Task 53

Technical and Economic Assessment

best practice examples of new generation solar thermal and PV driven heating and cooling systems

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Introduction

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- Solar cooling and heating can be **complex**
  - Solar Thermal or Photovoltaic driven
  - System design & configurations (backups, storages,…)
  - Demands (domestic hot water, space cooling, …)
  - …

→ Assessment in a **common comparable format**

- energetic, ecological, economic, evaluation
  → **T53E4 Assessment Tool**
- Assessment based on (monthly) energy balances
- Measured or simulated (sub) system
- Data base for Technical and Economic assessment

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Tool download
http://task53.iea-shc.org/
Final Version to be expected in
Autumn 2018

Technical Key Figures

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- Non-renewable primary energy ratio (PER_{NRE})

  Energy input (Q_{in}) converted in primary energy

  electricity: $\boldsymbol{\varepsilon}_{el}$ = 0.4 $kWh_{Use}/kWh_{PE.NRE}$

  natural gas: $\boldsymbol{\varepsilon}_{in}$ = 0.9 $kWh_{Use}/kWh_{PE.NRE}$

$$PER_{NRE} = \frac{\sum Q_{out}}{\sum \left(\frac{Q_{el,in}}{\varepsilon_{el}} + \frac{Q_{in}}{\varepsilon_{in}} \right)}$$

- Standardized Task 53 reference system

  Natural gas boiler, air-cooled vapor compression chiller

$$\mathrm{PER_{NRE.ref}} = \frac{\sum \mathrm{Q_{out}}}{\sum \left(\frac{\mathrm{Q_{out.heat}} + \mathrm{Q_{loss.ref}}}{\varepsilon_{\mathrm{in}} * \eta_{\mathrm{HB.ref}}} + \frac{\mathrm{Q_{out.cold}}}{\mathrm{SPF_{C.ref}} * \varepsilon_{\mathrm{el}}} + \frac{\mathrm{Q_{el,ref}}}{\varepsilon_{\mathrm{el}}} \right)}$$

- Non-renewable primary energy savings ($\mathbf{f_{sav.PER\text{-}NRE}}$)

$$f_{sav.PER-NRE} = 1 - \frac{PER_{NRE.ref}}{PER_{NRE.SHC}}$$

Economic Key figures

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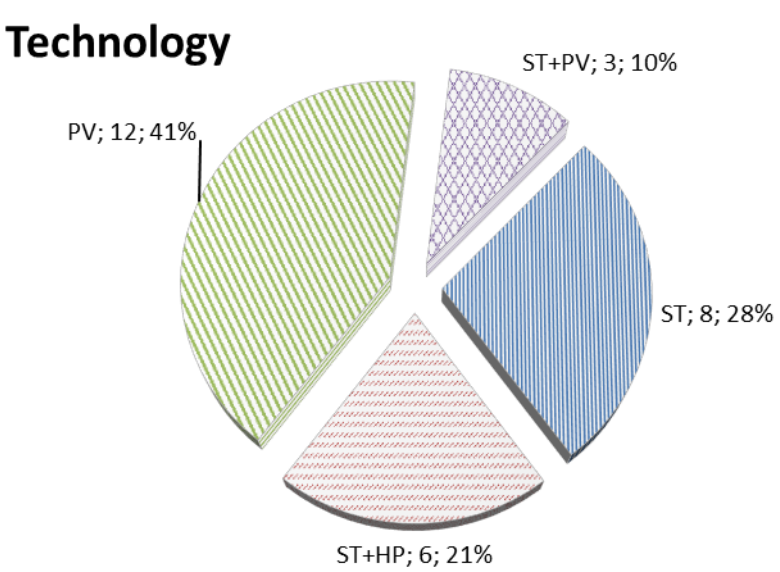
- Annuity method & input values based on EN-standards
- Standardized (data base) to calculate annualized costs
  - Investment, replacement & residual value
  - Maintenance & service,
  - Operational costs (energy, water)
  - Solar Heating and Cooling and Reference
  - → Levelized cost of energy

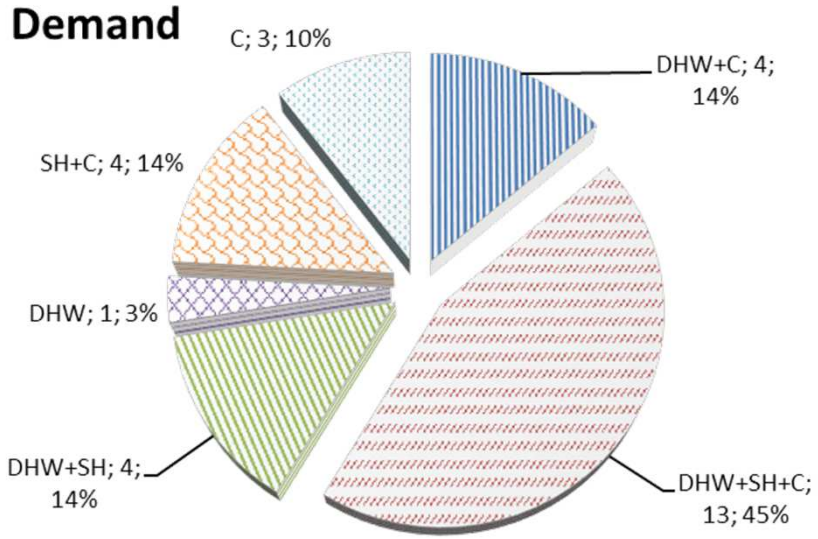
→CostRatio (CR)

$$\text{CostRatio(CR)} = \frac{annualized\ costs\ SHC}{annualized\ cost\ REF}$$

Overview Examples

- Assessment of 28 SHC plants with T53E4 Tool
  - 17 examples (28 configurations)
  - System & Subsystem Analysis
  - Trend analysis
  - Sensitivity analysis





Overview Examples

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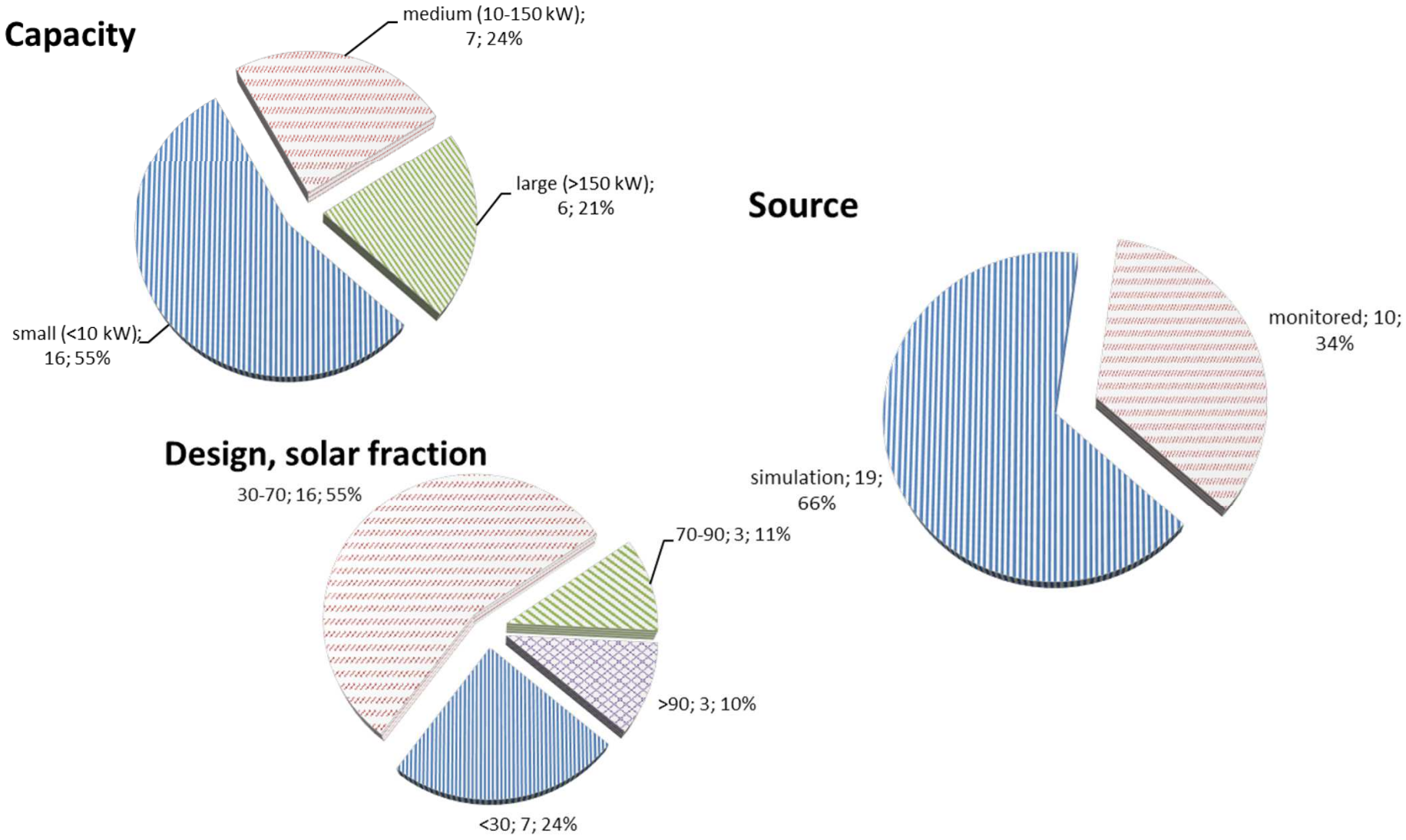
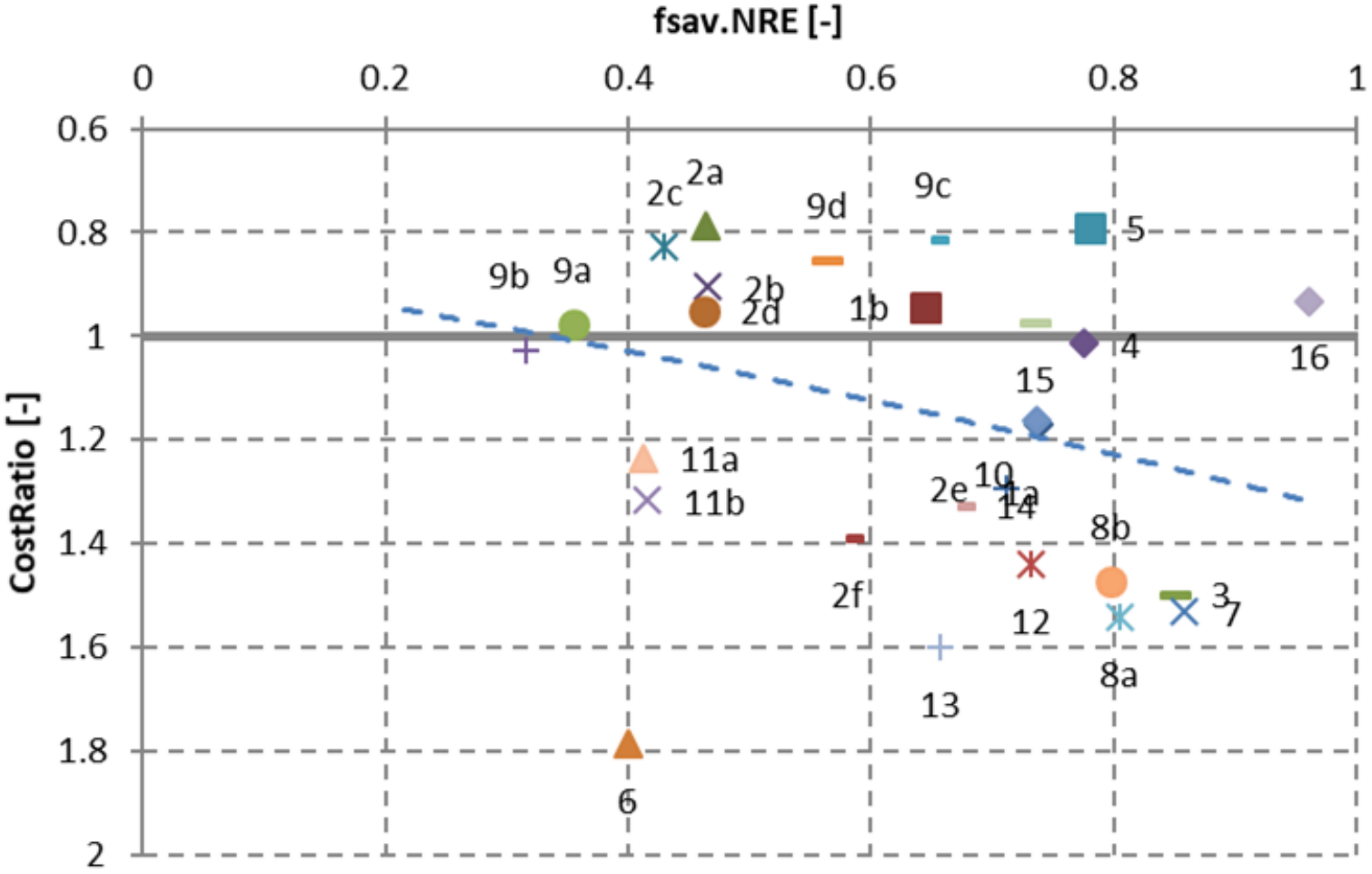


Results obtained

- Assessment of 28 SHC plants with T53E4 Tool
  - Technical analysis
    - Energy balance check
    - Comparison to T53 Standard
    - System & Subsystem Analysis
    - PER_{NRE}, $PER_{NRE.ref}$, $f_{sav.NRE}$, SPF_{equ}
  - Economic analysis
    - Investment, Replacement & Residual
    - Maintenance, Energy (electricity, natural gas,…)
    - Comparison to T53 Standard
    - Spec. Invest, $LCOE_{SHC}$, $LCOE_{REF}$, CR
- Trend analysis
- Sensitivity analysis

Summary Result

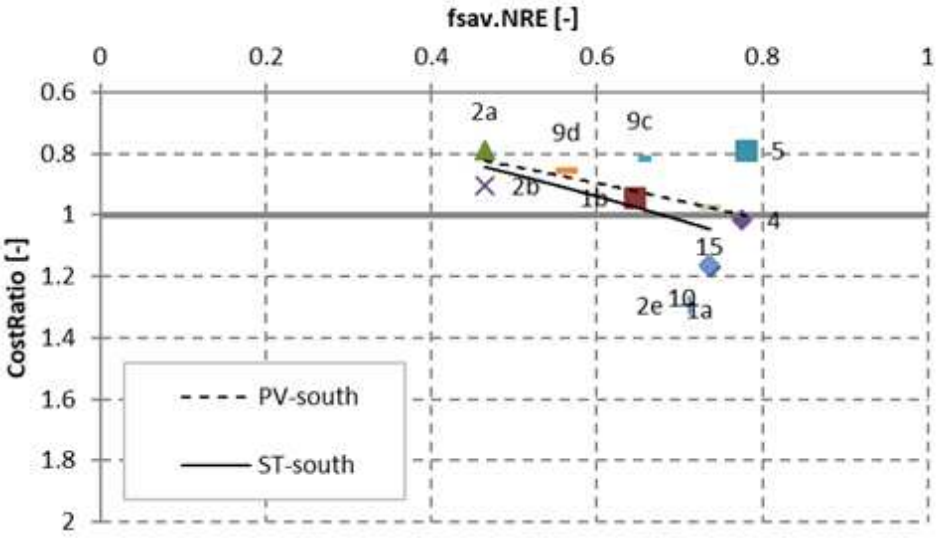
- Exclude plants with no annual energy balance

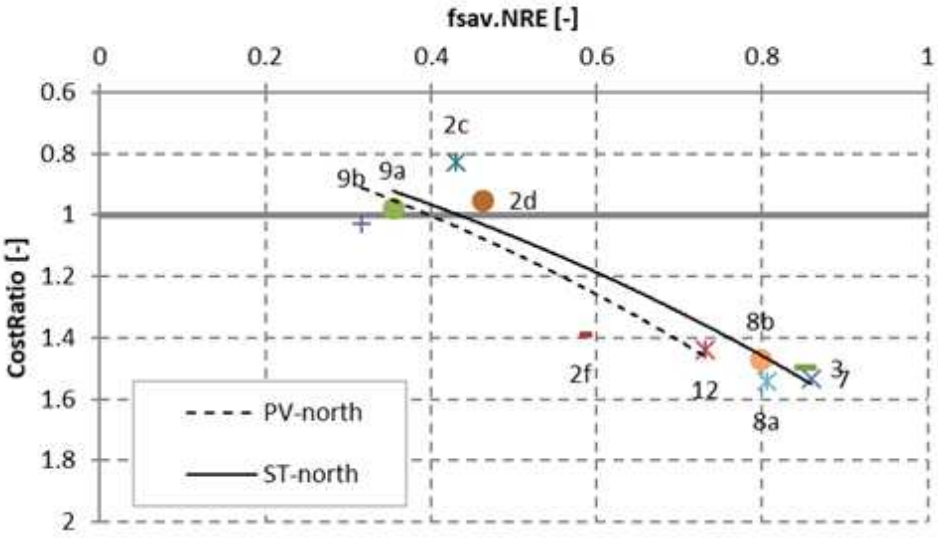


Trend analyses

- Many different configurations / boundaries
  - Size / demand / technology / data source / location…

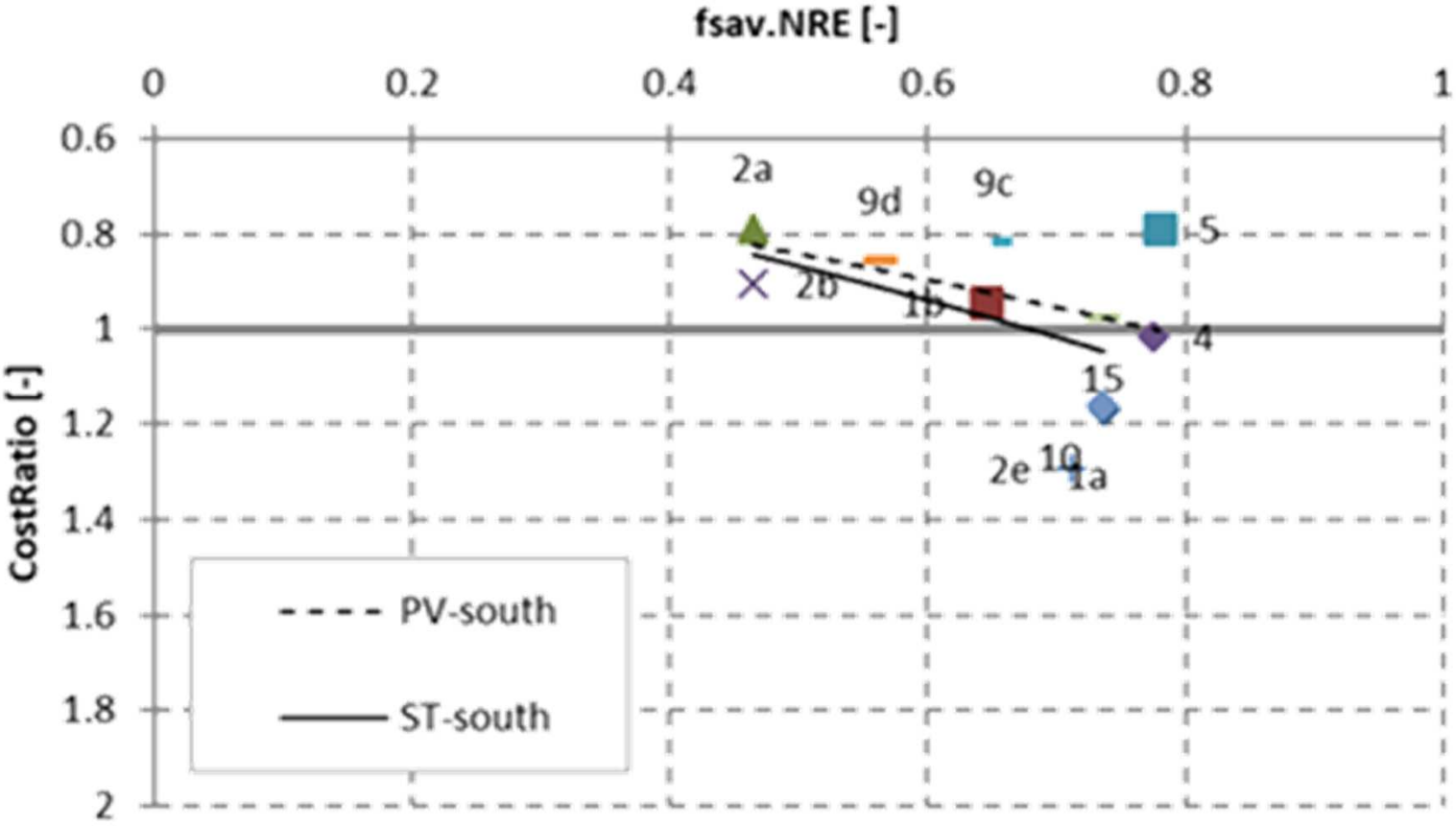
→ Clustering of results
  - south/northern location
  - PV and ST supported systems





Trend analyses

- Many different configurations / boundaries
  - Location & technology



Trend analyses

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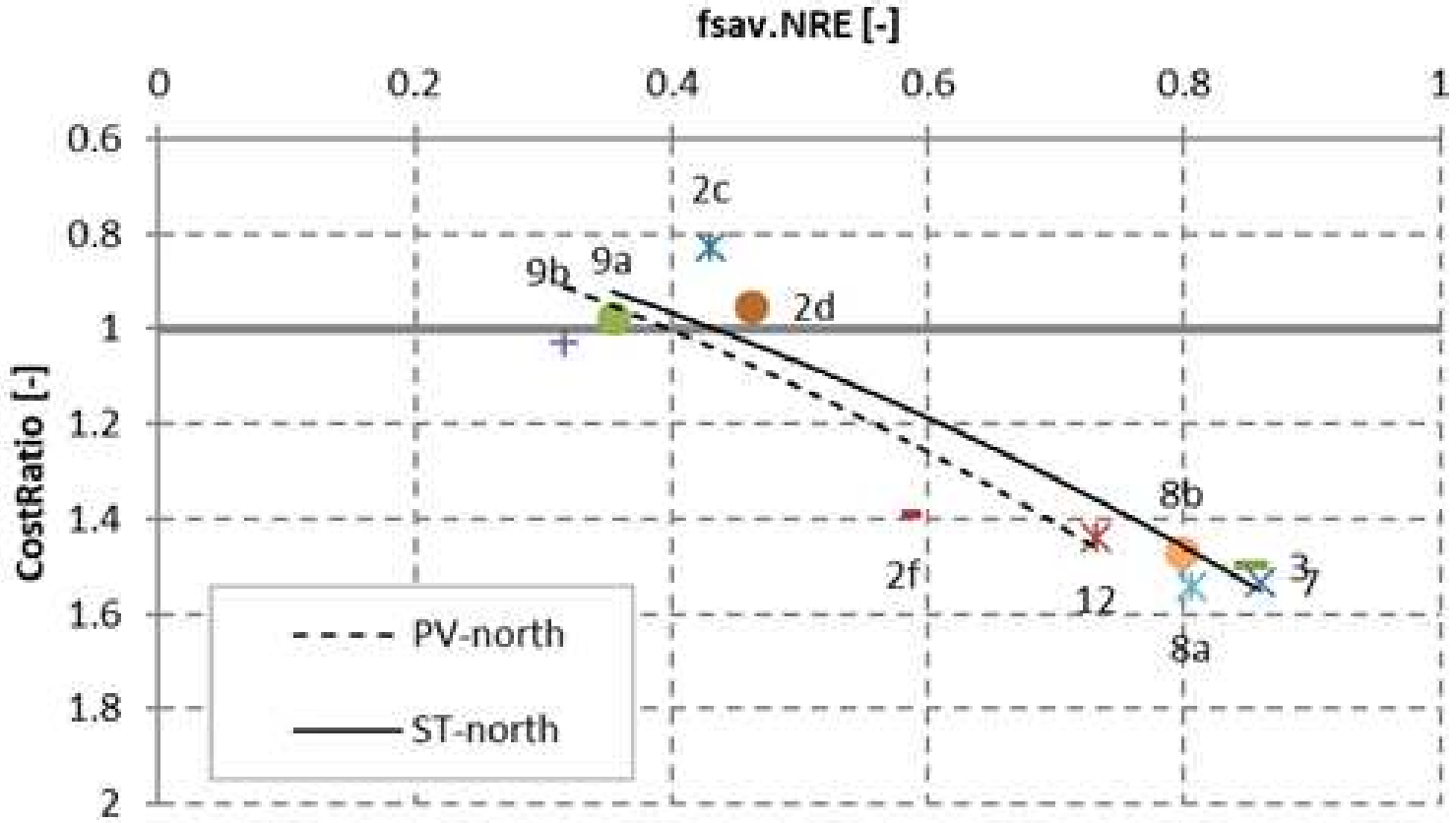
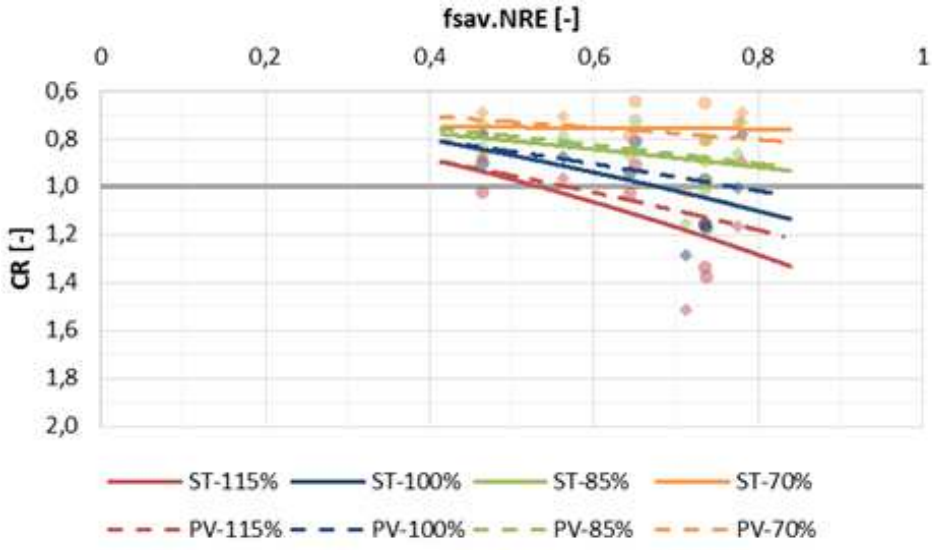
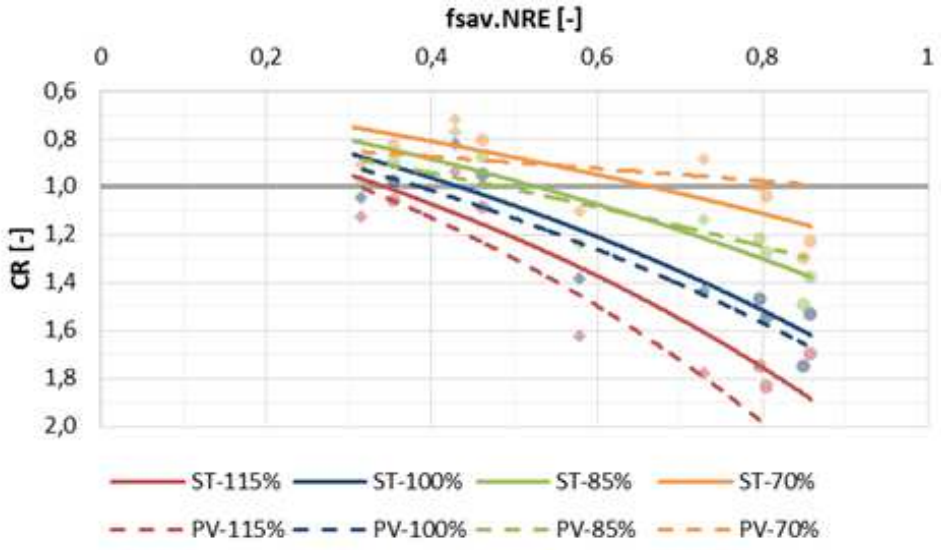


Sensitivity analyses

- Influence of chosen boundaries
  - Investment, Electricity, Natural Gas price
  - Auxiliary demand, Energy output,
  - Non-renewable primary energy conversion factors

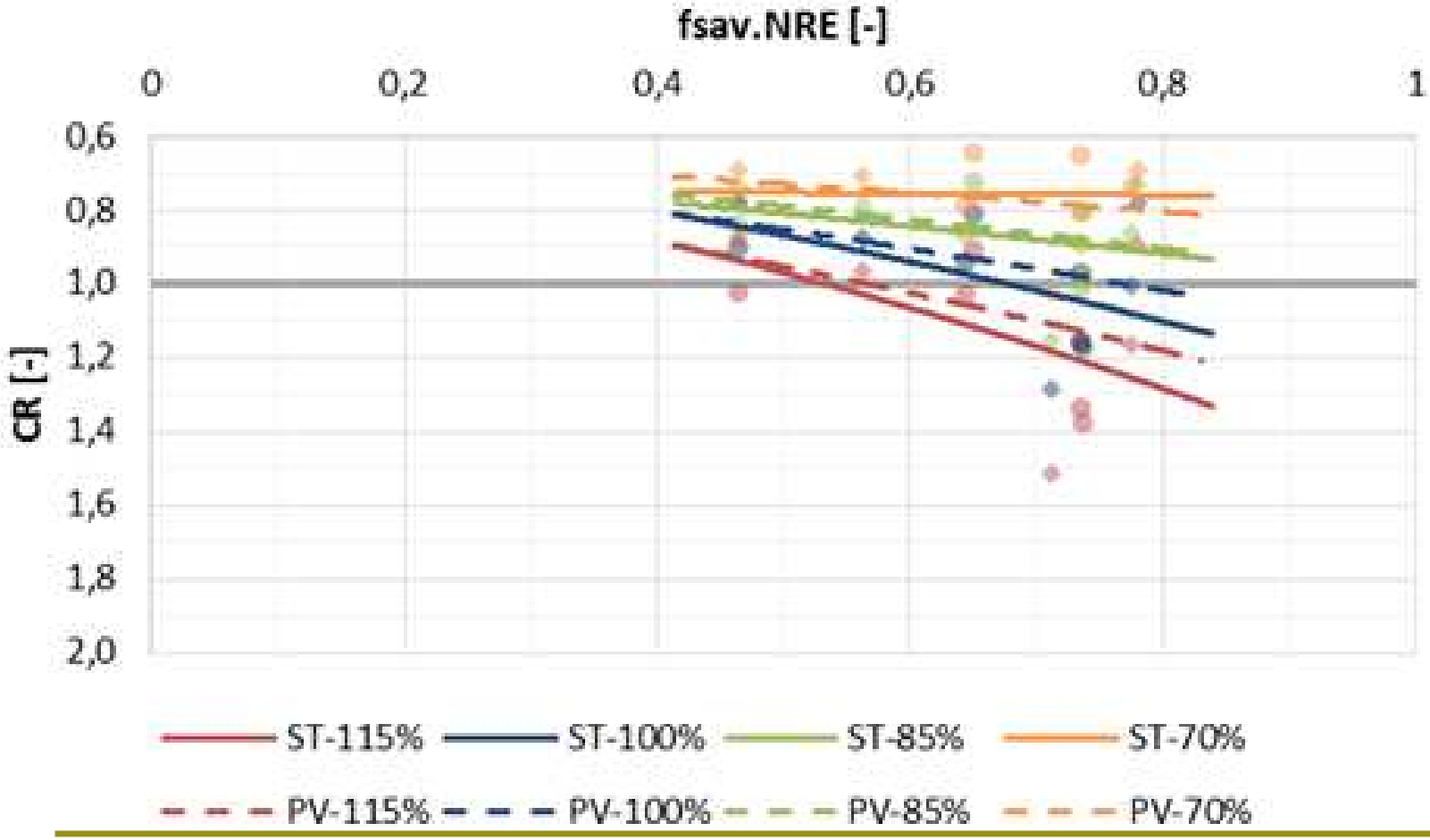
→ Influence shown on trends





Sensitivity analyses

- Influence of chosen boundaries
  - Investment cost



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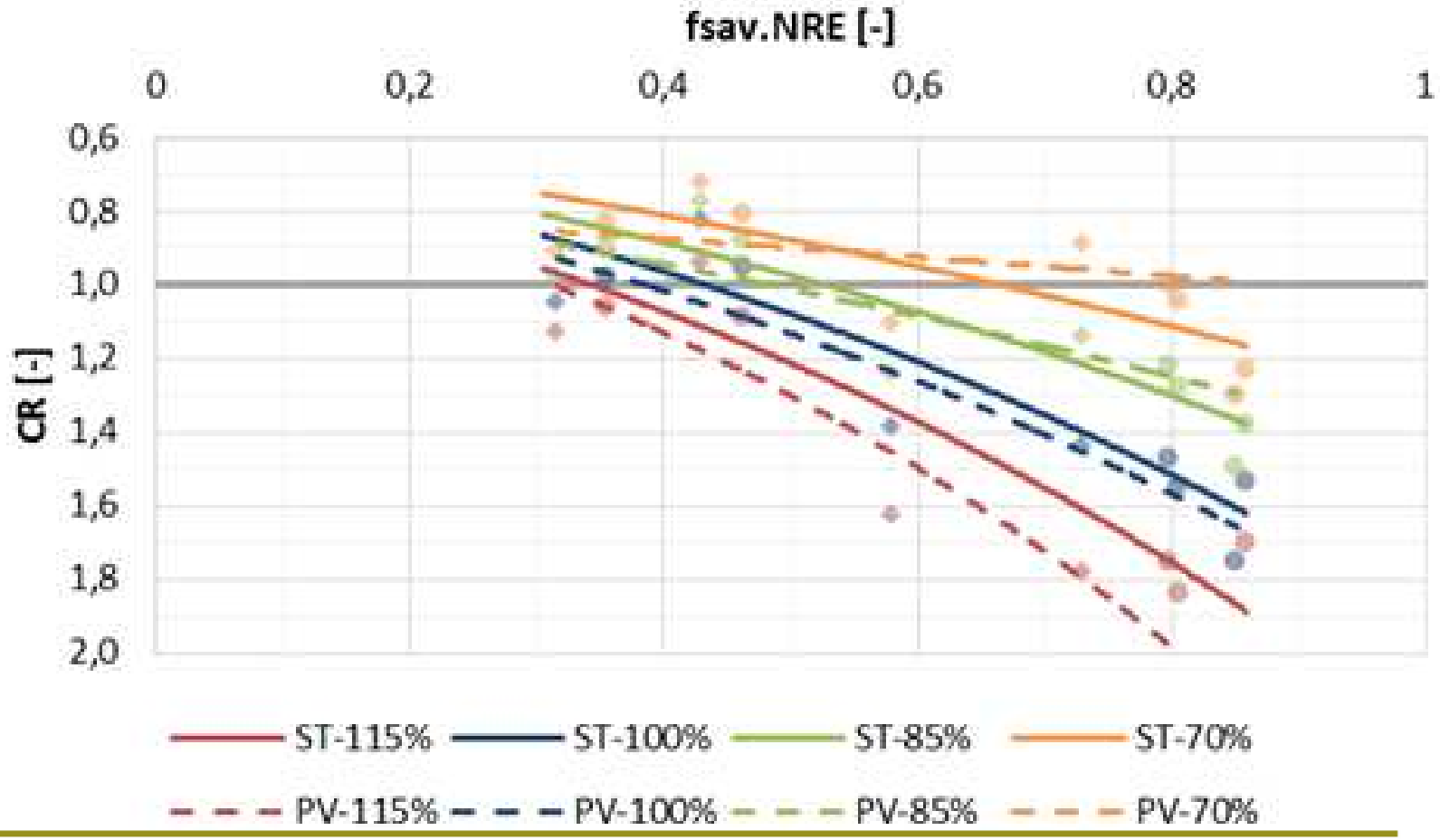

Summary

- T53E4 Assessment Tool
  - Simplified analysis of system / subsystem
  - Useful for benchmarking against reference and other RE
  - Focus on
    - non-renewable primary energy (fsav.NRE)
    - Cost Ratio

- Performance of SHC examples
  - Non-renewable Primary Energy Savings 40-80%
  - Higher savings lead to higher costs
  - Economics are mainly investment dominated
    - ➢ **Simplification and component reduction !!**

Summary

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- Sensitivity analysis
  - Effect of changes in boundaries
  - Trend wise comparison of results
  - Large differences for different systems

  →sensitivity for certain type of systems to follow soon
- Advantage of ST or PV is depending on …
  - Local conditions
  - System design & Application

→ Both technologies can be optimized

→ Cost competitiveness can be reached

Final reports of IEA SHC Task 53
to be expected soon
http://task53.iea-shc.org/

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Thank you for your attention!

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