Technical and economical analysis of solar cooling systems

Results of Task 53 (New Generation Solar Cooling)

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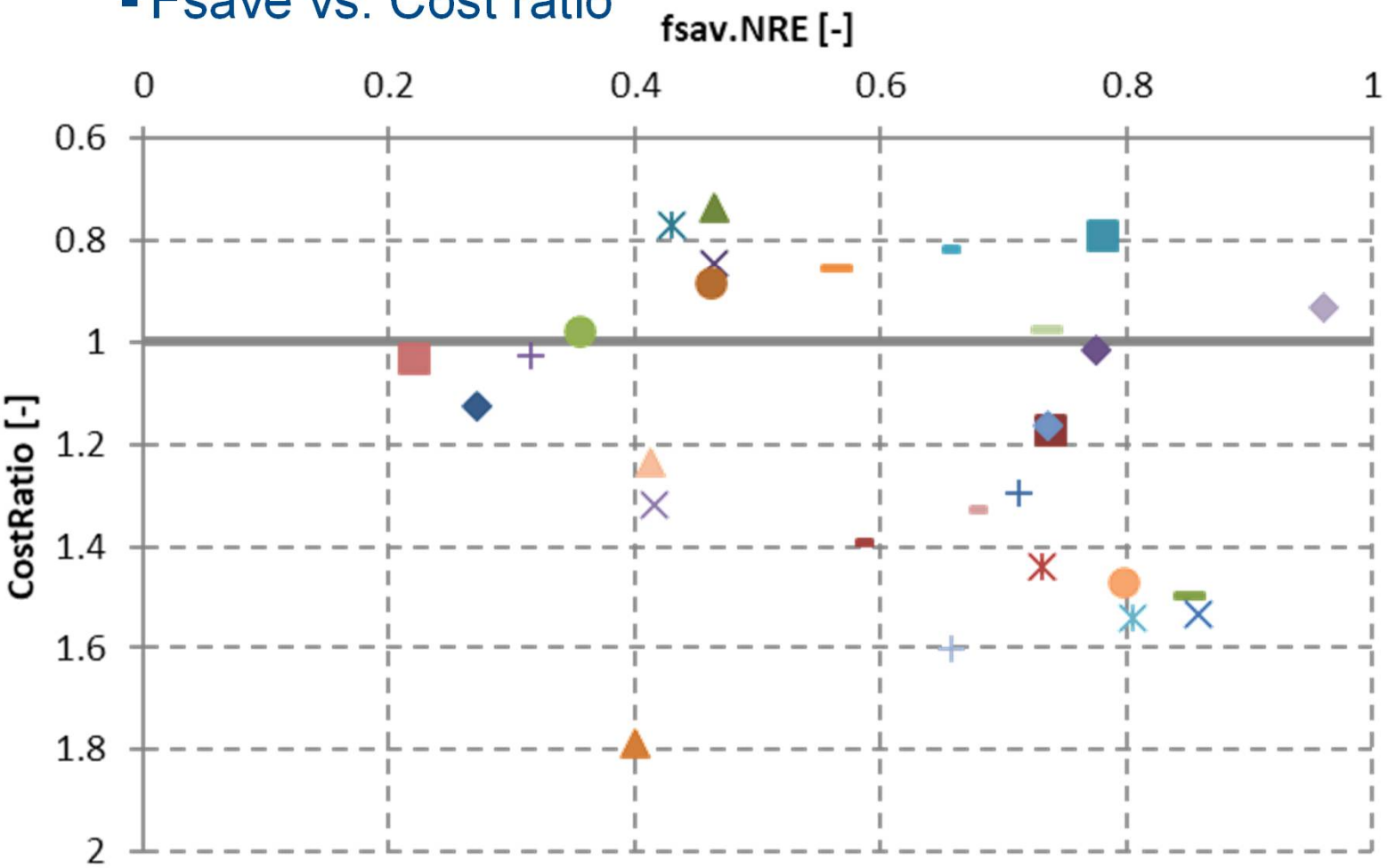
Motivation

Task 53

- Aim:
  - comparison of performance of PV and solar-thermal driven SHC systems
- Challenge:
  - High complexity (different technologies, configurations, control, storages)
  - Demand (space heating, domestic hot water, cooling)
  - Different capacities
  - Location
  - Boundaries (data available, which quality)
- T53E4-Tool developed to make comparison of systems
- 28 different cases of measured and simulated examples were analyzed

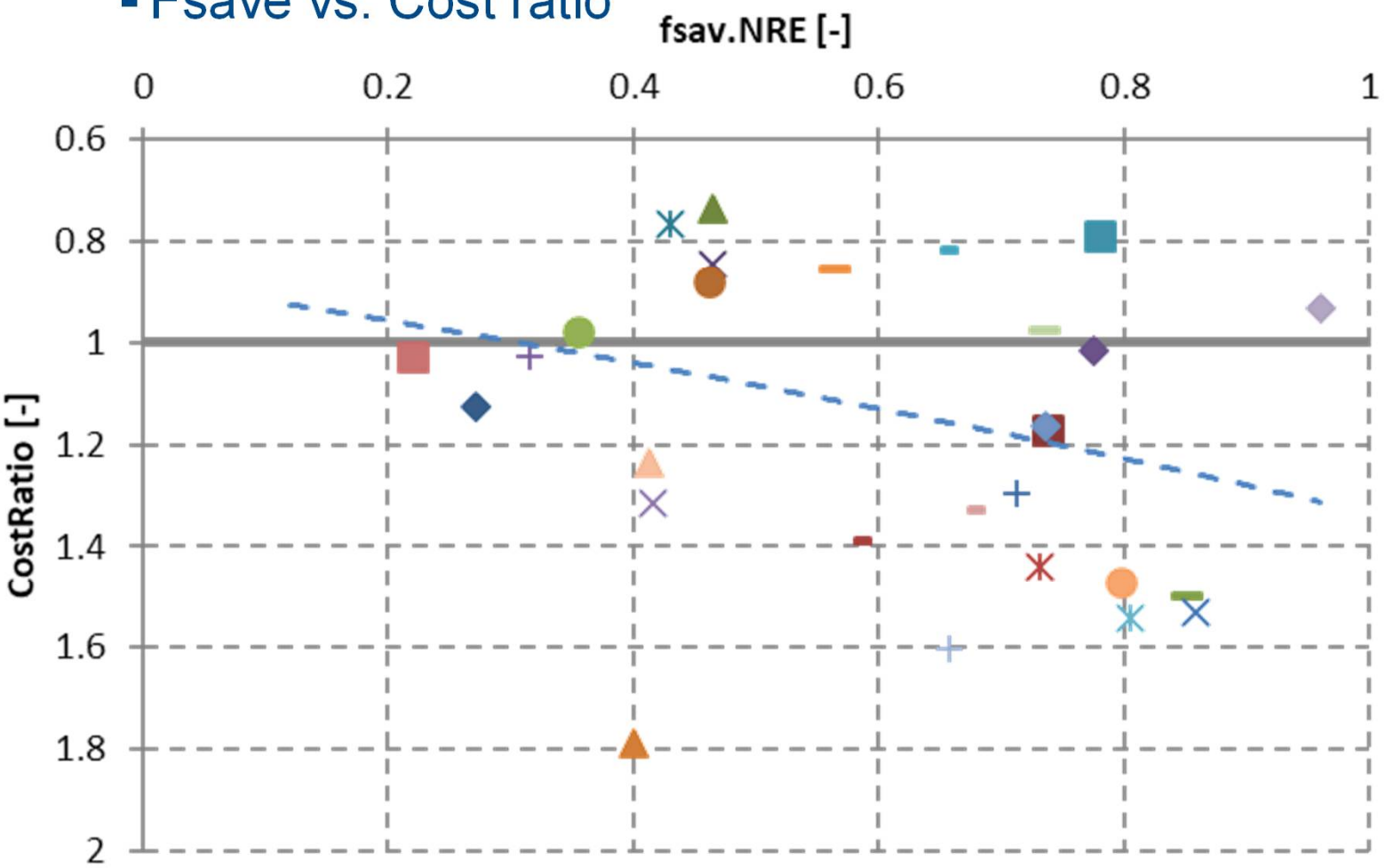
Primary energy savings vs. Cost ratio

- Fsave vs. Cost ratio



Primary energy savings vs. Cost ratio

- Fsave vs. Cost ratio



Analyzed systems T 53 - Overview

Task 53

Results shown in

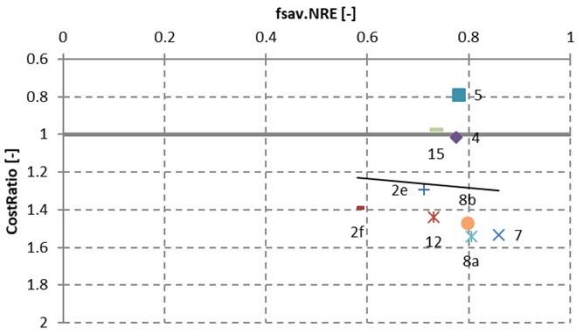
- **Trends** (Costs vs. Efficiency)
  - Categorized by boundary conditions
    - Location
    - Technology
    - Capacity
    - Demand

- **Sensitivity Analysis** (Costs vs. Efficiency)
  - Variation of
    - Investment costs
    - electricity price and gas price
    - auxiliary demand
    - energy output
    - PE conversion factor

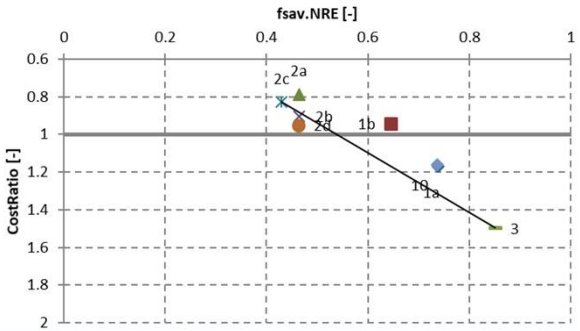
Trend: Capacity

- Small scale highest costs → designed to achieve high energy savings
- Intermediate scale are cost competitive at energy savings < 50 %
- Large scale cost competitve at higher energy savings

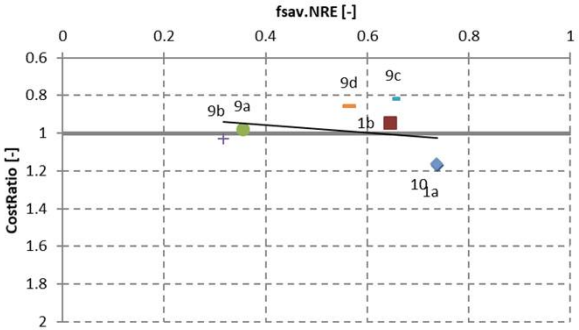
Small scale
<10 kW



Intermediate
scale



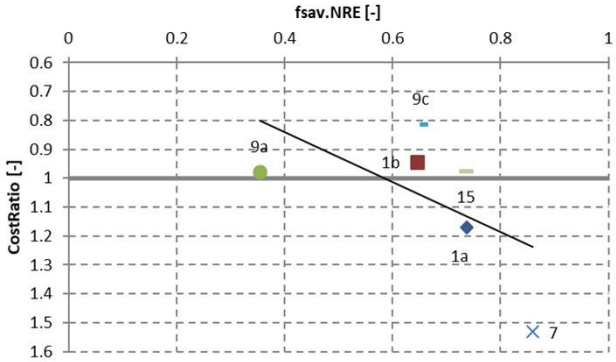
Large scale
>100 kW



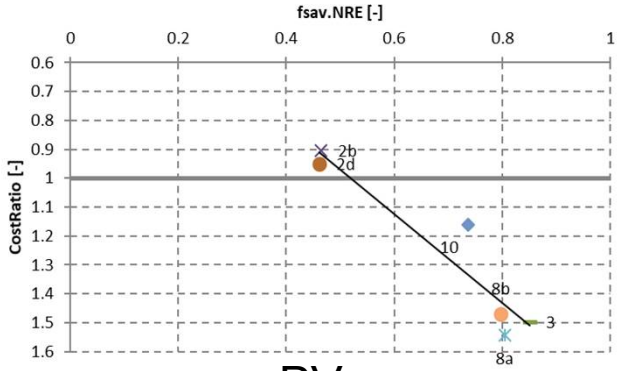
Trend: Technology

- ST + boiler lower increase than ST + HP
- ST + boiler = efficient use of both technologies
- PV systems perform better, because examples are in southern areas

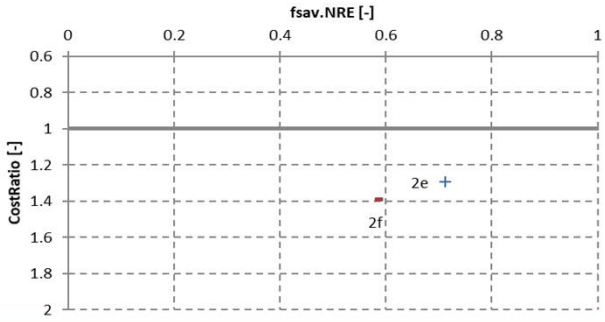
ST + boiler



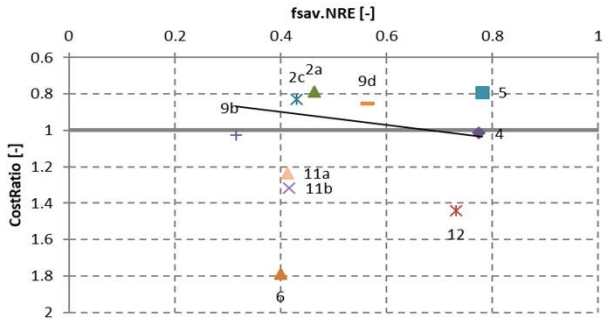
ST + HP



ST + PV



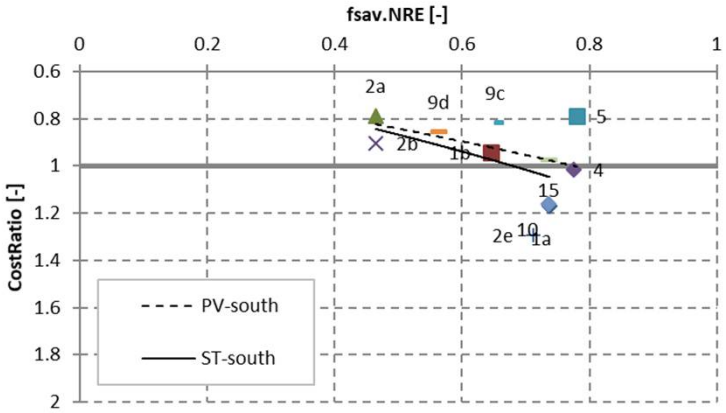
PV



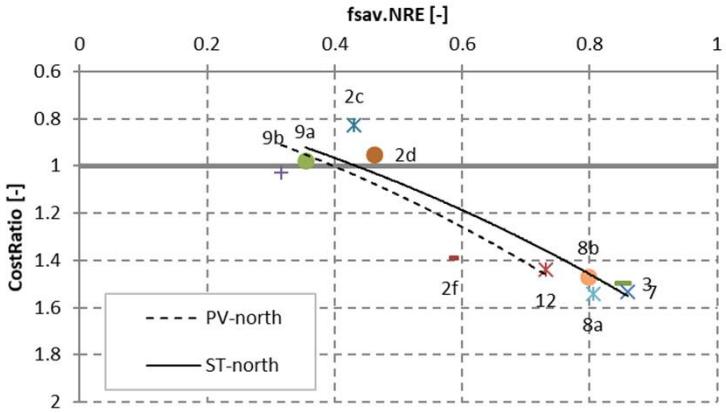
Trend: Location and technology

- Southern SHC systems more cost competitive than northern locations→ higher/more constant loads
- PV and ST nearly same performance when considering location

southern



northern

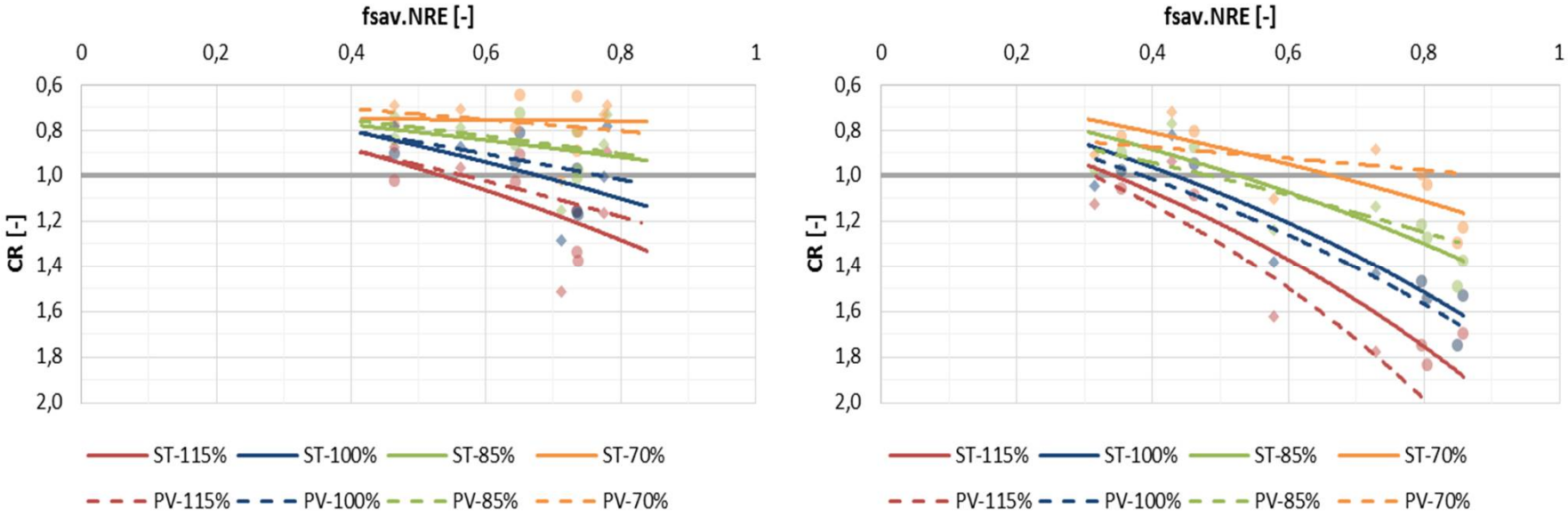


Sensitivity Analysis

- Influence of boundaries
  - Investment costs
  - Electricity price
  - Natural gas price
  - Auxiliary demand/energy input
  - Non renewable primary energy factor

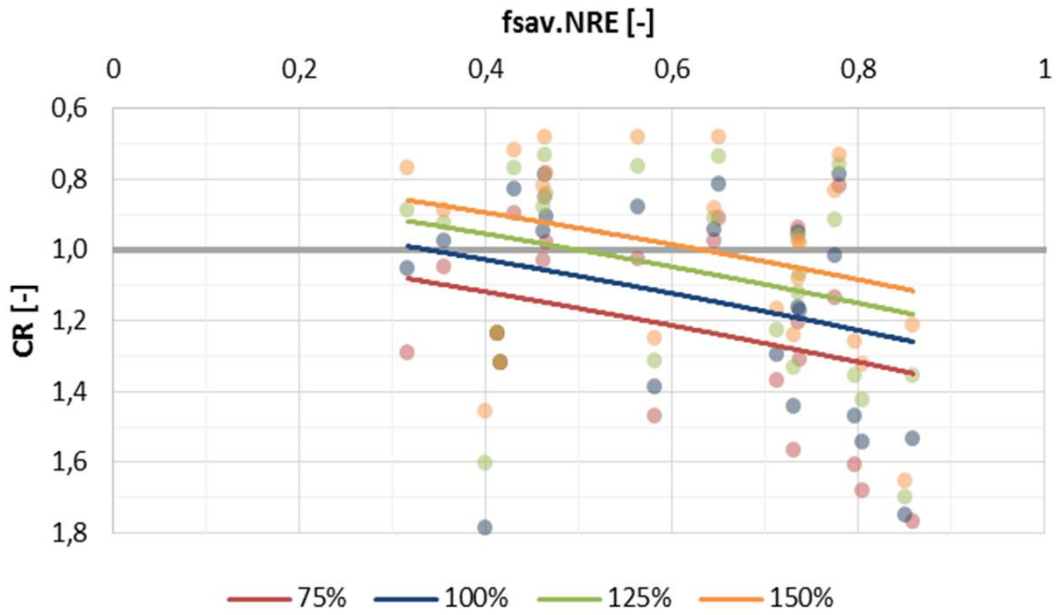
Sensitivity Analysis – Investment costs

- Only effects CR
- 100 % indicates standardized investment costs at the moment
- Plants with higher f_{sav} are more sensitive
- PV systems are more sensitive



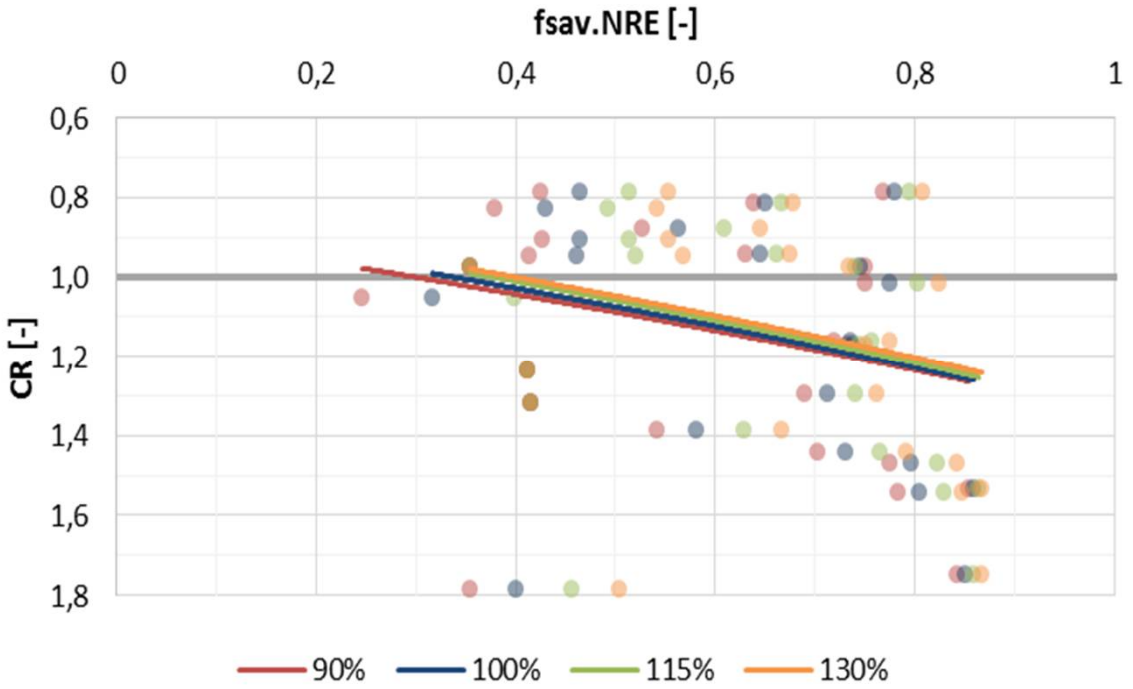
Sensitivity Analysis – Natural Gas Price

- Only effect CR
- Standard 5 €ct/kWh
- Effects reference system and ST + natural gas boiler



Sensitivity Analysis – Primary Energy Factor

- Only effects f_{sav}
- Electricity based systems more effected
- No significant influence



Summery

- Trends
  - Simplified comparison
  - Indication for Optimization
  - Higher savings result in higher costs
  - Location main influence on efficiency
- Sensitivity
  - Effect of changes in boundaries
  - Main influence: Investment costs & natural gas price (changes when reference system is different)

Limitations of analysis

- Analysis only showing trends no absolute numbers (too little amount of systems for analysis)
- Mainly demo systems – not commercial systems
- Costs standardized – vary on location, planning experience

Detailled analysis in Deliverable C3 of IEA SHC Task 53 „New Generation Solar Cooling“ (including trend, sensitivity and individual system analysis)

Conclusion

- Both solar thermal and PV –driven systems can be cost competitive when well designed
- No significant difference btw PV and ST – depends on level of optimization / proper design
- Focus for small system on easy to install and maintain systems
- PV preferred for small systems since easy to connect to HP
- ST systems need high investment costs (cooling tower) – only cost effective for large systems
- Cost competitiveness reached: fsave up to ~ 30 %

Conclusion

- Highest influence factor on CR: Investment costs – further research should focus on reduction

- Decrease of investment costs
  - By 15 % → fsave up to ~ 65 % at CR 1
  - By 30 % → considerably below CR 1

- Gas price also significant influence (mainly influence reference system)
  - Difficult to predict
  - Depend on political, economic and exploration boundary conditions
  - Increase of 50 % gas price → CR 1 can be achieved for fsave ~ 60 % (instead of 30 %)
- Other boundary conditions e.g. auxiliary demand, primery energy factor, … no significant influence

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IDEA TO ACTION

Thank you
for your Attention