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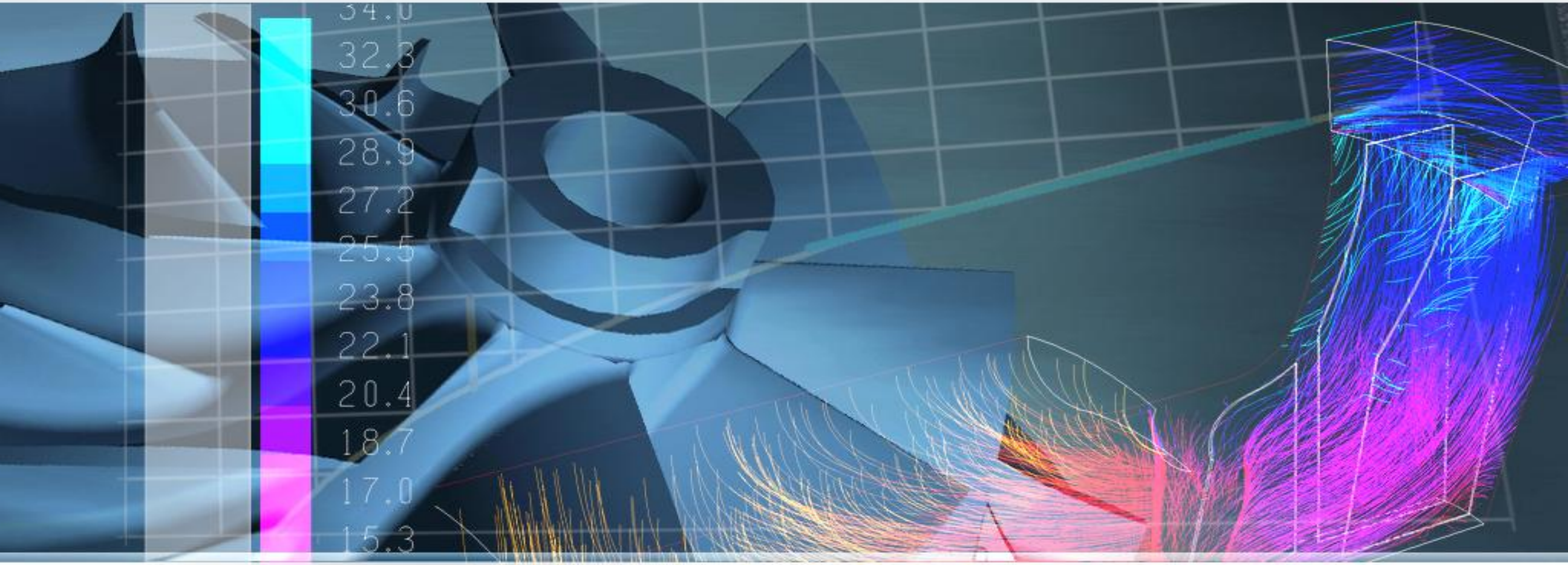



## Institute of Air-handling and Refrigeration (ILK Dresden)

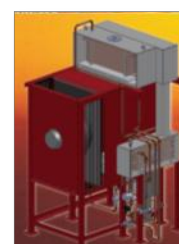
# Development of a small capacity directly air-cooled water/LiBr absorption chiller

## Chinese Solar Cooling Conference, Shanghai, 27.3.2015

# ILK Dresden – R&D company

- Founded in 1964
- Re-established as independent research institute in 1991

- Employees: 145
- Academics: 72 %
- mean age: ~44
- Laboratory area: ~3000 m²
- Test rigs: ~56
- Phys. / Chem. Laboratories: 25



# Background and goal of the development

## Problems in solar thermal cooling systems with small scale chillers

- Complexity of the system
- Interface problems because of different crafts (might be) involved
- Possibly high error rate during installation
- Auxiliary energy demand of the system
- Limited applicability of evaporative systems but high re-cooling sensibility of the cycle

# Challenges

- **Avoiding of an intermediate circuit:**
  **- to minimize the auxiliary energy demand (as re-cooling circuit pump usually consumes much electricity)**
  **- for a better approach of external and internal temperatures since temperature lift and driving temperature are limited**

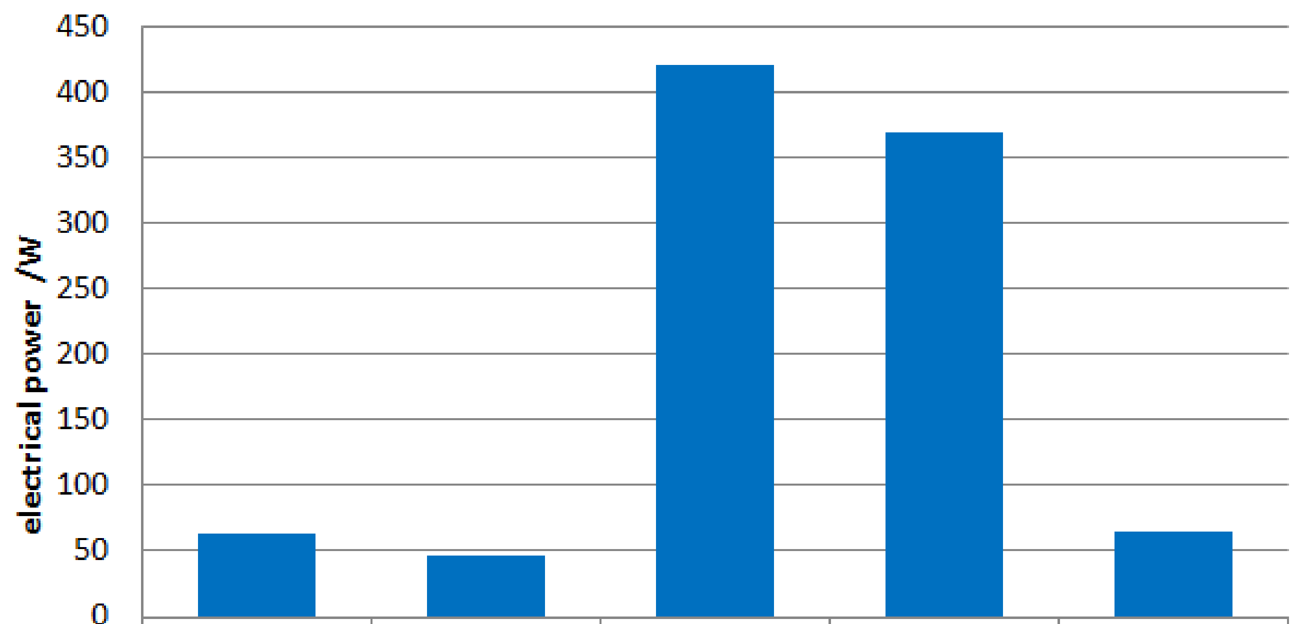
- **Air-cooled absorber needed**

- **Water as refrigerant -> big free section needed**

?

- **Air as heat transfer media -> big free section needed**

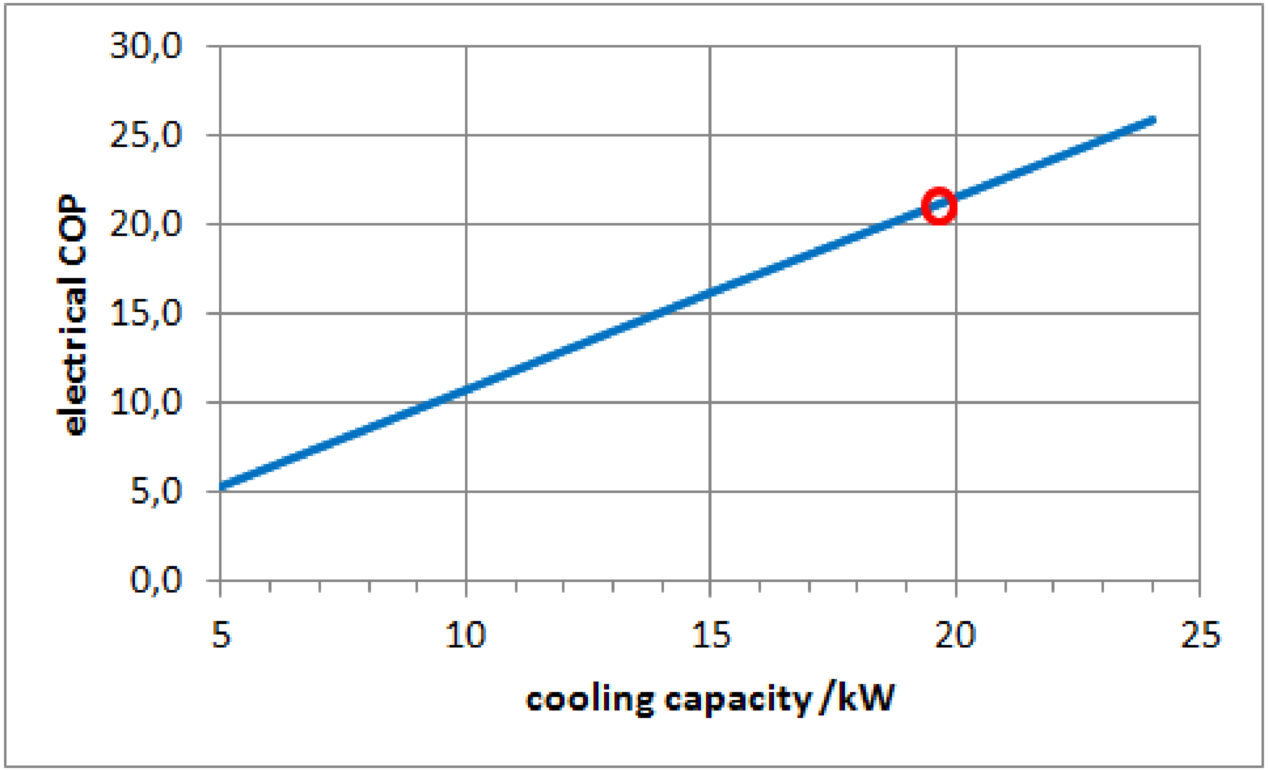
# Distribution of the auxiliary energy demand of a small scale water cooled absorption chiller




| | internal pumps | pump hot water | pump re-cooling water | fan re-cooler | pump chilled water |
|---|---|---|---|---|---|
| Pel /W | 64 | 46 | 421 | 370 | 65 |

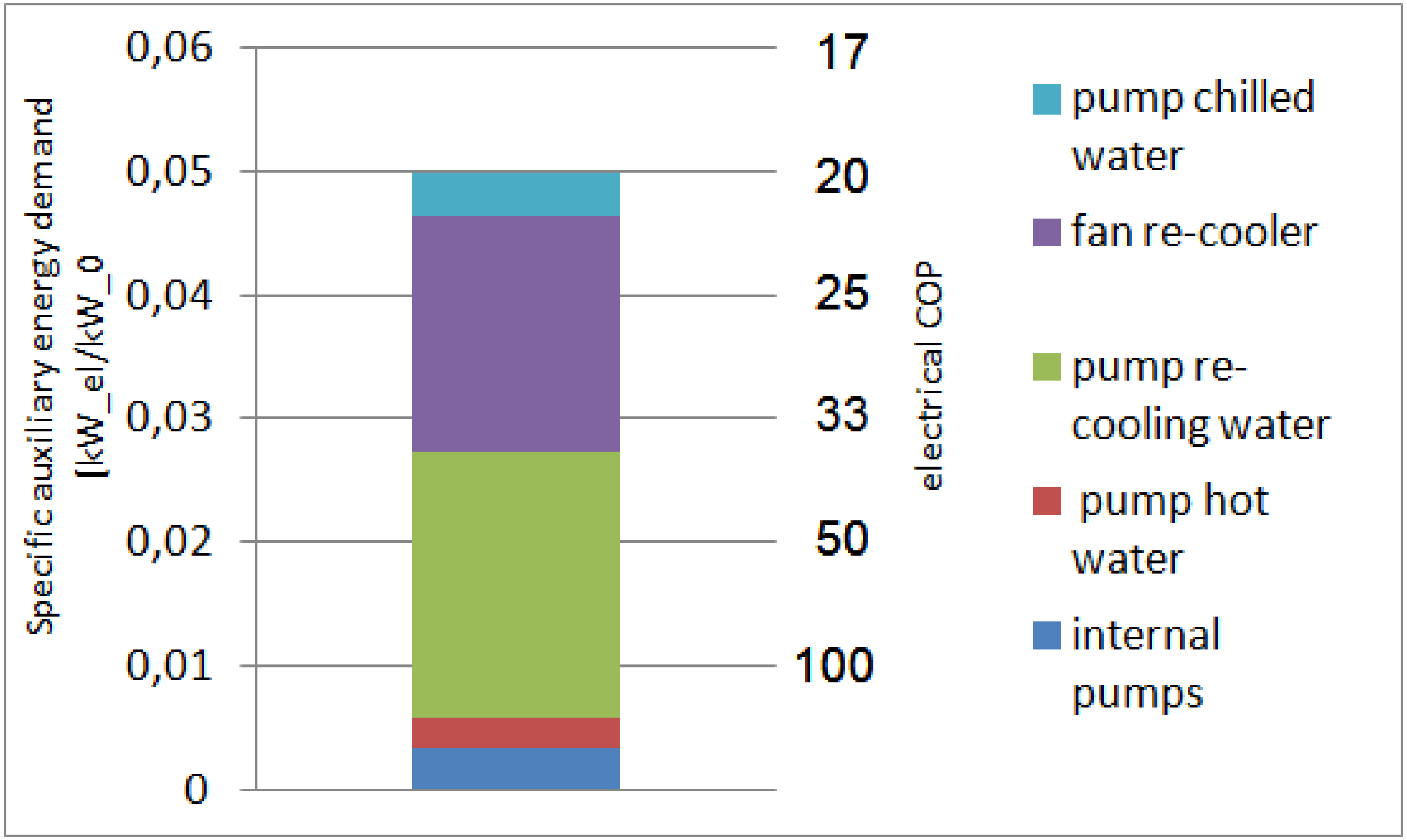
Nominal cooling capacity: 19,4 kW

# Auxiliary energy demand of the system




**Auxiliary energy demand of the system with constant speed pumps/fans as a function the cooling capacity**

# Distribution of auxiliary energy demand



# Examples of air-cooled absorption chillers

Source: Rotartica


Source Helioplus

**$H_2O$/LiBr, rotating HX, intermediate circuit**

**$NH_3$/$H_2O$ -> high working pressure!**

**Gas driven -> high driving temperature**

# Examples of air-cooled absorption chillers

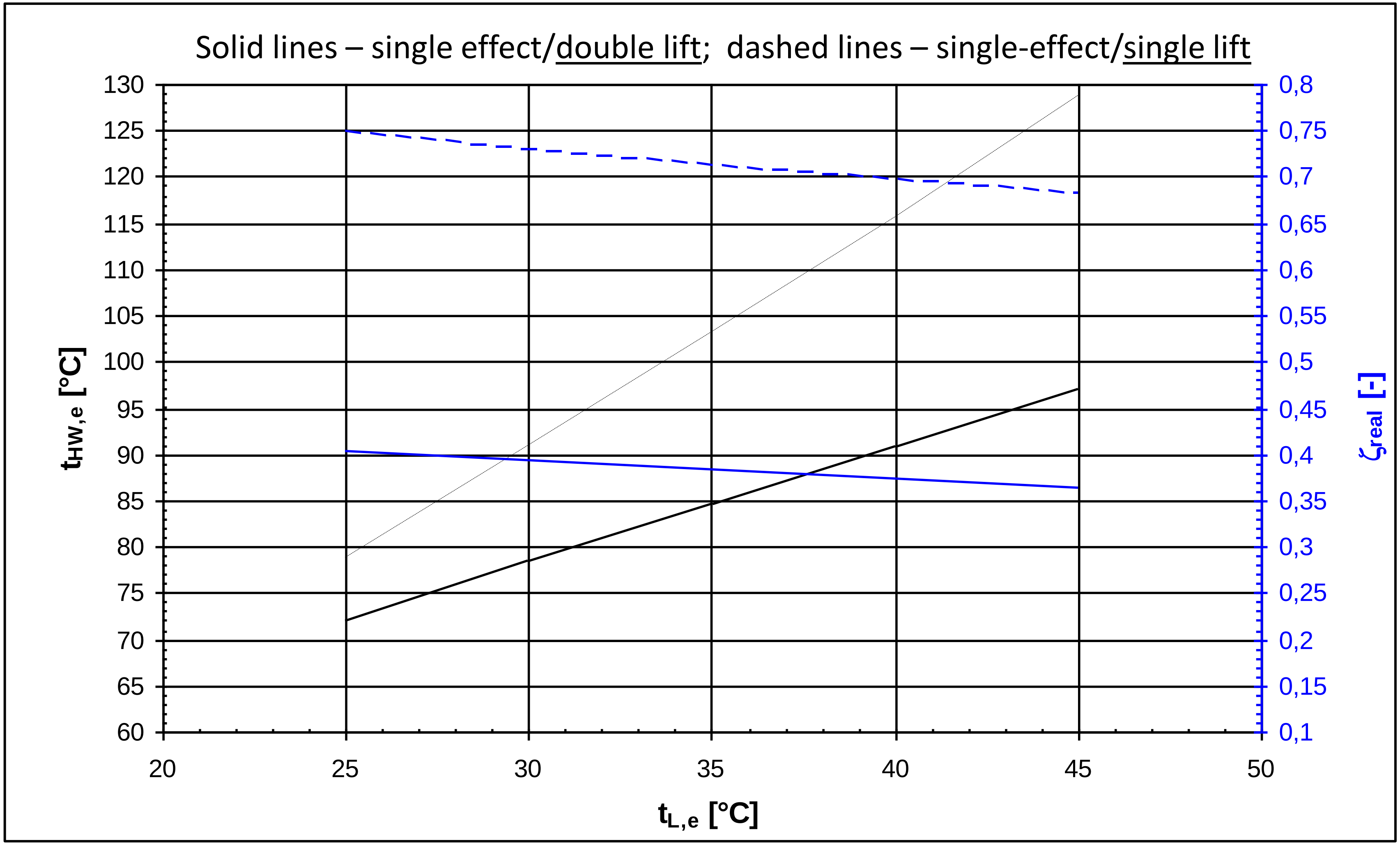
Source: Broad

Source: Broad

## $H_2O/LiBr$, gas driven, intermediate circuit

**$Q_0$=23 kW; zetta=1,1, $P_{el}$=1,8kW ($COP_{el}$=12,7)**

# Balancing Single Lift vs. Double Dift




chilled water out: 13 °C

# Aimed specifications for the development

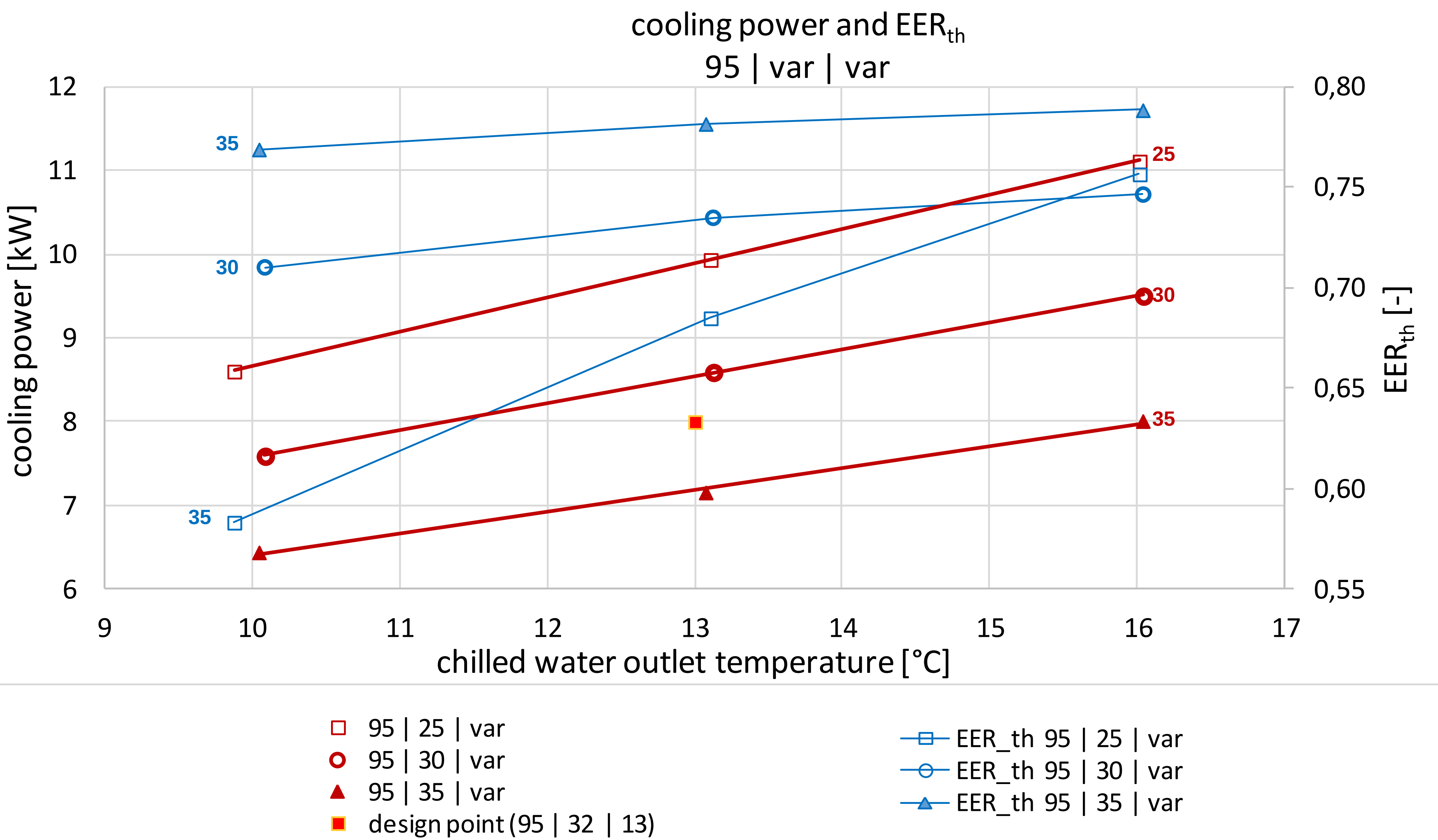
| External Fluid | Nominal Condition | Operating Range |
|---|---|---|
| Chilled water temperature (water w. 20 % Glycol) | 18 °C / 13 °C (in/out) | 6 °C … 20 °C (out) |
| Heating water temperature (water w. 20 % Glycol) | 95 °C / 87 °C (in/out) | 75 °C … 105 °C (in) |
| Ambient air (for re-cooling) | 32 °C / 42 °C (in/out) | 10 °C … 32°C (in) |
| Cooling capacity | 8 kW | |

- Condenser and Absorber directly air-cooled
- Outdoor installation, frost save
- Auxiliary energy consumption at nominal conditions < 60 $W_{el}/kW_0$ („EER“ > 16)
- Single effect / single lift

# Test of components within functional model

# Improved functional model


# First lab results



# Restrictions of lab measurements

- Limited space and height in lab
- No free outflow of absorption chiller outlet air
  -> increased air-side counter pressure
  -> higher fan speed for same air flow rate needed
  -> increased power consumption of fan
  => no meaningful results regarding $EER_{el}$
- Difficulty to maintain even temperature distribution

# Conclusion and Outlook

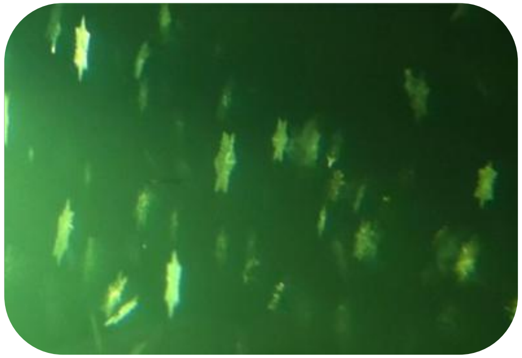
- Thermal design point reached
- No useful results regarding electrical efficiency yet
- Field test planned in summer 2015

Results expected regarding

- Electrical efficiency
- Operational experience
- Outdoor installation

# Vacuum ice slurry technology for high density cold storage, e.g. in PV driven cooling systems

- High energy density (93 kWh/m³)
- Higher  efficiency than conventional ice bank storage through high evaporation temperature
- No glycol circuit needed
- Ice slurry is pumpable
- Capacity range: 50 … 500 kW
- Matching solar radiation and cooling demand



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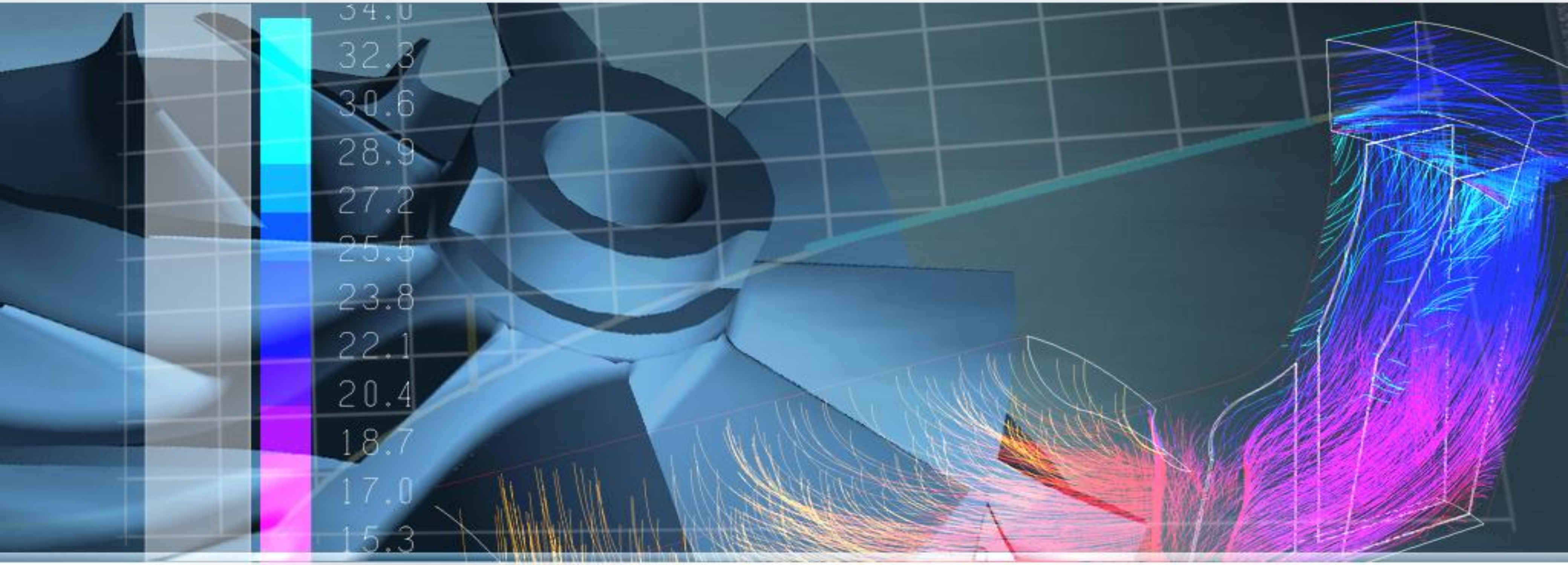


# Thanks for your attention!

## Questions?

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