



Adapted Monitoring procedure for New Generation Solar Cooling & Heating Systems IEA SHC Task 53 – Subtask C1

Bettina Nocke,
AEE – Institut für Nachhaltige Technologien
A-8200 Gleisdorf, Feldgasse 19

Daniel Neyer, Katharina Stadler, Alexander Thür
Universität Innsbruck,
Institut für Konstruktion und Materialwissenschaften, A - Innsbruck

Karl A. Berger
Austrian Institute of Technology GmbH, A – Wien



Task 48 Subtask B7 EURAC, UIBK..... "Collection of criteria to quantify the quality and cost competitiveness for solar cooling systems"

In T 48 B7, a proposal for an appropriate evaluation procedure for the technical and economic performance assessment of SHC systems is set up

based on the source-sink-approach as in Task 44

Detailed conversion factors for different countries were defined

Source		Sink													
		Electricity	Energy Carrier	Sun	Waste Heat	Solar Collectors	Ground Probes	Primary Storage	Rejection Storage	Cold Backups	HP	Hot Backups	Secondary Storage	Heat Distribution	
		EI	EC	Su	He	SC	GP	PS	RS	CB	HP	HB	SS	HD	
Electricity	EI									x	x	x			
Energy Carrier	EC											x			
Sun	Su					x									
Waste Heat	He														
Solar Collectors	SC														
Ground Probes	GP														
Waste Heat Exchanger	HH														
Primary Storage	PS														
Rejection Storage	RS														
Cold Backups	CB														
HP	HP														
Hot Backups	HB														
Secondary Storage	SS														
Heat Distribution	HD														
		efficiency of the boiler - η_{HB}													
		country	no hot backup			natural gas			pellets			specific HB			
		Austria	0,01			0,875			0,814			0,85			
		Australia	0,01			0,66			0,85			0,85			
		France	0,01			0,91			0,78			0,85			
		Germany	0,01			0,96			0,85			0,85			
		Italy	0,01			0,9			0,85			0,85			
		P.R.China	0,01			0,95			0,9			0,85			
		x1	0,01			0,95			0,9			0,85			
		x2	0,01			0,9			0,85			0,85			
		T48 Standard	0,01			0,9			0,85			0,85			



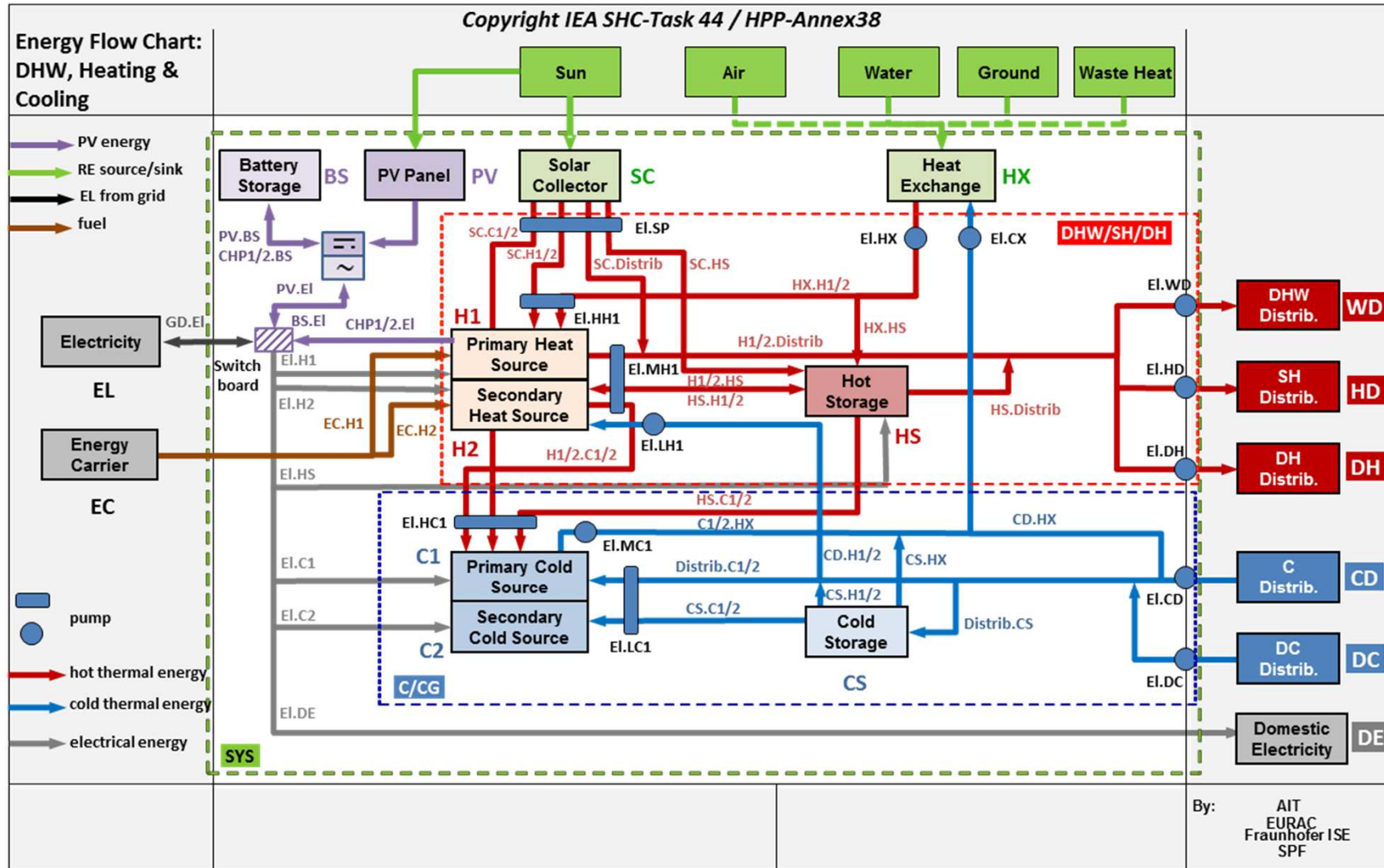
Task 48 Subtask B7 EURAC, UIBK

“Collection of criteria to quantify the quality and cost competitiveness for solar cooling systems”

- To show the level of quality of the solar cooling and heating systems
- to extend the quality characteristics from a component level to a system level
- tested with real cases

- ❖ Key Performance Figures
- ❖ Indicative Economic Analysis

Task 53 Subtask C1: Extended Monitoring procedure for NG SHC Systems



Task 53 Subtask C1: Adapted Monitoring procedure - Components available

Solar Thermal Collectors (SC)	<ul style="list-style-type: none"> • Flat Plate Collector • Evacuated Tube Collector
Photovoltaic (PV)	<ul style="list-style-type: none"> • Photovoltaic Panels • BOS (balance of system)-components
Heating (H1, H2)	<ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> • Hot Storage • Cold Storage • Battery Storage
Heat Rejection (HX)	<ul style="list-style-type: none"> • wet cooling tower • dry cooling tower • hybrid cooling tower

each component includes a technical and economical assessment and evaluation base



Task 53 Subtask C1: Adapted Monitoring procedure – what else is new?

- PV systems and electricity produced by CHP
- Heating utilities – heat distribution (HD), domestic hot water (WD) and district heating (DH)
- Cooling utilities - cold distribution (CD), district cooling (DC)
- domestic electricity (DE)
- conversion factors for Primary Energy and CO₂-equivalent for different countries (just in Task 48)
- updated efficiency factors for reference boilers and vapour compression chillers (in collaboration with related manufacturers).
- monthly variable factors are now available

Task 53 Subtask C1: Calculation of Key Performance Indicators

$$\%_{SC} = \frac{Q_{SC, System}}{Q_{SC} + Q_{EC, H1} + Q_{EC, H2} + Q_{EC, C1} + Q_{EC, C2}}$$

$$\%_{PV} = \frac{PV.EL}{PV.EL + GD.EL}$$

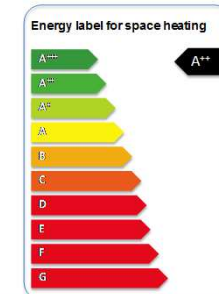
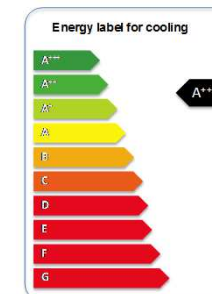
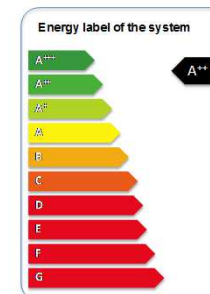
$$PER_{NRE, system} = \frac{Q_{final, system}}{Q_{PE, NRE}}$$

$$PER_{NRE, ref, sys} = \frac{Q_{final, system}}{\frac{Q_{(HD+WD+DH), system} + Q_{loss, ref}}{\epsilon_{EC, ref} * \eta_{HB, ref}} + \frac{Q_{(CD+DC), System}}{SPFC, ref * \epsilon_{el}} + \frac{Q_{el, ref}}{\epsilon_{el}}}$$

$$f_{sav, NRE, PER, sys} = 1 - \frac{PER_{NRE, ref, sys}}{PER_{NRE, sys}}$$

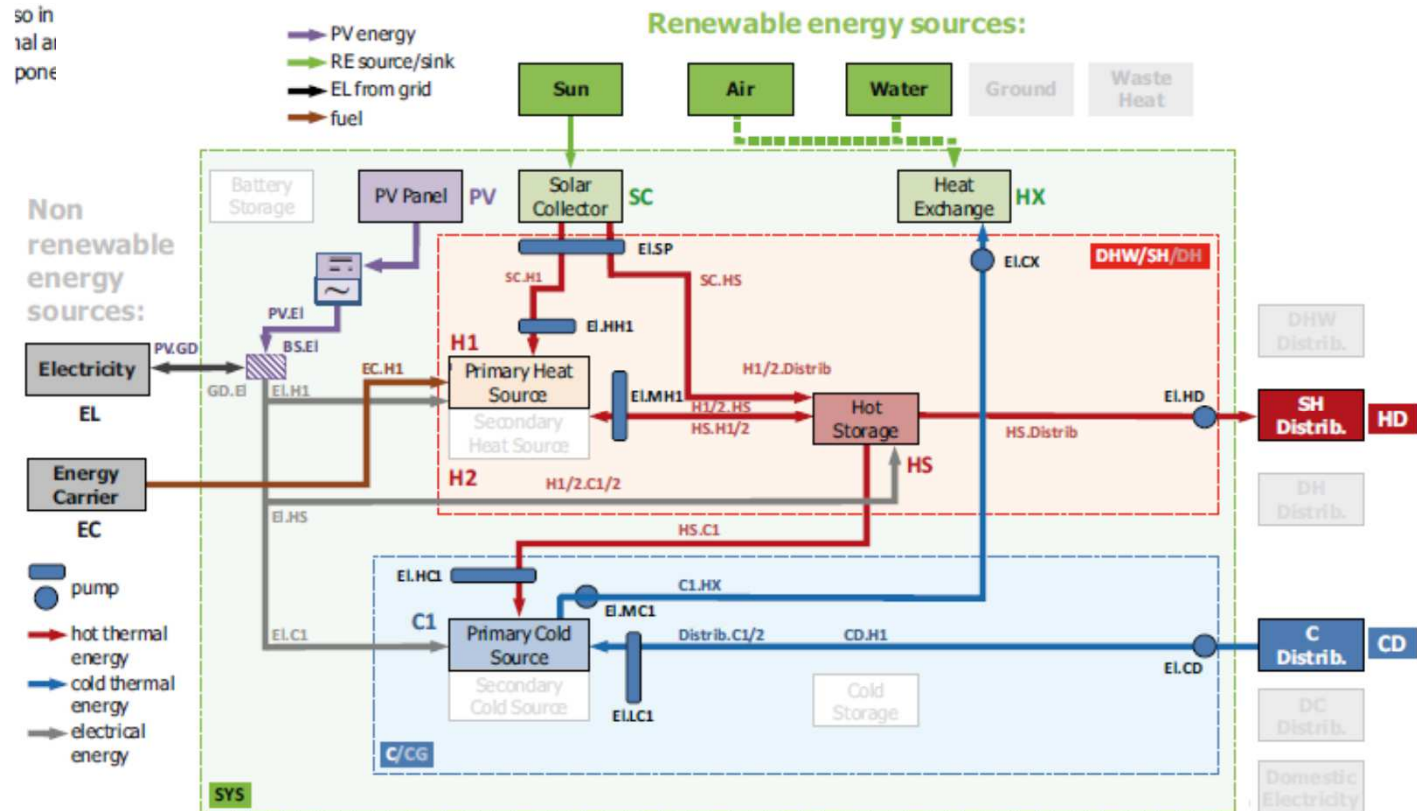
$$SPF_{equ, sys} = \frac{PER_{NRE, sys}}{\epsilon_{el}}$$

Energy Labelling



Task 53 Subtask C1: Adapted Monitoring - First example

Office building in Austria (Gleisdorf)



Solar Thermal Collectors (SC)	65 m ² Flat Plate Collector
Photovoltaic (PV)	35 m ²
Heating (H1)	Local heat (wood chip boiler)
Cooling (C1)	Absorption Chiller
Storage (HS)	Hot Storage
Heat Rejection	wet cooling tower

Calc Task 53	
PER _{NRE}	9,66
PER _{NRE,ref}	0,82
fsav _{NRE,PER}	92%
SPF _{equ}	16,35

Task 53 Subtask C1: Adapted Monitoring - currently status

- The presented work is still in ongoing process !!!! (V1.4)
- Cost Key Figurs (€/kWh) are going to be implemented in the tool and if required, other aspects emerging during the course of Task 53.
- Further PV-related issues will be included, such as
 - ❖ Yield ($\text{kWh}_{\text{el}} / \text{kW}_{\text{p}}$)
 - ❖ Performance Ratio (%)
 - ❖ benefits from self-consumption of solar produced electricity
- The interaction with the electricity grid, that means one of the advantages of "NG SHC", depends strongly on the boundary conditions in the energy policy environment which is in a transformation phase.
- The developed schematics can be used to evaluate the influence of different policy measures on the operation and performance of NG SHC systems.