IEA SHC Task 53 – Subtask C

Technical and economic assessment TOOL

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Solar Heating and Cooling can be complex
Rating systems for Solar Heating and Cooling

- Fair key figure … comparable with SEER?
- How to combine gas and electricity in one key figure?
- Benchmarks for and against
  - Solar cooling
  - Conventional system

→ Technical and economic evaluation Excel TOOL
Introduction

- Several Key Performance Indicators in TOOL
  - Efficiency on building & component level
  - Electricity / Primary Energy / CO2 Emissions

- Excel Tool for evaluation of systems
  - Technical assessment
  - Indicative economic analysis
Technical Assessment – Selected Key Figures

- **Equivalent Seasonal Performance Factor (SPFequ)**
  
  Primary energy flows expressed in electrical equivalent units used to compare with any (non-) renewable system.

  \[
  SPF_{equ} = \frac{\sum Q_{out}}{\sum Q_{el,in} + \sum \frac{\varepsilon_{el} \cdot Q_{th,in}}{\varepsilon_{in}}}
  \]

- **Fractional savings (fsav_PRE-NRE)**
  
  For non-renewable Primary Energy Compared with REF System

  T53 standard: natural Gas / air cooled VCC

  \[
  f_{sav.PER} = 1 - \frac{PER_{ref}}{PER_{SHC}}
  \]
Indicative Economic Analysis

- Method & input values based on VDI- and EN-standards
- Annualized costs for
  - Investment
  - Replacement & residual value
  - Maintenance & service
  - Operational costs (energy, water)

→ Levelized costs of energy
  (Cooling + Space Heating + Domestic Hot Water)

\[
\text{cost ratio} = \frac{\text{levelized costs } SHC}{\text{levelized cost } \text{REF}}
\]
Results from T48 vs. T53!
Results from T48 vs. T53!
More DETAILS

- @ Workshop...
Assessment Tool

Main Target:
→ system assessment & evaluation
→ Comparison of SHC & Reference Systems
→ Overall system & subsystem
→ Labelling / Benchmarking

- Standard & specific values
- Adaption from T48 to 53
Difference T48 – T53

- SOL = ST or PV or ST+PV
- More components and complex systems
  - Bivalent,
  - PV, CHP, revHP
  - ...
- More Reference systems are available
  - Efficiency (based on monthly average load)
  - District heating
  - Electrical
  - Oil
  - ...
Difference T48 – T53

- Additional Useful Energy
  - district heating (DH)
  - District cooling (DC)
  - Domestic electricity (DE)
- 10 sub systems evaluated
  - Overall system (DHW+SH+C+DH+DC+DE)
    - DHW / DHWsol
    - SH / SHsol
    - C / Csol
    - DH / DHsol
    - DC / DCsol
Difference T48 – T53

- Analysis / Assessment on monthly energy balance
  - Efficiency - $\eta$,
  - Primary energy factor - $\varepsilon$
  - ...on a monthly base!

- Economics for all components
  - Investment costs
  - Maintenance
  - Residual / replacement
  - Energy / water
  - Feed in Tariff for: Electricity (PV, CHP), District Heating/Cooling
Technical assessment – boundary
## Systems & components

- **Technical and economic data available for**

<table>
<thead>
<tr>
<th>components</th>
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</thead>
<tbody>
<tr>
<td><strong>Solar Thermal Collectors (SC)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Flat Plate Collector</td>
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<tr>
<td></td>
<td>• Evacuated Tube Collector</td>
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<tr>
<td><strong>Photovoltaic (PV)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Photovoltaic Panels</td>
</tr>
<tr>
<td></td>
<td>• BOS (balance of system)-components</td>
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<tr>
<td><strong>Heating (H1, H2)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Natural Gas Boiler</td>
</tr>
<tr>
<td></td>
<td>• Pellets Boiler</td>
</tr>
<tr>
<td></td>
<td>• Heat Pump (not reversible/reversible)</td>
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<tr>
<td></td>
<td>• Absorption Heat Pump (not reversible/reversible)</td>
</tr>
<tr>
<td></td>
<td>• Combined Heat&amp;Power Plant</td>
</tr>
<tr>
<td></td>
<td>• District Heating (as heat source)</td>
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<tr>
<td><strong>Cooling (C1, C2)</strong></td>
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</tr>
<tr>
<td></td>
<td>• Air-Cooled Vapour Compression Chiller</td>
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<tr>
<td></td>
<td>• Water-Cooled Vapour Compression Chiller</td>
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<tr>
<td></td>
<td>• Absorption Chiller (Single Effect &amp; Double Effect)</td>
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<tr>
<td></td>
<td>• Adsorption Chiller</td>
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<tr>
<td></td>
<td>• District Cooling (as cold source)</td>
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<tr>
<td><strong>Storage (HS, CS, BS)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Hot Storage</td>
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<tr>
<td></td>
<td>• Cold Storage</td>
</tr>
<tr>
<td></td>
<td>• Battery Storage</td>
</tr>
</tbody>
</table>
\[ \text{PER}_{\text{NREsys}} = \frac{Q_{CD,\text{System}} + Q_{DC,\text{System}} + Q_{HD,\text{System}} + Q_{WD,\text{System}} + Q_{DH,\text{System}} + Q_{el,DE}}{\varepsilon_{EC1} \cdot Q_{EC,H1} + \varepsilon_{EC2} \cdot Q_{EC,H2} + Q_{el,sys} \left( \frac{\%_{GD,\text{sys}}}{\varepsilon_{el}} + \frac{\%_{PV,el} \cdot TPV}{\varepsilon_{PV,el}} \right)} \]
SUB system – COOLING – \( \text{PER}_{\text{NRE,C}} \)

\[
\text{PER}_{\text{NRE,C}} = \frac{Q_{\text{CD, System}}}{\epsilon_{\text{EC1}}} + \frac{Q_{\text{EC,H1}} * \%_{\text{H1,C}}}{\epsilon_{\text{EC1}}} + \frac{Q_{\text{EC,H2}} * \%_{\text{H2,C}}}{\epsilon_{\text{EC2}}} + Q_{\text{el,C}} * \left( \frac{%_{\text{GD,C}}}{\epsilon_{\text{el}}} + \frac{%_{\text{PV,C}} * TP_{\text{PV}}}{\epsilon_{\text{PV,el}}} \right)
\]
SUB system - SOLAR COOLING – \( \text{PER}_{\text{NRE,Csol}} \)

\[
\text{PER}_{\text{NRE,Csol}} = \frac{Q_{CD,\text{sol}}}{Q_{el,\text{Csol}} \times \left( \frac{\%_{GD,C}}{\epsilon_{el}} + \frac{\%_{PV,C} \times TPV}{\epsilon_{PV,el}} \right)}
\]
KPIs – don’t mix them up…

Comparing thermal and electrical driven System…

- PV + VCC \[\Rightarrow SPF_{el.C} = SPF_{equ.C_{sol}} > SPF_{equ.C}\]
- ST&ACM + VCC \[\Rightarrow SPF_{el.thC} > SPF_{el.C}\]
  \[SPF_{el.thC} = SPF_{equ.C_{sol}} \neq SPF_{equ.C}\]
- ST&ACM + HB \[\Rightarrow SPF_{el.thC} \neq SPF_{equ.C}\]
- ...a lot more in documentation....
Example - Feistritzwerke

- 65m² ST, 19kWc, 300kW DH
- ...

→ excel TOOL
Discussion

- Examples
- Reference
- Costs
- To be included as default: Spain? ??

...???
ToDoS

- Paper – Eurosun!?  
  - Abstract  24/04/2016  
  - Paper  09/2016

- Tool  05/16  
  - Sub system calculations  
  - Check different systems  
  - Update: how to use ppt…

- Documentation  06-07/16  
  - To be updated…  
  - Examples could be included?
Thank you for your attention!

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