IEA SHC Task 53 – Subtask C
Technical and economic assessment TOOL

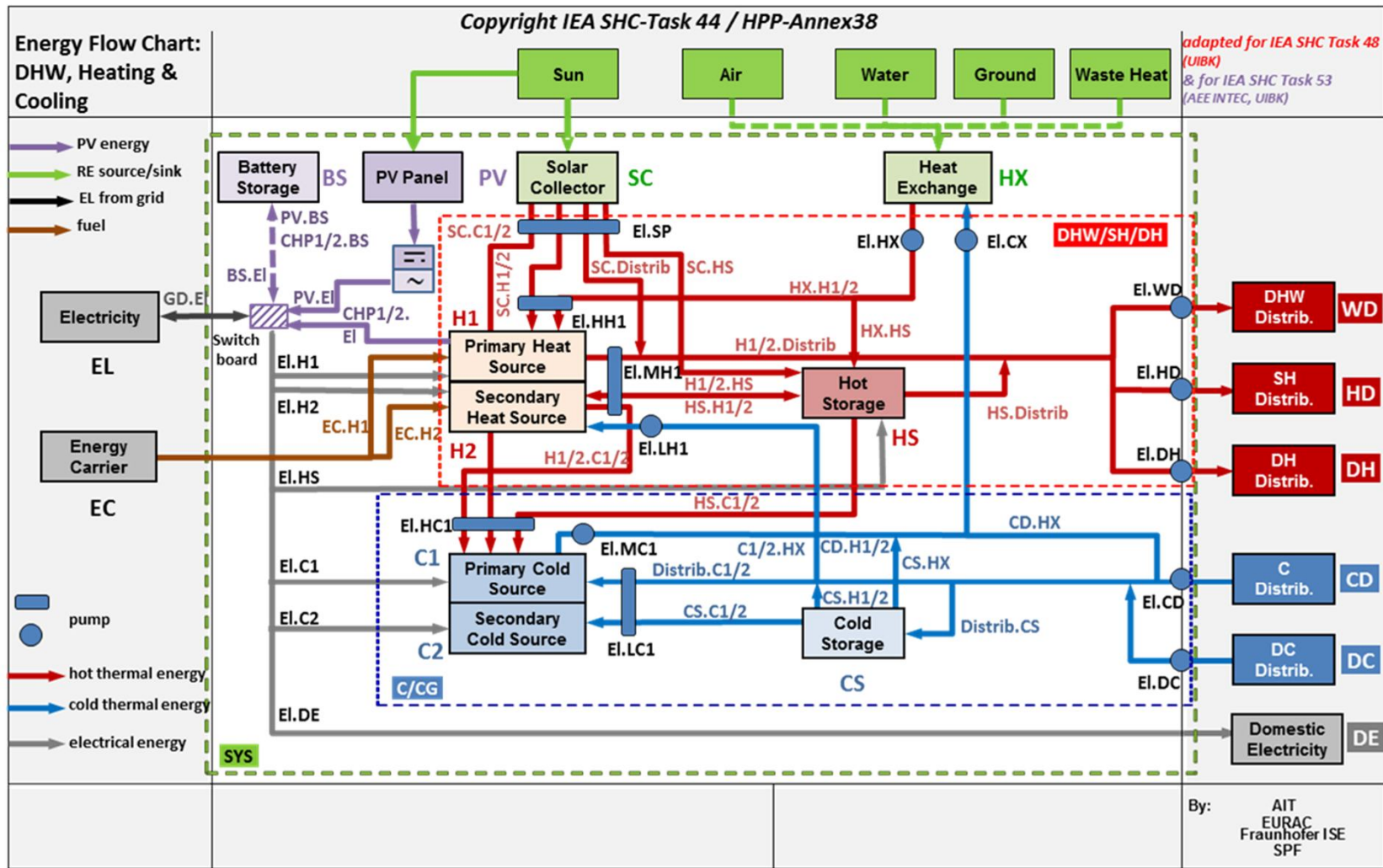**Daniel Neyer, Alexander Thür**
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Solar Heating and Cooling can be complex

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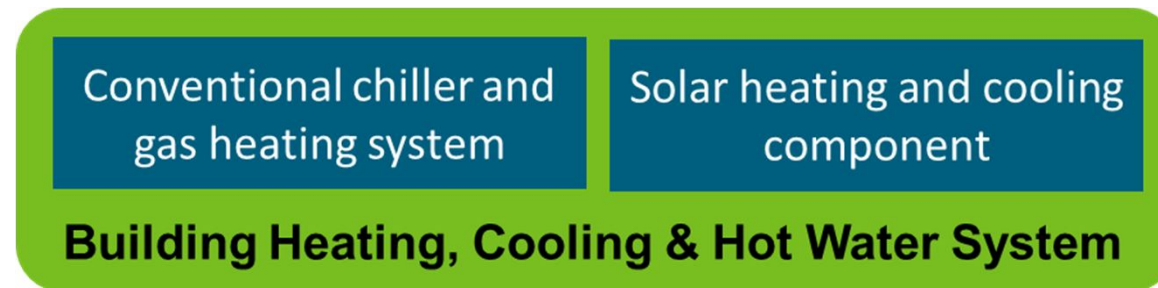
- Fair key figure … comparable with SEER?
- How to combine gas and electricity in one key figure?
- Benchmarks for and against
  - Solar cooling
  - Conventional system

→ Technical and economic evaluation Excel TOOL

Introduction

- Several Key Performance Indicators in TOOL
    → Efficiency on building & component level
    → Electricity / Primary Energy / CO_2 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

$$SPF_{equ} = \frac{\sum Q_{out}}{\sum Q_{el,in} + \sum \frac{\varepsilon_{el} * Q_{th,in}}{\varepsilon_{in}}}$$

■ 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
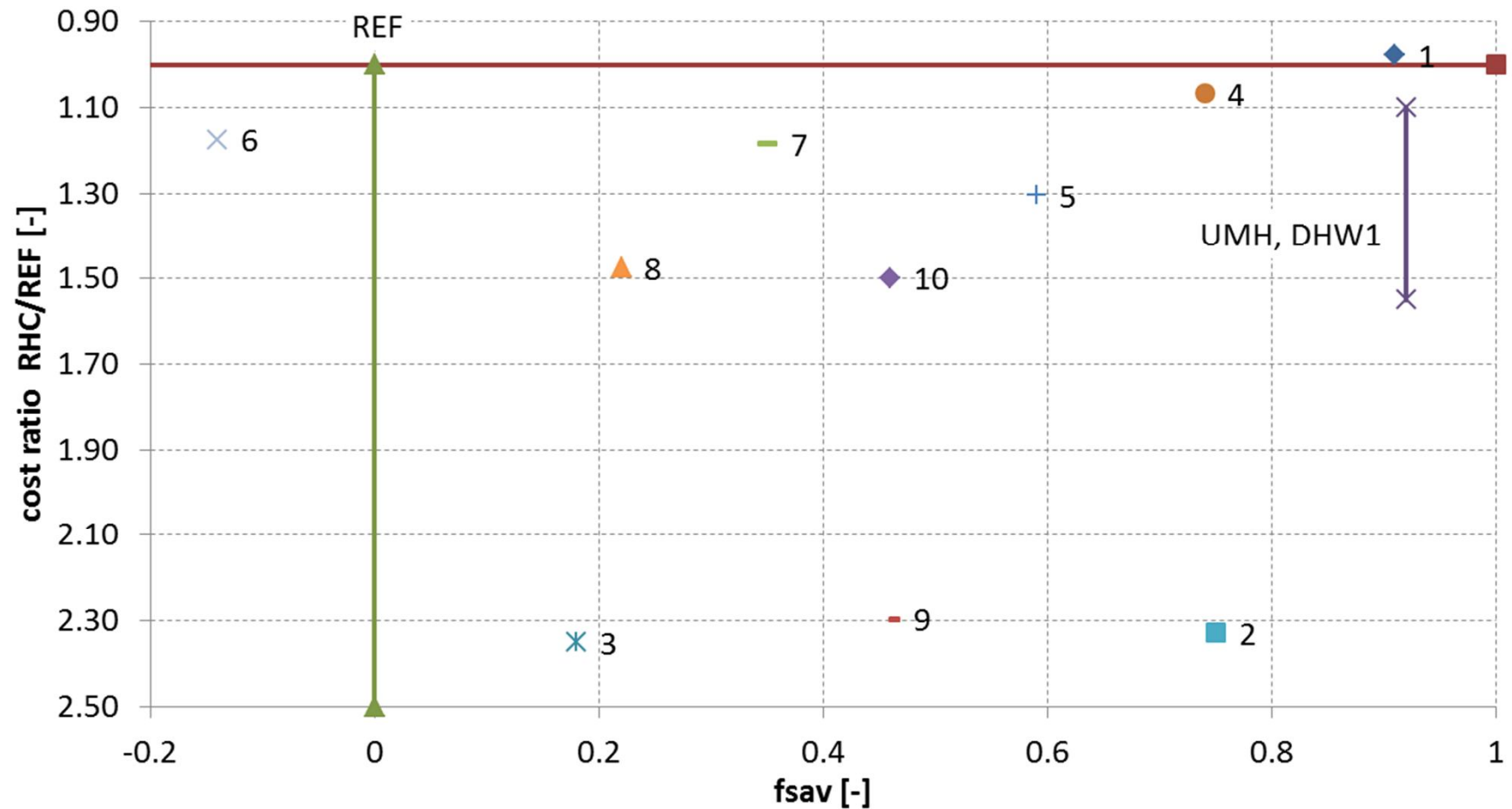 - Operational costs (energy, water)

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

$$\text{cost ratio} = \frac{levelized\ costs\ SHC}{levelized\ cost\ REF}$$

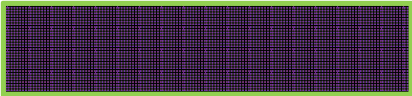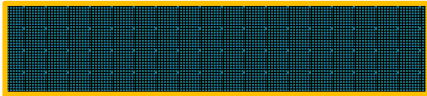# Results from T48 vs. T53!
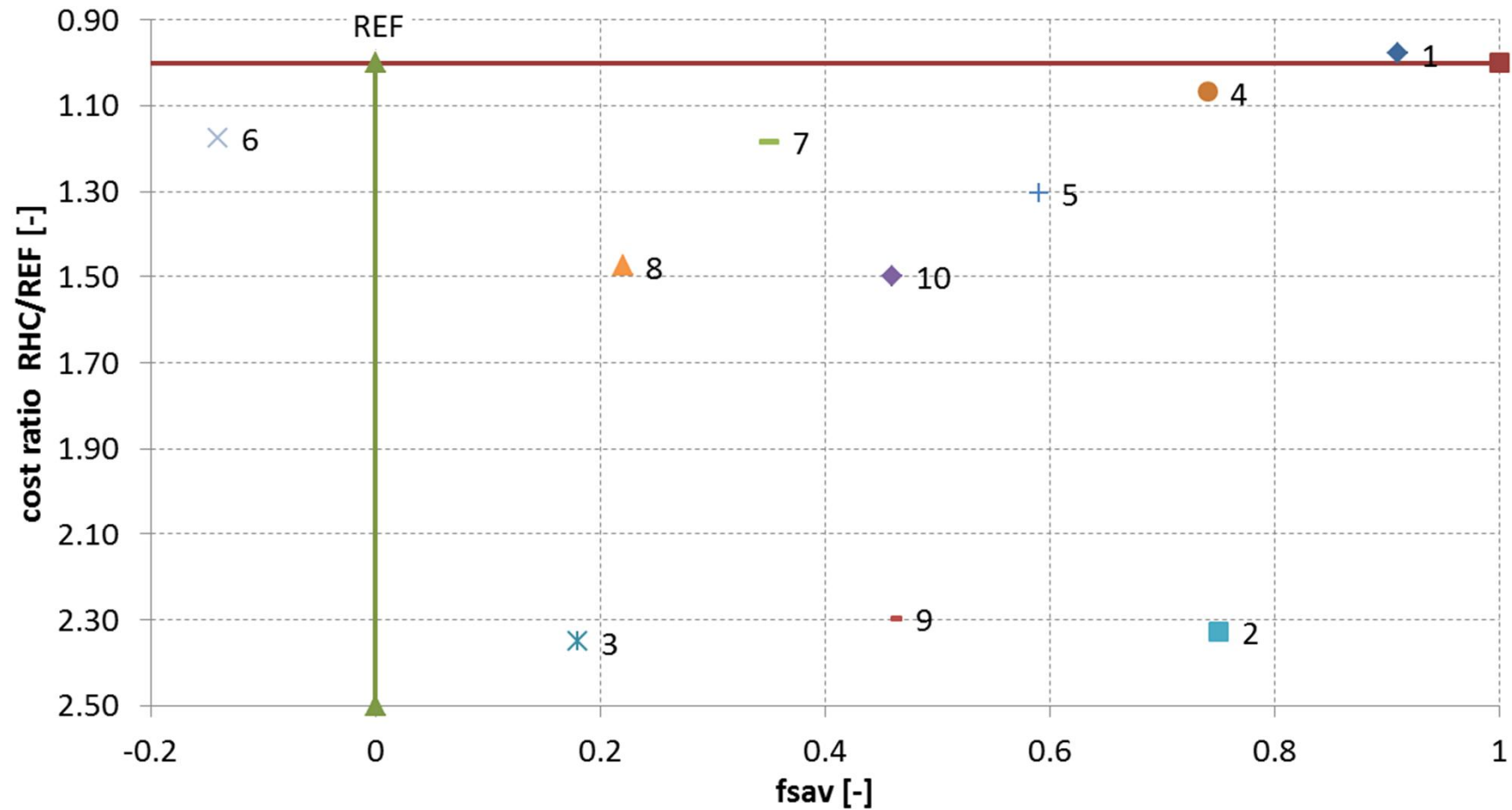
Results from T48 vs. T53!

More DETAILS

- @ Workshop...

Assessment Tool

Main Target:

→ system assessment & evaluation

→ Comparison of SHC & Reference Systems

→ Overall system & subsystem

→ Labelling / Benchmarking

- &

- 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
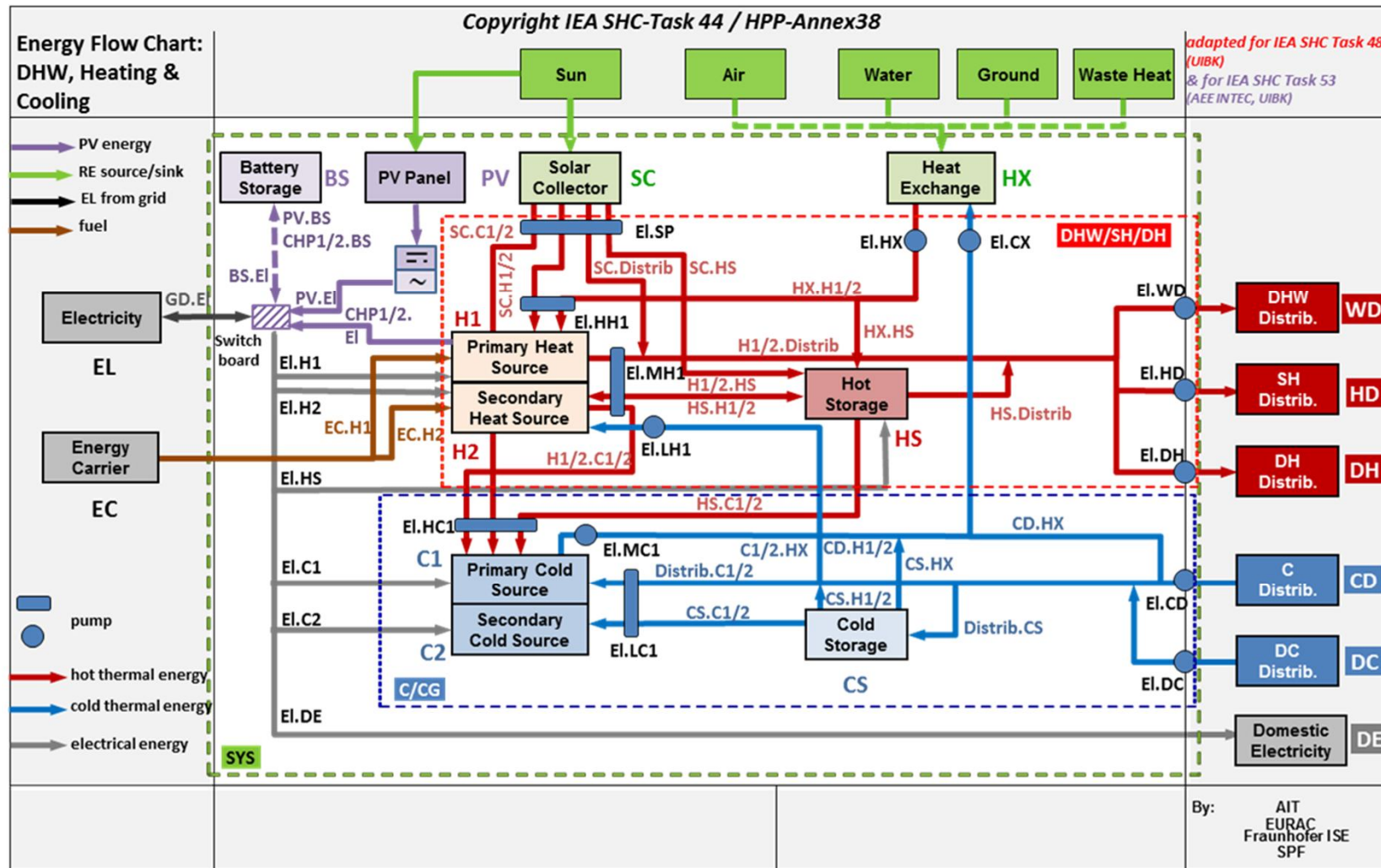 - Electrical
  - Oil
  - …

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 - η,
  - Primary energy factor - ε
  - …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
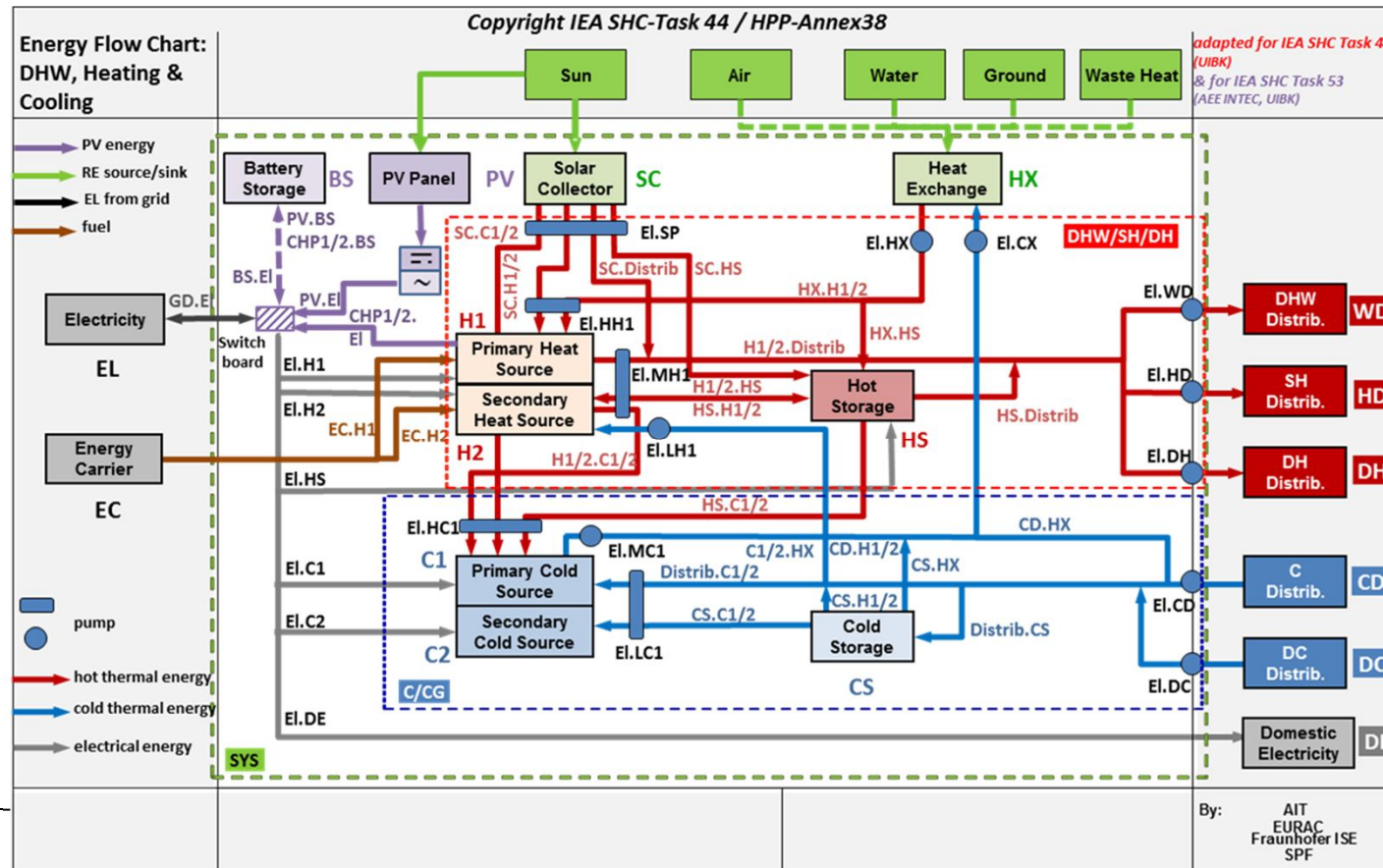
Technical assessment – boundary

Systems & components

- Technical and economic data available for

	components
Solar Thermal Collectors (SC)	• Flat Plate Collector • Evacuated Tube Collector
Photovoltaic (PV)	• Photovoltaic Panels • BOS (balance of system)-components
Heating (H1, H2)	• Natural Gas Boiler • Pellets Boiler • Heat Pump (not reversible/reversible) • Absorption Heat Pump (not reversible/reversible) • Combined Heat&Power Plant • District Heating (as heat source)
Cooling (C1, C2)	• Air-Cooled Vapour Compression Chiller • Water-Cooled Vapour Compression Chiller • Absorption Chiller (Single Effect & Double Effect) • Adsorption Chiller • District Cooling (as cold source)
Storage (HS, CS, BS)	• Hot Storage • Cold Storage

SYSTEM - PER_{NREsys}

$$PER_{NRE,sys} = \frac{Q_{CD.System} + Q_{DC.System} + Q_{HD.System} + Q_{WD.System} + Q_{DH.System} + Q_{el.DE}}{\dfrac{Q_{EC.H1}}{\varepsilon_{EC1}} + \dfrac{Q_{EC.H2}}{\varepsilon_{EC2}} + Q_{el.sys}\left(\dfrac{\%_{GD.sys}}{\varepsilon_{el}} + \dfrac{\%_{PV.el} * TPV}{\varepsilon_{PV.el}}\right)}$$

Energy Flow Chart: DHW, Heating & Cooling — Copyright IEA SHC-Task 44 / HPP-Annex38 — adapted for IEA SHC Task 48 (UIBK) & for IEA SHC Task 53 (AEE INTEC, UIBK). By: AIT, EURAC, Fraunhofer ISE, SPF

SUB system – COOLING – PER$_{NRE,C}$
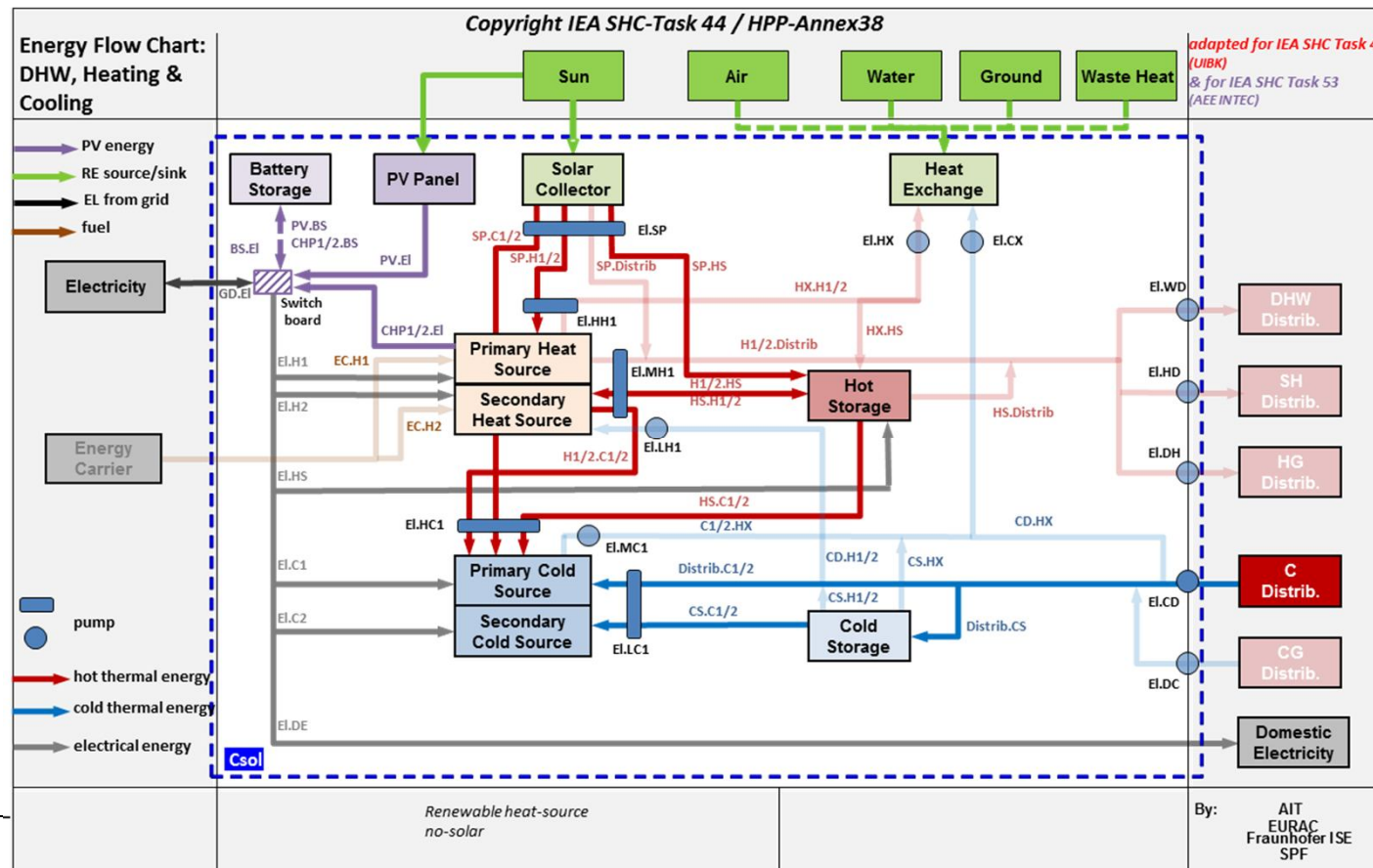
$$PER_{NRE,C} = \frac{Q_{CD.System}}{\dfrac{Q_{EC.H1} * \%_{H1.C}}{\varepsilon_{EC1}} + \dfrac{Q_{EC.H2} * \%_{H2.C}}{\varepsilon_{EC2}} + Q_{el.C} * \left(\dfrac{\%_{GD.C}}{\varepsilon_{el}} + \dfrac{\%_{PV.C} * TPV}{\varepsilon_{PV.el}}\right)}$$

Energy Flow Chart: DHW, Heating & Cooling — Copyright IEA SHC-Task 44 / HPP-Annex38, adapted for IEA SHC Task 48 (UIBK) & for IEA SHC Task 53 (AEE INTEC)
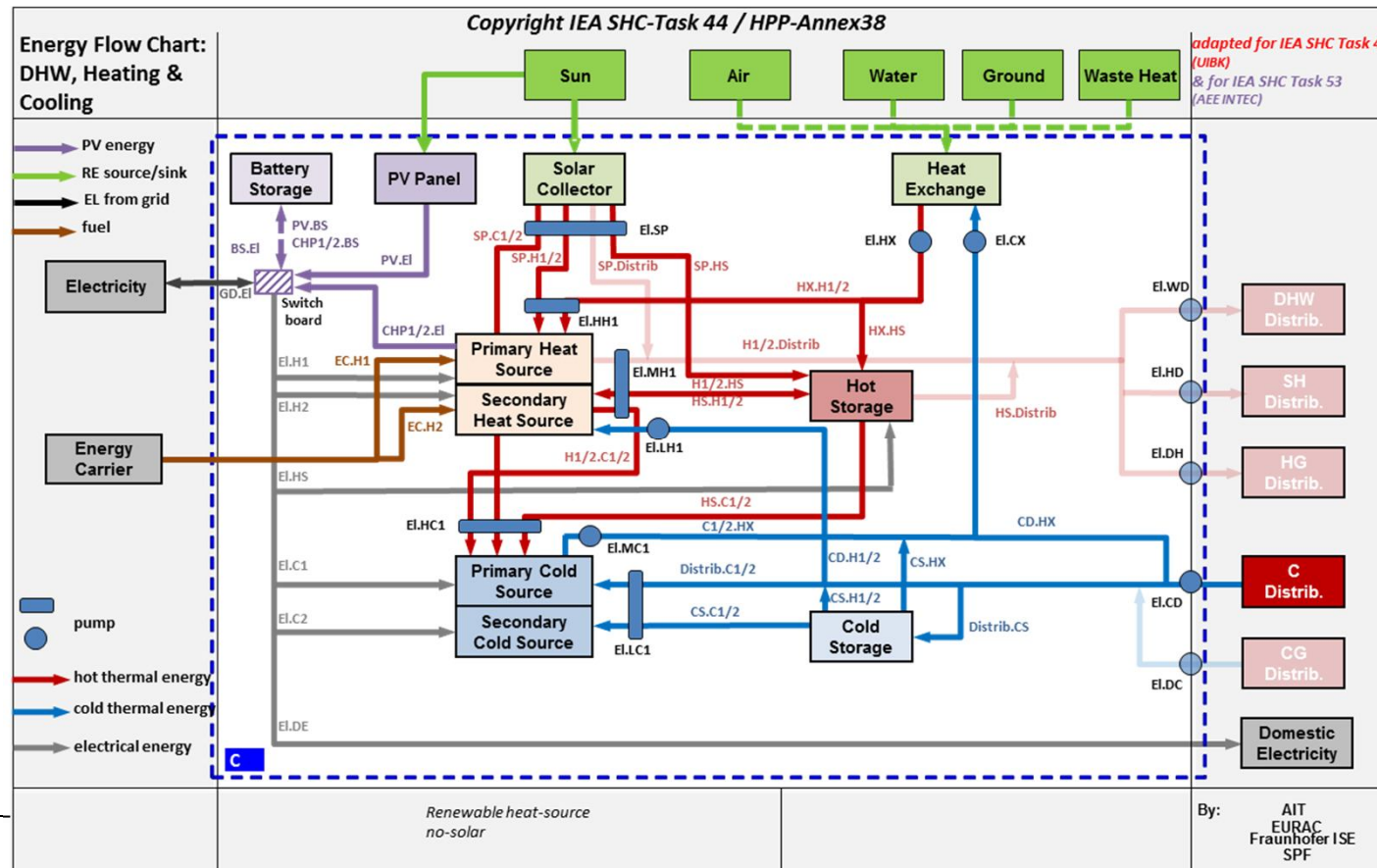
SUB system - SOLAR COOLING – PER$_{NRE,Csol}$

$$PER_{NRE,Csol} = \frac{Q_{CD.sol}}{Q_{el.Csol} * \left(\frac{\%_{GD.C}}{\varepsilon_{el}} + \frac{\%_{PV.C} * TPV}{\varepsilon_{PV.el}}\right)}$$

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Energy Flow Chart: DHW, Heating & Cooling

adapted for IEA SHC Task 48 (UIBK) & for IEA SHC Task 53 (AEE INTEC)

KPIs – don't mix them up…

Comparing thermal and electrical driven System…

- PV + VCC $\rightarrow$ $SPF_{el.C} = SPF_{equ.Csol} > SPF_{equ.C}$

- ST&ACM + VCC $\rightarrow$ $SPF_{el.thC} > SPF_{el.C}$
$$SPF_{el.thC} = SPF_{equ.Csol} \neq SPF_{equ.C}$$

- 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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