SPF activities in the field of Solar Cooling

IEA SHC Task Definition Meeting
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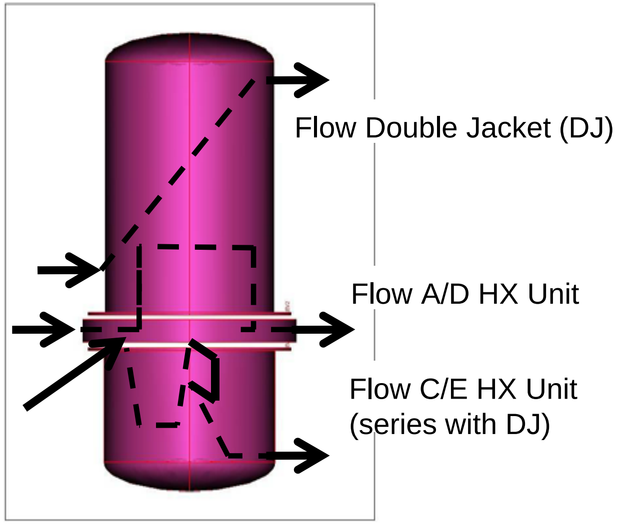
HSR
HOCHSCHULE FÜR TECHNIK
RAPPERSWIL
FHO Fachhochschule Ostschweiz

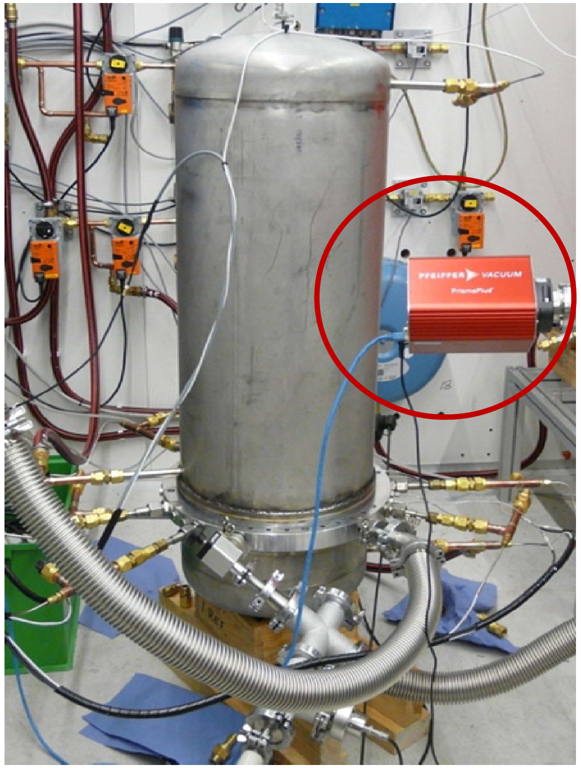
SPF
INSTITUT FÜR
SOLARTECHNIK


• SPF Institute for Solar Technology
• University of Applied Sciences Rapperswil
• approx. 40 scientists and engineers
• 30% in Department Testing
• 70% in Department Research

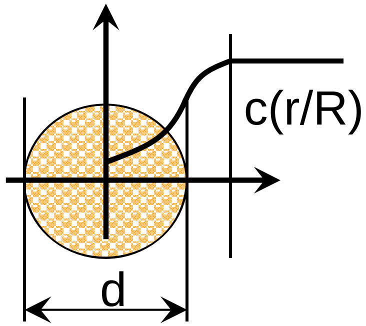
Sorption Storage Project

- **Design and construction of sorption heat and mass exchanger, design**
- **Use of vacuum technology (vessel, data and fluid feed through)**



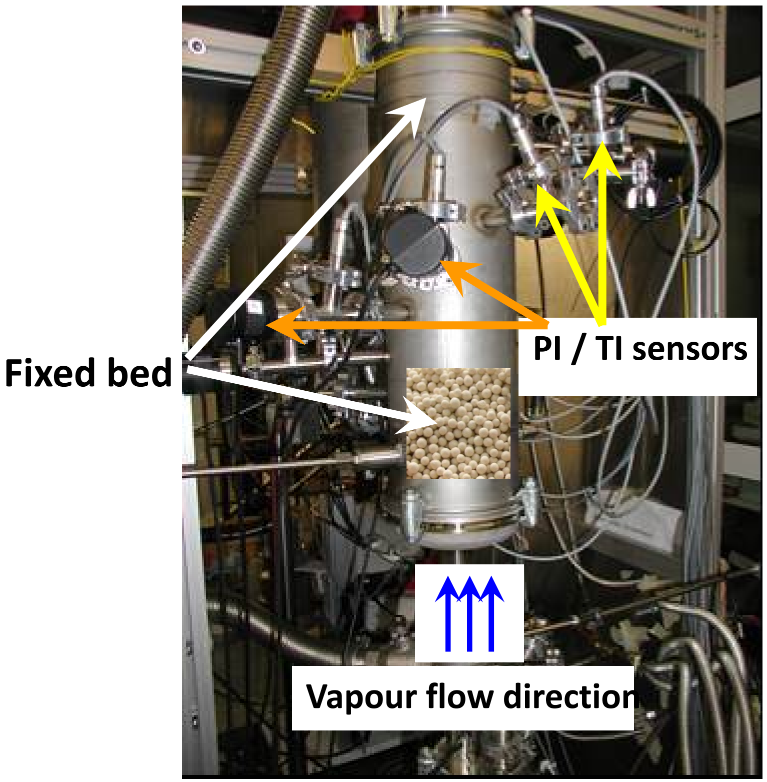


Mass spectroscopy
up to 200amu

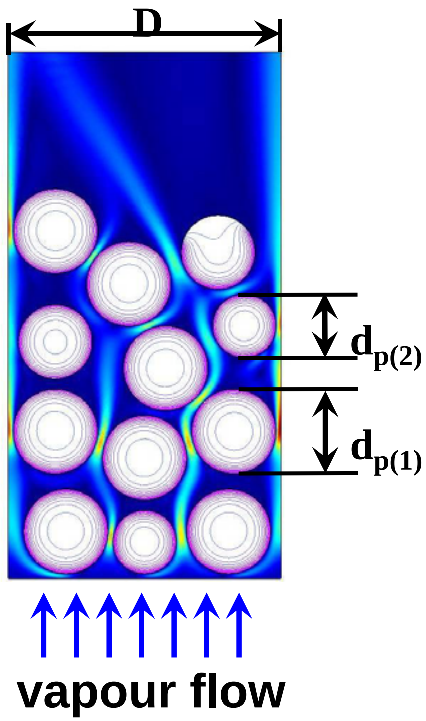


Sorbent concentration
in a particle (Particle model)

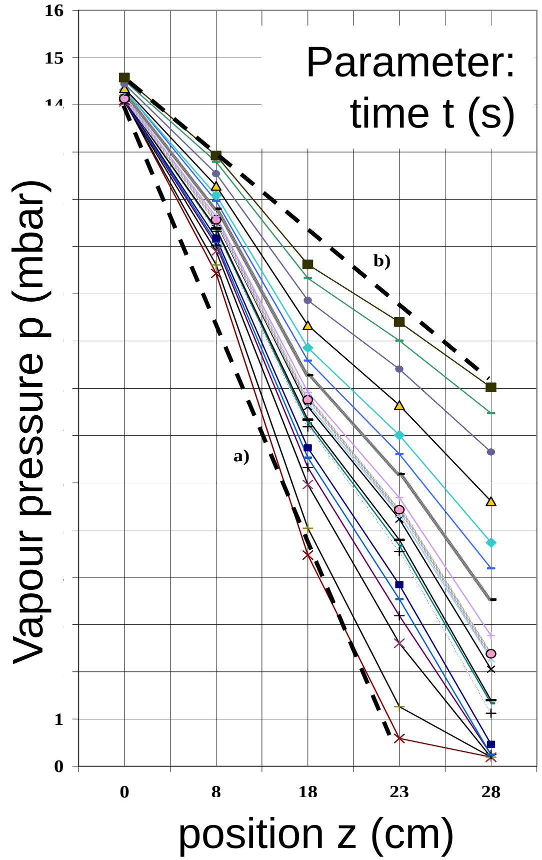
Sorption Storage Project



Fixed sorption bed - zeolite.



Velocity and concentration profile.
(Fixed bed model)



Vapour pressure loss $\Delta p(t, z)$
→ Power loss.

Absorption Cooling – System Characterization

LiBr-H_2O machine at SPF-HSR

Absorption Cooling Machine
PHÖNIX SonnenKlima GmbH

Solar collector field (T_{solar})

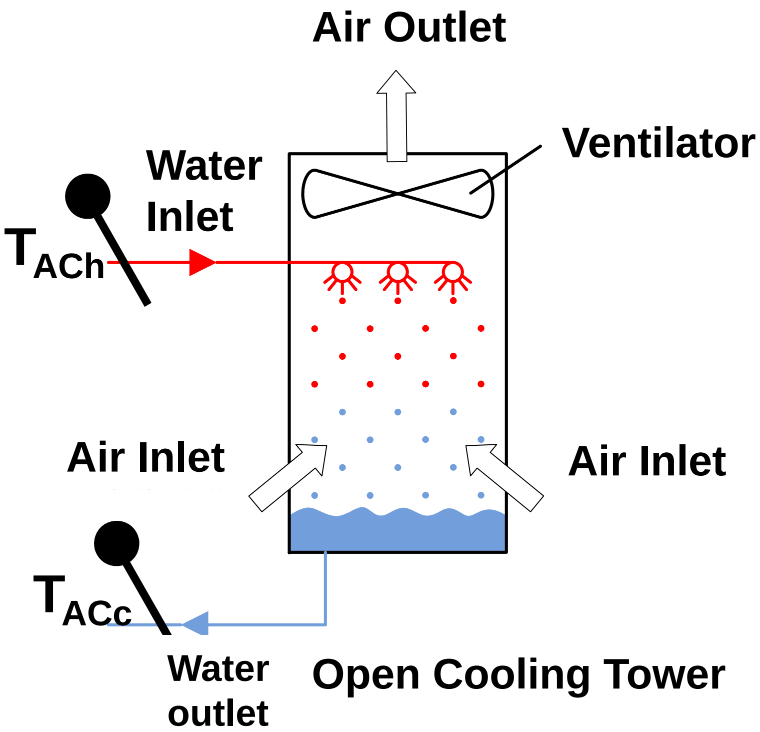
Cooling tower (T_{AC})

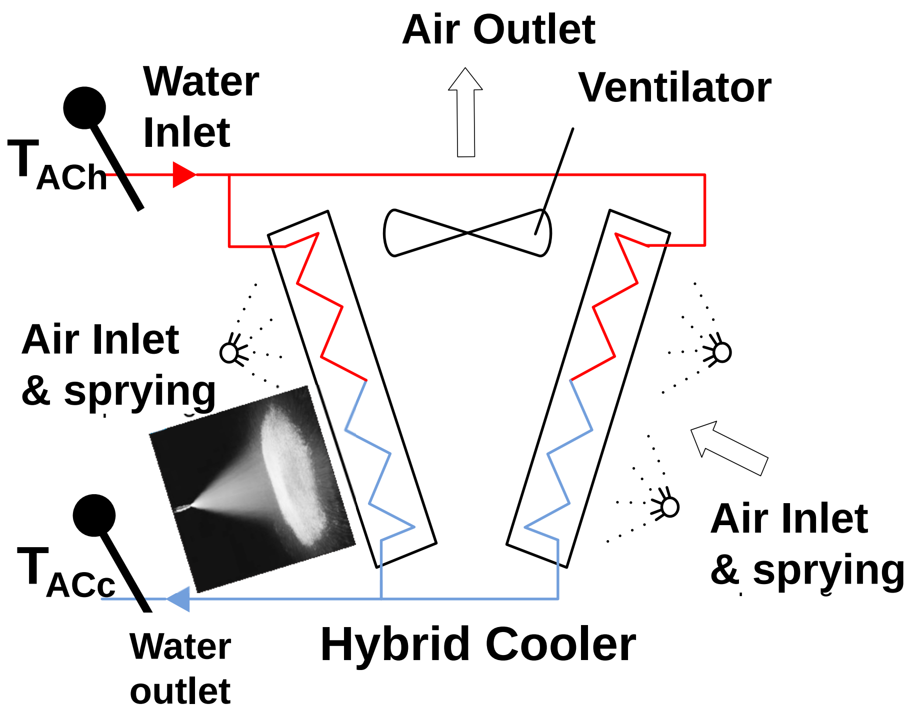
Cold seiling (T_E)

Component Characterization and Development

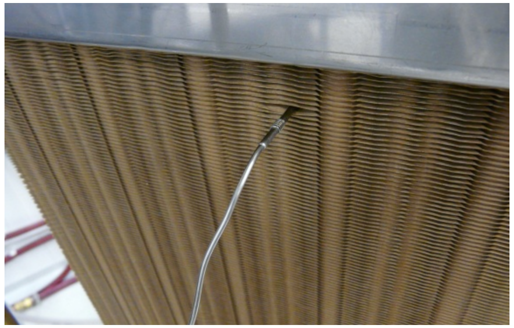
Heat rejection: Reduction of auxiliary energy and water use

Open Cooling Tower versus Hybrid Cooler



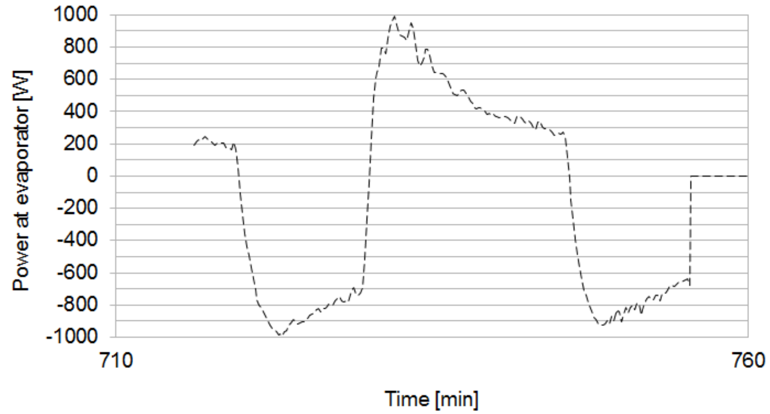


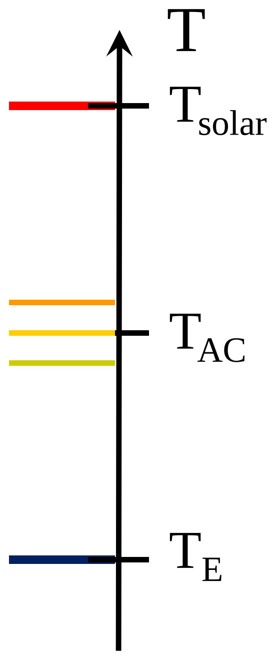
Thermal characterisation of sorption heat and mass exchangers:
Test rig for components of 1 kW cooling power.
Sorption kinetics m(t) in the gram range (sorption material)



Coated heat and mass exchanger.

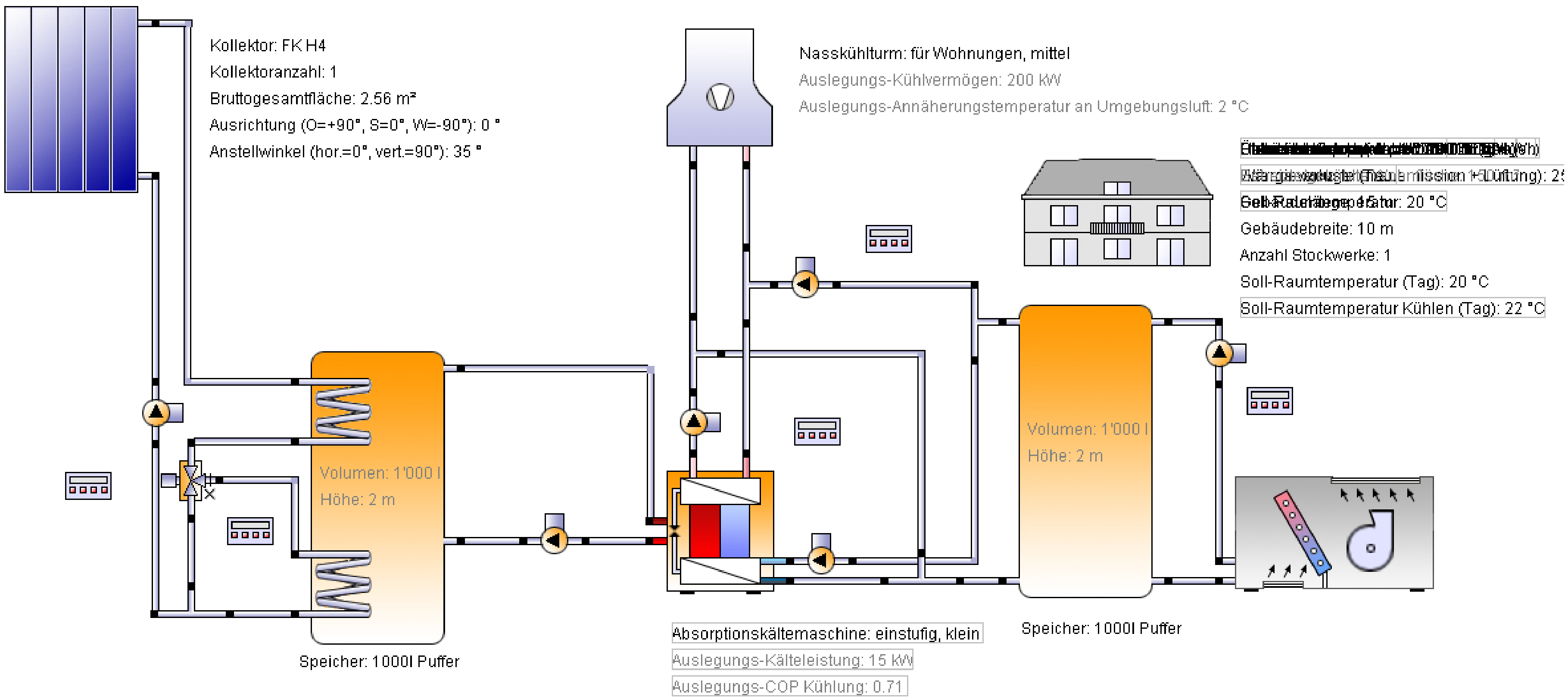
T_{solar}=85°C T_{AC}=30°C T_E=20°C





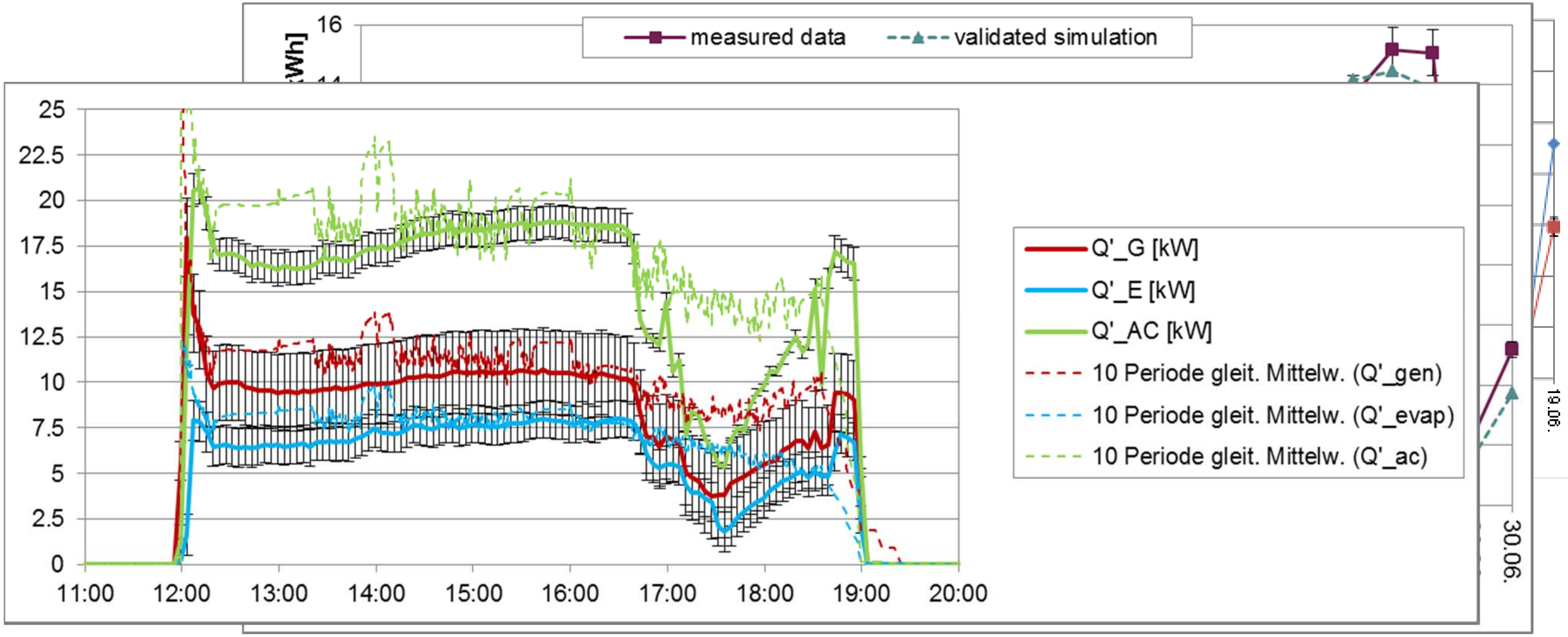
Simulation of solar thermal cooling system

Simulation of systems, solar thermal energy plant combined with hot water and cold water storage as well as free cooling and cold storage



Simulation of Solar thermal cooling system

- **Validation with measurement data from an adsorption system (with additional free cooling) and an adsorption system**
- **Optimiziation of control conditions / strategies.**



CO_2 Emissions of different systems and locations

Locations. Lugano, Athens & Dubai
Buildings: SFH, Office Building, Factory Building

Lugano	AKM	KKM + PV	nur KKM
EFH	3.5	5.4	19.8
Bürobau	46.9	100.6	369.6
Fabrikbau	147.5	316.6	1'163.4
Athen	**AKM**	**KKM + PV**	**nur KKM**
EFH	11.8	18.2	67.0
Bürobau	81.1	174.1	639.7
Fabrikbau	175.3	376.2	1'382.3
Dubai	**AKM**	**KKM + PV**	**nur KKM**
EFH	18.3	28.2	103.5
Bürobau	106.4	228.4	839.1
Fabrikbau	458.7	984.5	3'617.2

Tabelle 4: CO_2 Emission der Systeme an den jeweiligen Standorten in t/Laufzeit

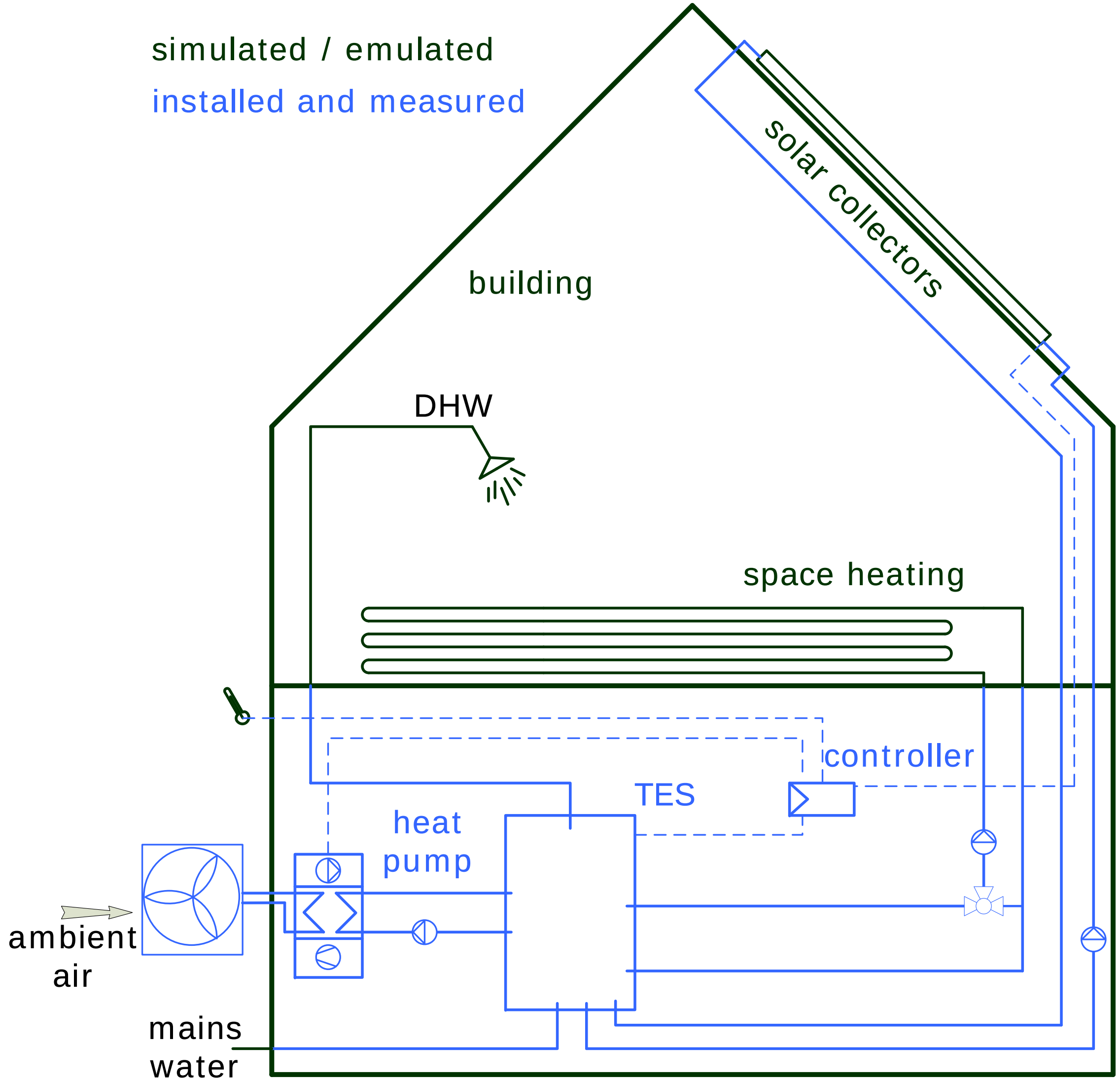
Assessment Criteria

A Functionality
B Investment
C Operation costs
D Heating costs
E Total costs for 20 years
F CO_2 emission

Lugano	Kühlsysteme																				
Gebäude	Solarthermie / AKM							PV Anlage / KKM							Strom-Mix / KKM						
	A	B	C	D	E	F	total	A	B	C	D	E	F	total	A	B	C	D	E	F	total
EFH	1	0	1	1	0	2	5	2	1	2	1	1	1	8	2	2	0	1	2	0	7
Bürogebäude	2	0	1	2	0	2	7	2	1	2	0	1	1	7	2	2	0	1	2	0	7
Produktions- /Industriebau	2	1	1	2	2	2	10	2	0	2	0	0	1	5	2	2	0	1	1	0	6
Athen	Kühlsysteme																				
Gebäude	Solarthermie / AKM							PV Anlage / KKM							Strom-Mix / KKM						
	A	B	C	D	E	F	total	A	B	C	D	E	F	total	A	B	C	D	E	F	total
EFH	1	0	1	2	0	2	6	2	1	2	0	2	1	8	2	2	0	1	2	0	7
Bürogebäude	2	1	1	2	2	2	10	2	1	2	0	2	1	8	2	2	0	1	0	0	5
Produktions- /Industriebau	2	1	1	2	2	2	10	2	0	2	0	1	1	6	2	2	0	1	0	0	5
Dubai	Kühlsysteme																				
Gebäude	Solarthermie / AKM							PV Anlage / KKM							Strom-Mix / KKM						
	A	B	C	D	E	F	total	A	B	C	D	E	F	total	A	B	C	D	E	F	total
EFH	1	0	1	-	0	2	4	2	1	1	-	1	1	6	2	2	1	-	2	0	7
Bürogebäude	2	1	1	-	2	2	8	2	1	2	-	2	1	8	2	2	0	-	0	0	4
Produktions- /Industriebau	2	1	2	-	2	2	9	2	0	2	-	0	1	5	2	2	0	-	1	0	5

Tabelle 5: Beurteilung der Systeme an den verschiedenen Standorten. Für Dubai ist keine Heizbedarf vorhanden, daher ist in der Spalte D kein Eintrag.

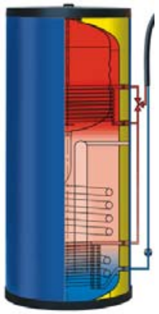
Whole System Test (Concise Cycle Test)



Whole System Test (Concise Cycle Test)

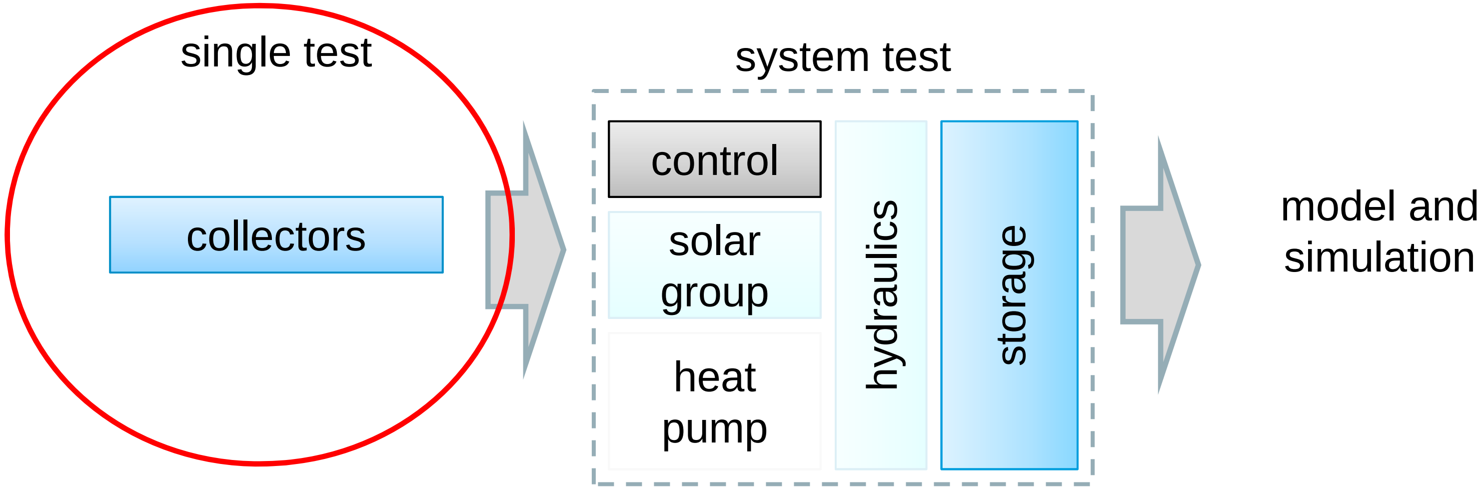
Good components do not yet make a good system

heat pump



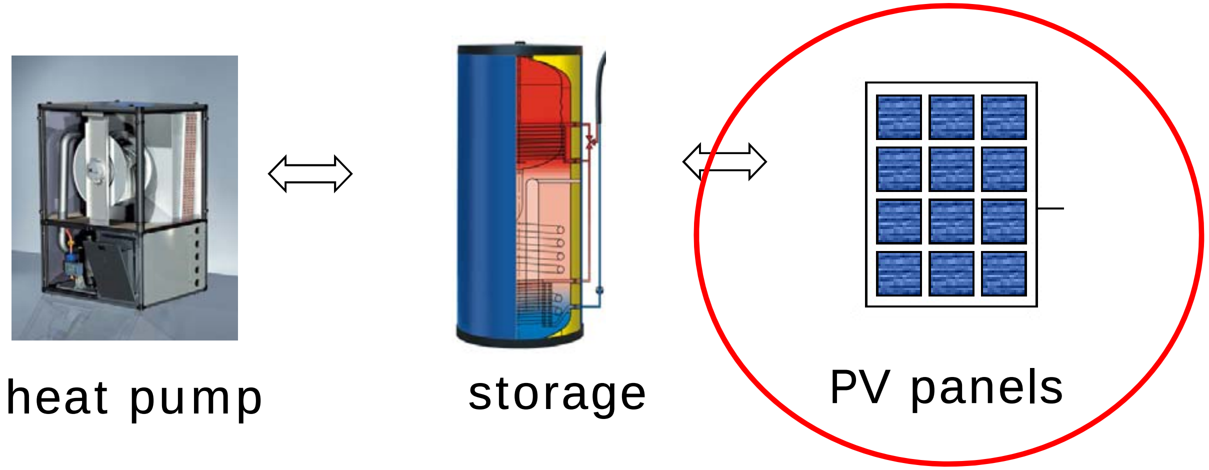
storage

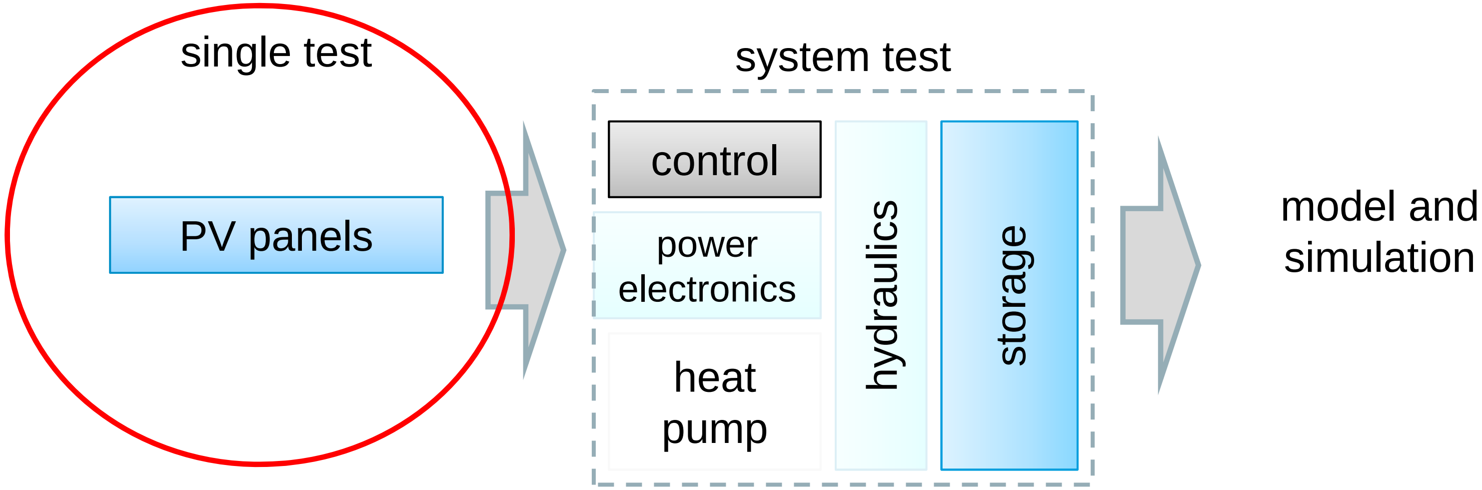
collectors



Whole System Test (Concise Cycle Test)

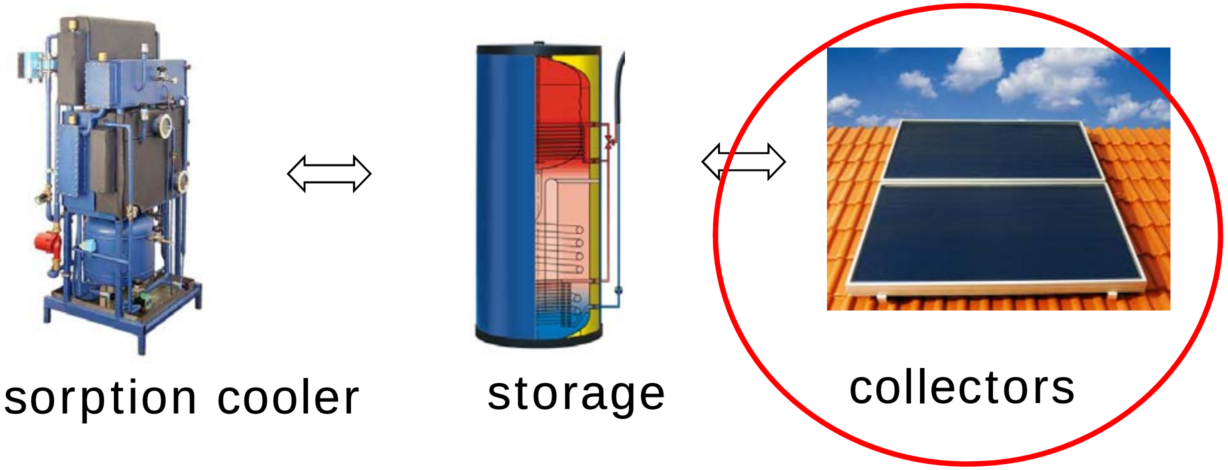
Good components do not yet make a good system

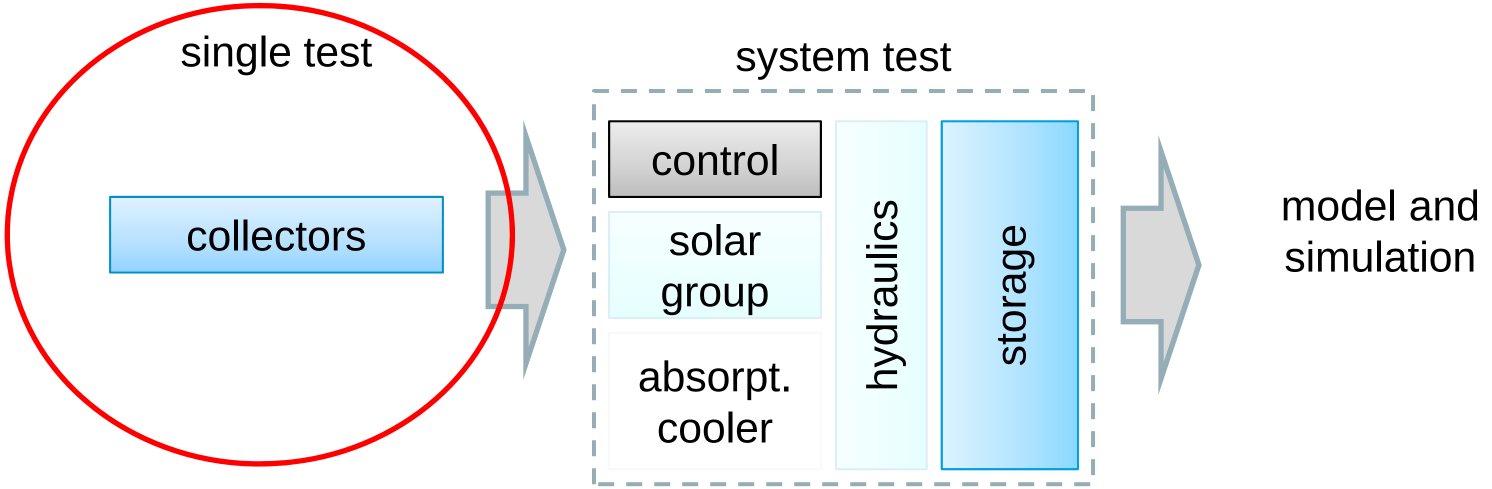




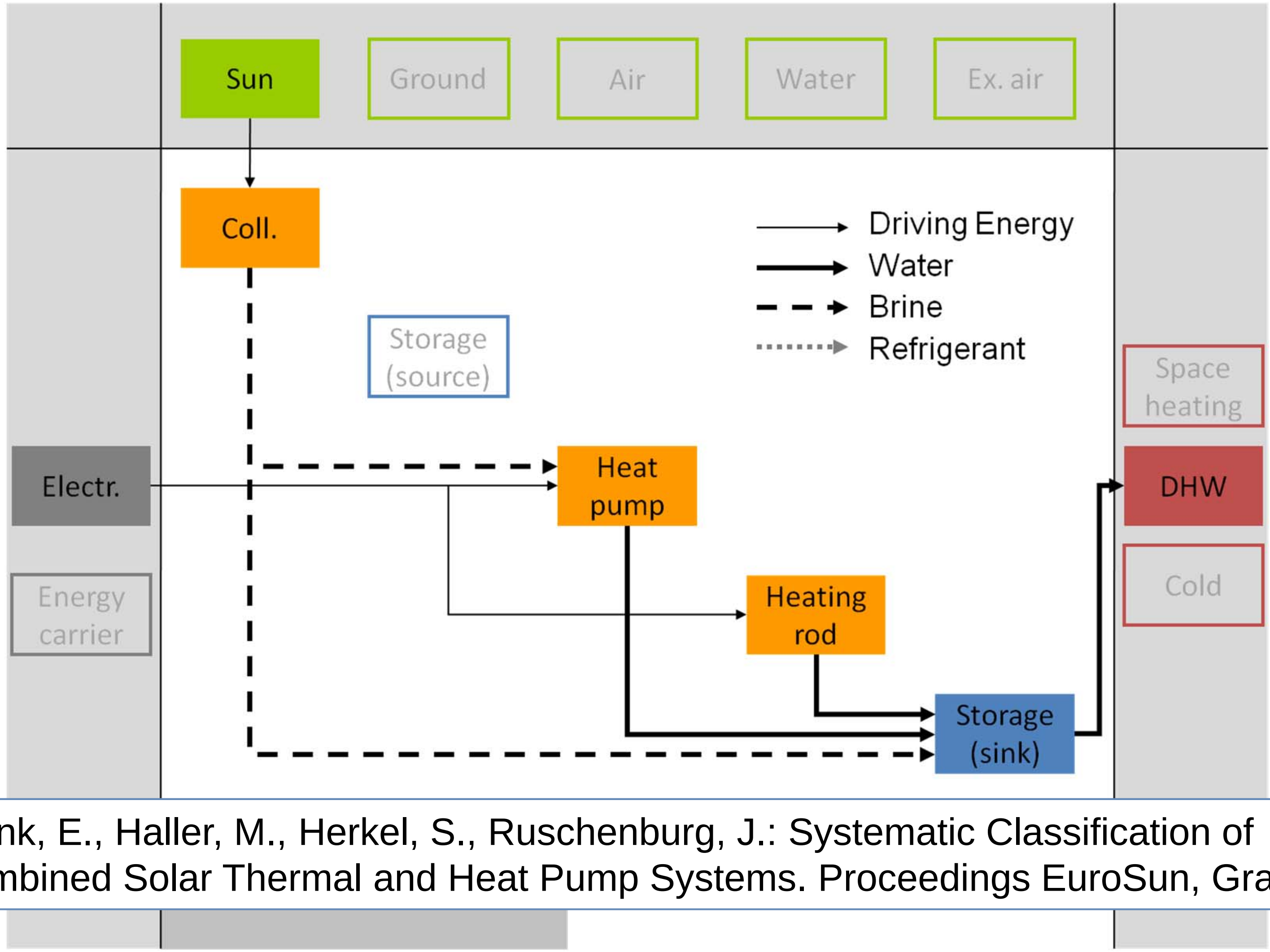
Whole System Test (Concise Cycle Test)

Good components do not yet make a good system



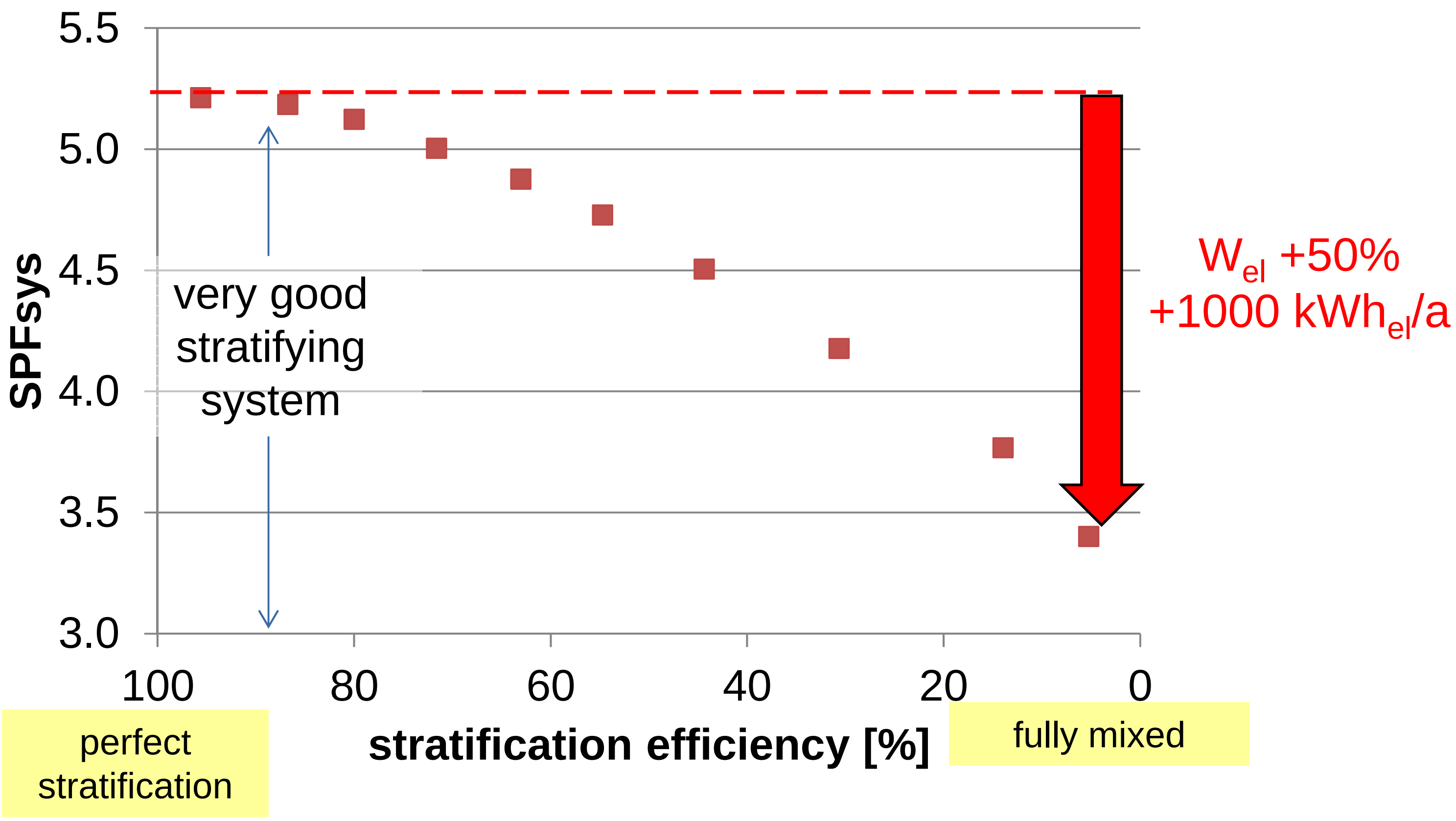


IEA SHC Task 44 System Classification



Frank, E., Haller, M., Herkel, S., Ruschenburg, J.: Systematic Classification of Combined Solar Thermal and Heat Pump Systems. Proceedings EuroSun, Graz, 2010

IEA SHC Task 44 Simulations on Solar Thermal Heat Pump Systems



*Details: TRNSYS-Simulationen mit T44A38 Referenzsystem. Klima Strasbourg, Last SFH45, 15 m² Kollektorfeld, **Sole-Wasser Wärmepumpe**, 900 liter Speicher. Schichtungseffizienz nach Haller et al. (2010) und Logie et al. (2010).*

IEA SHC Task 49: Solar Process Heat

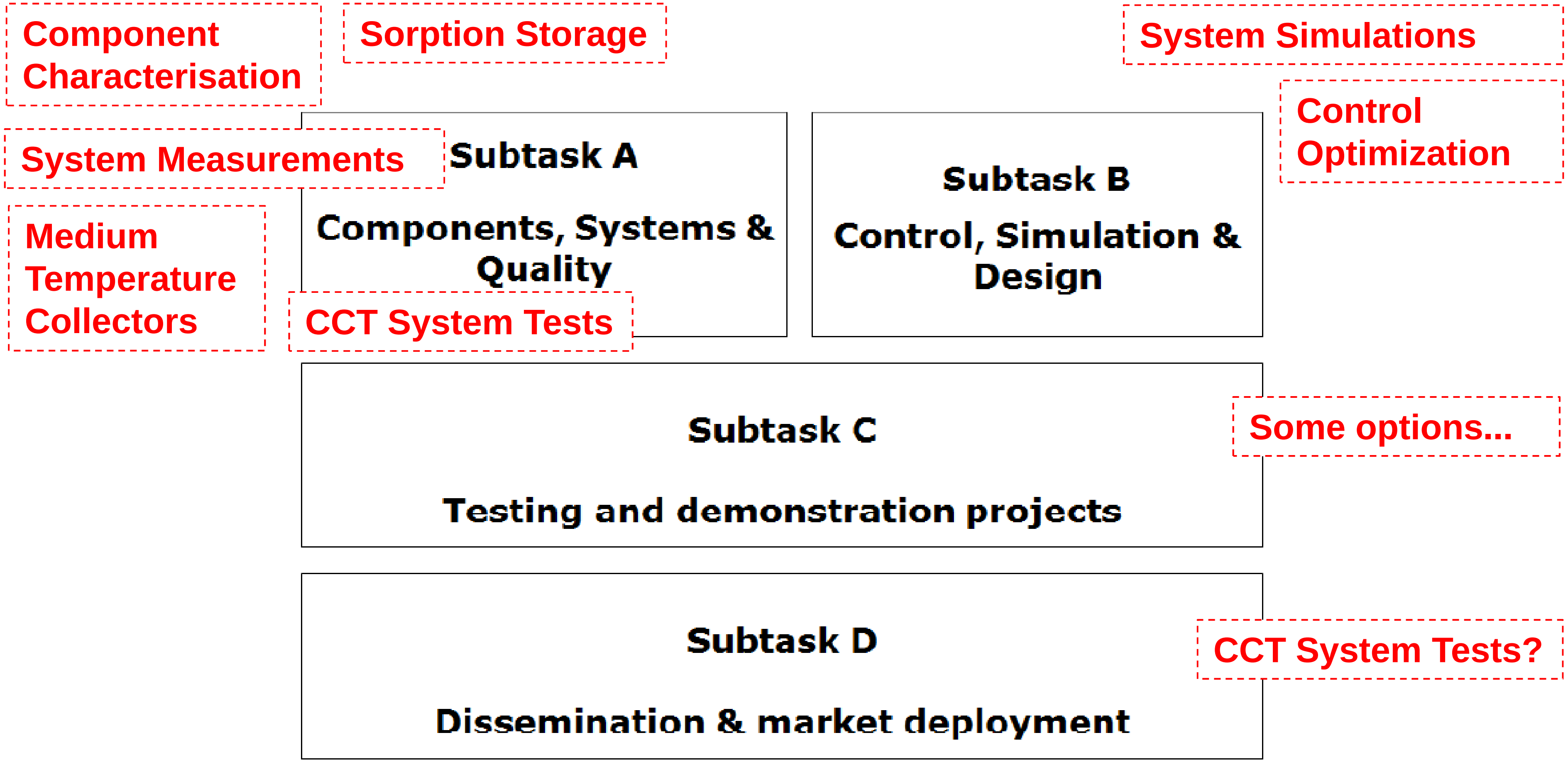
Subtask A: Process Heat Collectors
Lead country: Switzerland (Elimar Frank – SPF)

Objectives:

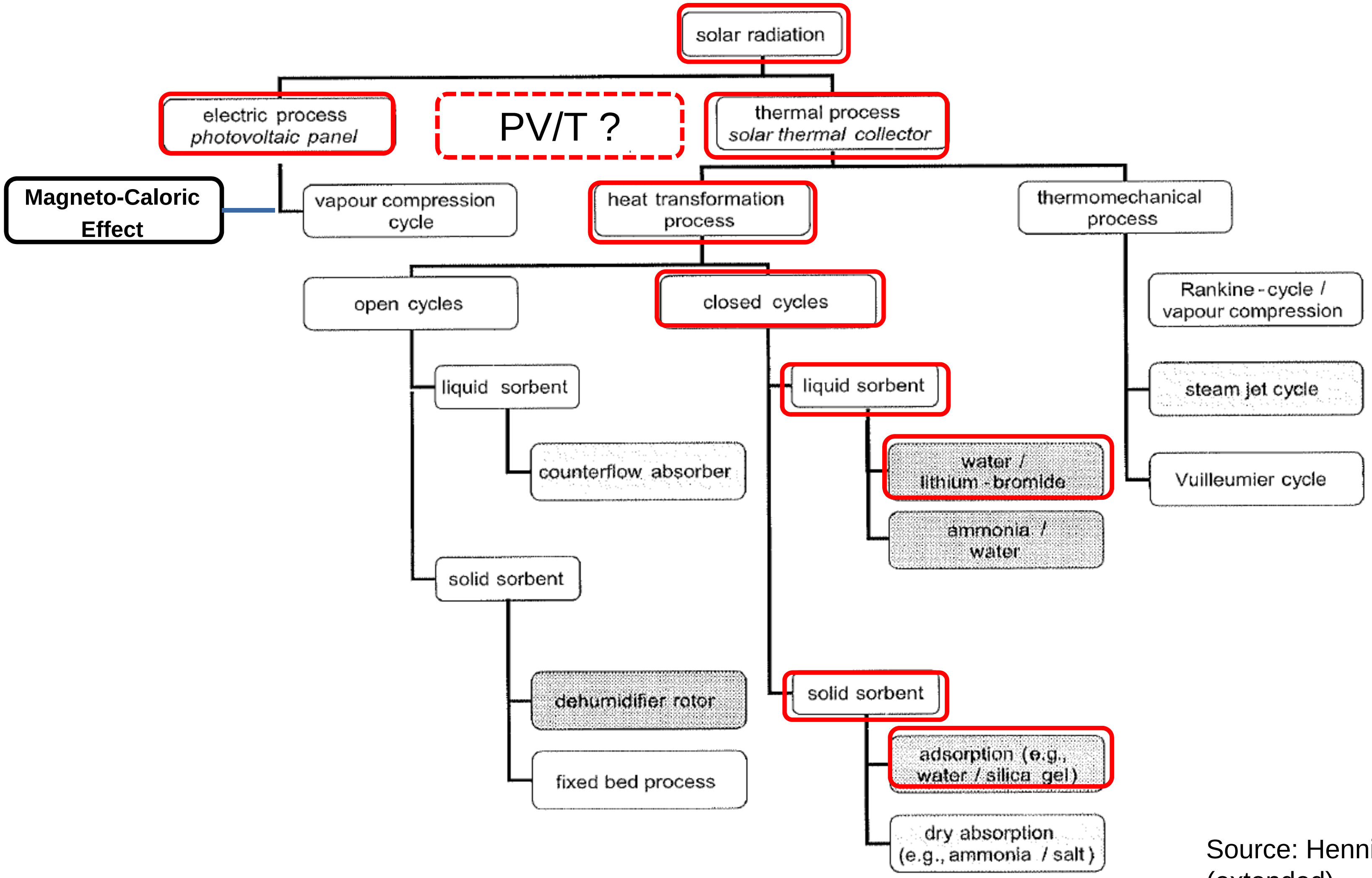
- Improving solar process heat collectors and collector loop components
- Providing a basis for the comparison of collectors with respect to technical and economical conditions
- Recommendations for further improvement of standardized testing procedures

HoTT: SPF Test Rig for Collector Measurements up to 200 °C

SPF activities related to Subtasks



SPF activities (summary and outlook)



Source: Henning et al. (extended)

Thank you!