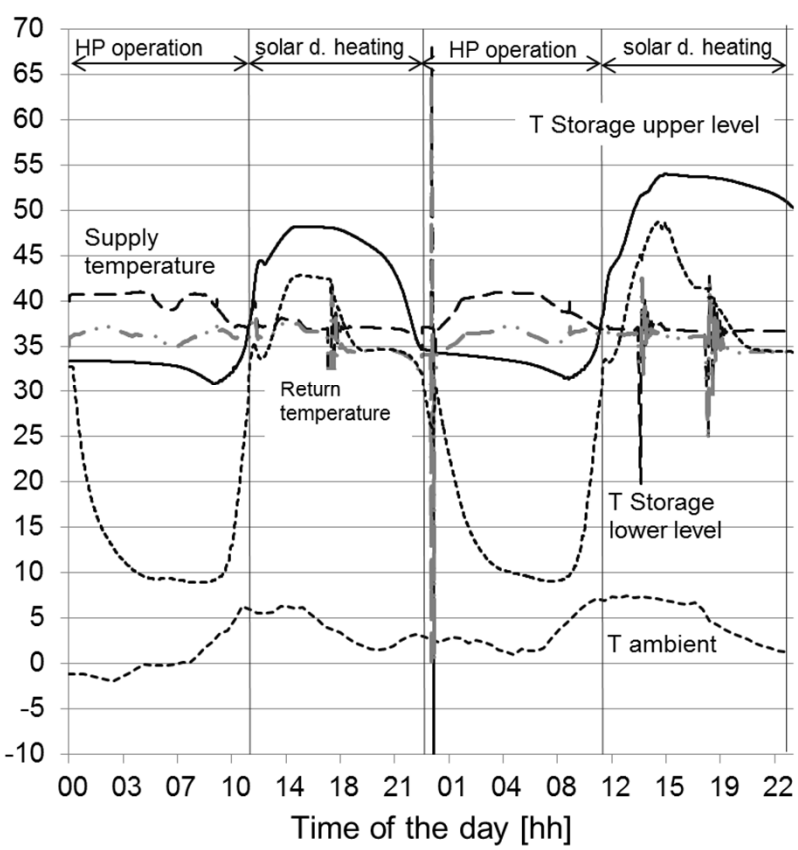
Heating (two days in FEB 2012)

measurement



simulation



4 – Conclusion & Recommendations

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Positive experience in real operation

- All operational modes automatically possible
- Flexibility of the system proven, no extra backup source for heating and cooling needed!) -> All energies from "one single source"

- High primary energy efficiency in solar cooling mode (PER < 0,3)
- High solar fraction of cooling (56%)
- Thermal design point reached (all operational modes)
- Low auxiliary electrical consumption ->

  high COP_{el} = 8,7 (whole cooling season)

4 – Conclusion & Recommendations

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Improvement potential & things to avoid in the future

- Partly weak thermal efficiency of absorption chiller in gas driven mode (esp. mixed solar/gas mode)
- Partly low *part load* efficiency (gas mode; summer & winter)

  → Improved design of internal absorption cycle needed

  (solution heat exchanger efficiency & solution mass flow)

- Simplification of planning and installation process for competitive economics needed and in progress

  → Pre-designed, pre-engineered system (hydraulic and control)
- **New R&D project** starting in Sept. forcing all mentioned improvement possibilities (efficiency and initial economics)

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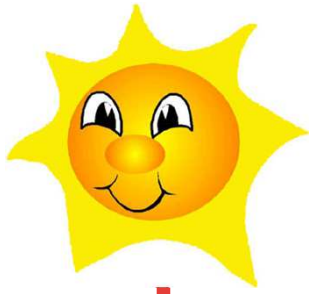

Thank you for your attention!

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