



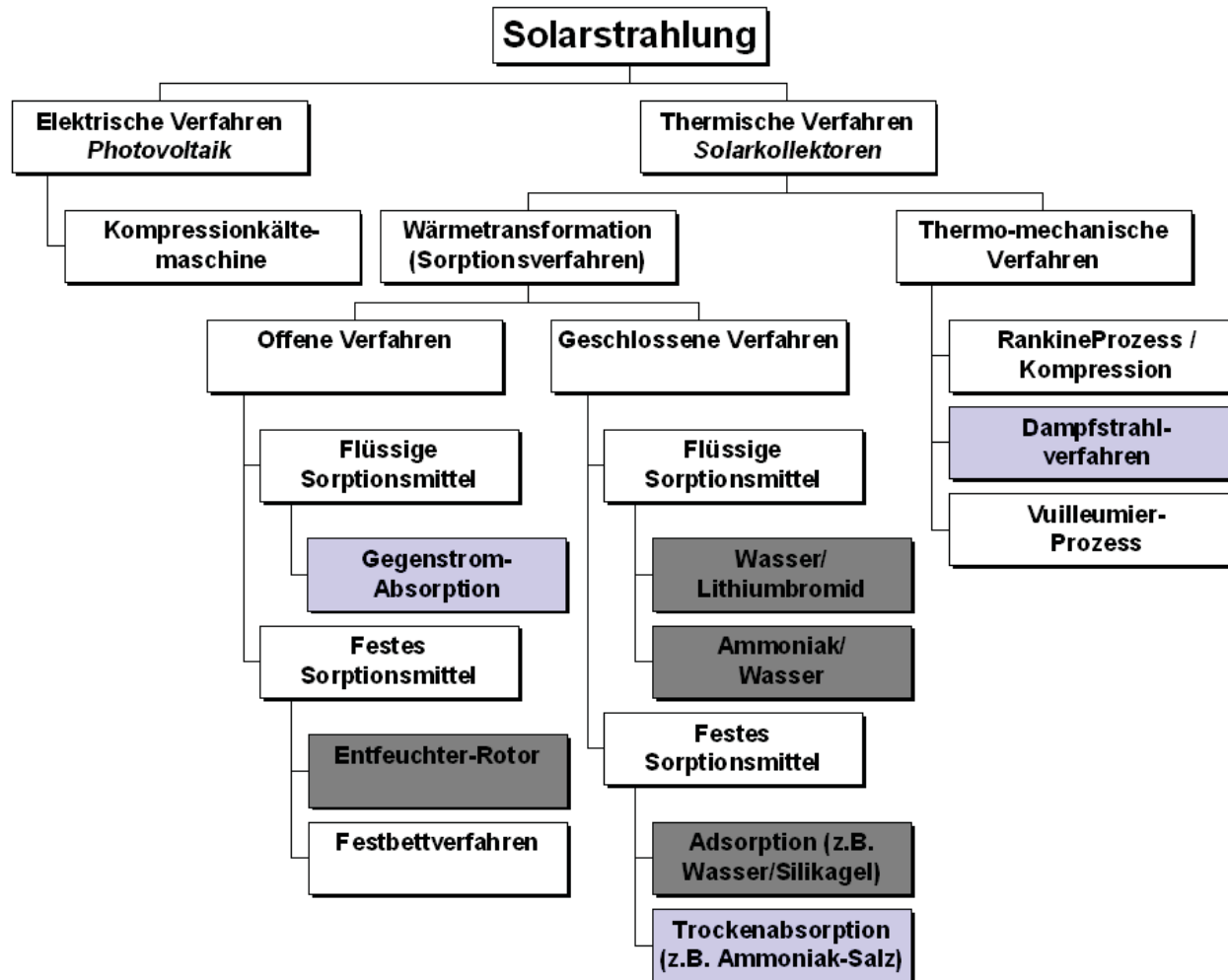
Technologieüberblick und Ergebnisse IEA SHC Task 38 „Solar Air – Conditioning and Refrigeration“

Alexander Thür
Dagmar Jähnig

AEE – Institut für Nachhaltige Technologien (AEE INTEC)
A-8200 Gleisdorf, Feldgasse 19
AUSTRIA

Seminar – Solares Heizen und Kühlen
Graz, 15. Dezember 2011

Technologieüberblick



(Quelle: Henning, Hans-Martin (Hrsg.): Solar-Assisted Air-Conditioning in Buildings – A Handbook for Planners, Springer Verlag, 2004)

Dieses Projekt wird im Rahmen der IEA-Forschungskooperation im Auftrag des Bundesministeriums für Verkehr, Innovation und Technologie durchgeführt.



Kältetemperaturen - Antriebstemperaturen

Luftkonditionierung

Offene Sorption

16 ... 20 °C

50 ... 95 °C

$COP_{th}: 0,5 - 1$



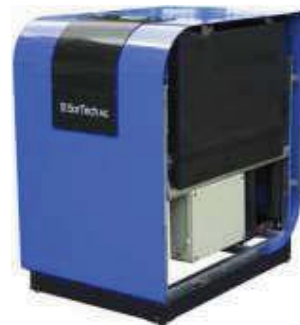
Kaltwasserbereitstellung

Geschlossene Adsorption

6 ... 20 °C

60 ... 90 °C

$COP_{th}: 0,4 - 0,7$



Absorption
H₂O - LiBr

6 ... 20 °C

70 ... 100 °C

$COP_{th}: 0,6 - 0,8$



Absorption
NH₃ - H₂O

-50 ... 20 °C

65 ... 140 °C

$COP_{th}: 0,6 - 0,8$



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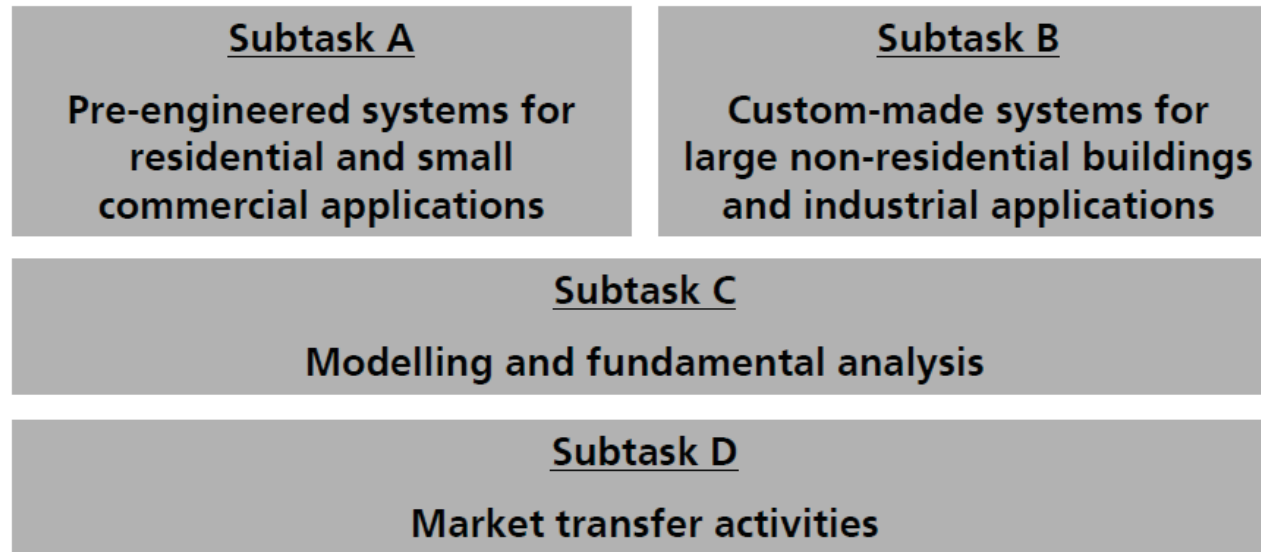


IEA SHC Task 38

„Solar Air – Conditioning and Refrigeration“



Beteiligung: 12 Länder, 49 Institutionen, >60 Teilnehmer



AEE – Institut für Nachhaltige Technologien

AIT – Austrian Institut of Technology

ASIC - Austria Solar Innovation Center

TU-Graz Institut für Wärmetechnik

Universität Innsbruck - Institut für Konstruktion und Materialwissenschaften

Podesser Consulting

S.O.L.I.D. Gesellschaft für Solarinstallation und Design mbH

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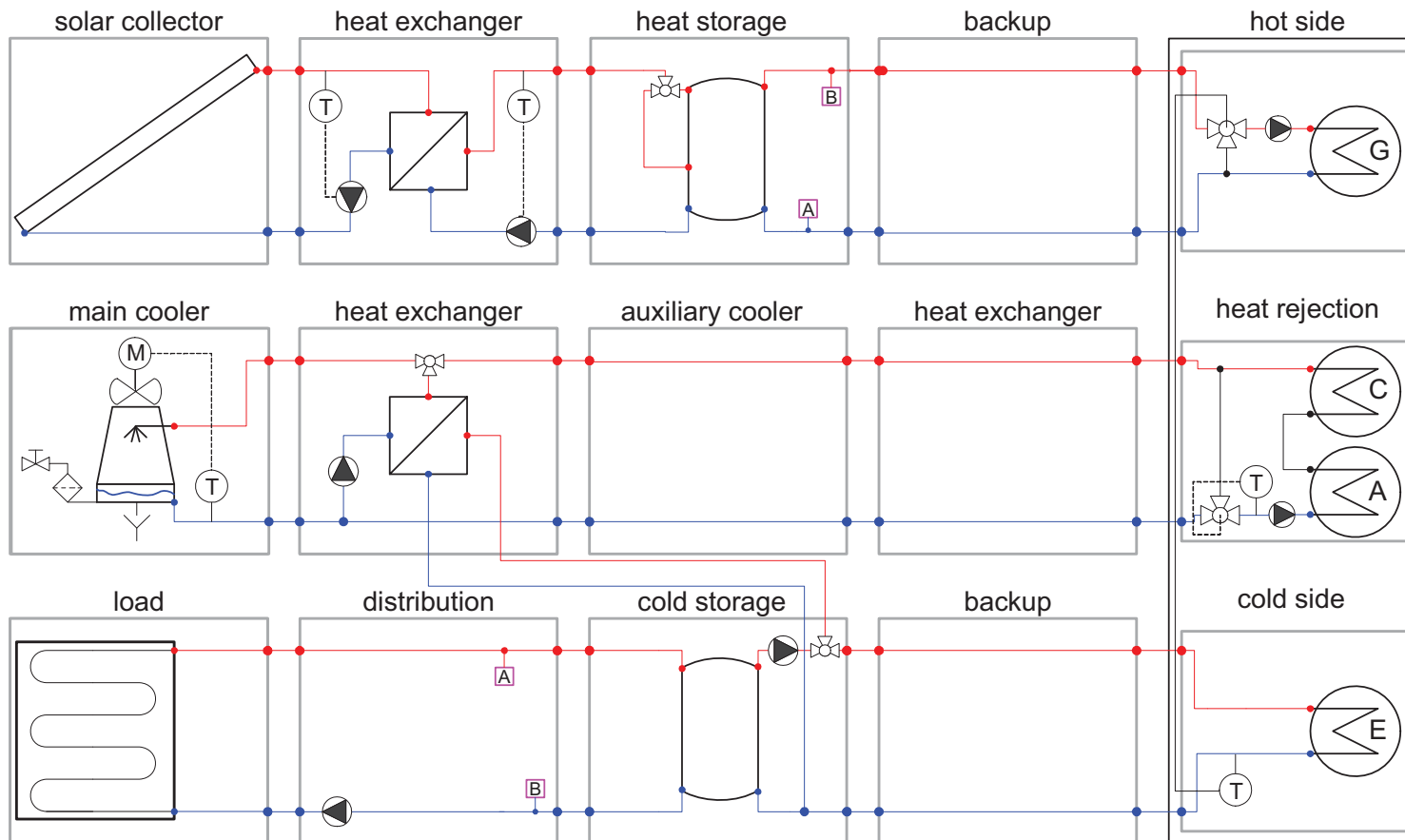


Activities Subtask A

- Overview on Market Available Components
 - Small capacity chillers
 - Heat rejection units
 - Solar combisystems where a chiller can be integrated
 - Cold storages
- D-A1: „Market Available Components for Systems for Solar Heating and Cooling with a Cooling Capacity <20kW

Activities Subtask A

- D-A2: Collection of selected systems schemes
“Generic Systems”: ZAE-Bayern



Dieses Projekt wird im Rahmen der IEA-Forschungskoope-ration im Auftrag des Bundesministeriums für Verkehr, Innovation und Technologie durchgeführt.

Activities Subtask A

- D-A2: Collection of selected systems schemes “Generic Systems”: ZAE-Bayern

Generic system approach

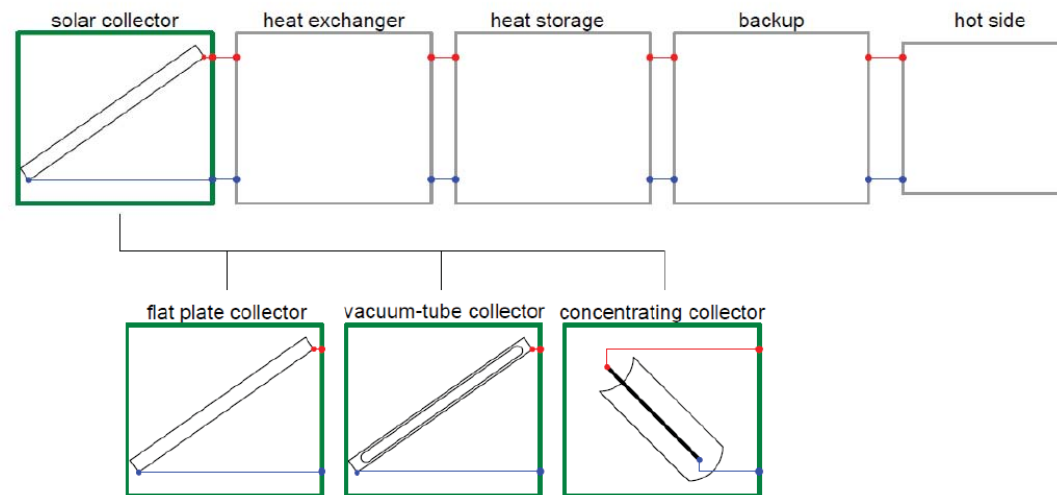


Figure 4: Solar sub-system: options for the solar collector

Activities Subtask A

- D-A3a bzw. D-B3b: “Monitoring Procedure for Solar Cooling Systems”

Microsoft Excel - 111108_T38_MonProc_V6-0_SC Okt10_Sept11_ACM_AlexCorr111125.xls

AK38

IEA SHC Task 38 “Unified monitoring procedure for solar heating and cooling system”

Summary Name of the system: Town Hall Gleisdorf
 Place: Gleisdorf / Austria
 Contact Person: Alexander Thier
 e-mail of contact person: a.thier@eez.gor.at
 Name of the institution for the monitoring: AEE INTEC

Collector field:
 Surface area: 254,0 m²
 Inclination: 29°30'
 Orientation: 309/30°S
 Type: Glühstrahl/TTC/Quadrant

Heat Exchanger:
 Type: PVT SVEP B26120MVP
 Power: 180 kW

Back Up Conventional fuel:
 Heating Power: 180 kW
 Fuel Type: 30% average (DecCO₂Min) district heating, natural gas

Back Up RES fuel:
 Heating Power: - kW
 Fuel Type: -
 Hot Storage: n Storage Buffer
 Volume (lit): 4,5 m³
 Volume (m³): -
 Volume (third): -
 Type connection: -

Costs Per Kilowatt
 Cost of total cooling system: IT
 Cooling capacity installed: 100 kW
 COPk: 0,23

AB Adsorption
 Chilling Power: 35 kW
 Manufacturer: Yaski
Cooling Tower
 Cooling Power: 100 kW
 Manufacturer: Ballauffore
 Type: FKT 021
 Water consumption: around 1 m³/day
Back Up:
 Chilling Power: CDP
 Manufacturer: TROCES Klingenberg
Cold Storage:
 Volume: 1 m³
DEC:
 Chilling Power: 35 kW
 Air volume flow: 6250 m³/h
 Regeneration P: 0,25
 Manufacturer: TROCES Klingenberg
Distribution T: Cooling Elements
 Fan Code: -

First level: Basic information on primary energy COP and Costs
 Basic information on primary energy ratio PER

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PER_res	0,84	0,33	0,85	0,83	0,86	0,31	1,05	1,60	0,31	0,52	0,43	0,56
PER_fossil	0,84	0,33	0,85	0,83	0,86	0,31	1,05	1,60	0,31	0,52	0,43	0,56
PER_ref	0,84	0,82	0,82	0,82	0,82	0,82	0,82	0,82	0,33	1,05	1,04	1,03
PER_ref with ref. AHU postheating, Tsupply fixed to: °C	0,84	0,82	0,82	0,82	0,82	0,82	0,82	0,82	0,33	1,05	1,04	1,03
DIWof	0,84	0,82	0,82	0,82	0,82	0,82	0,82	0,82	0,33	1,05	1,04	1,03
PER_ref without ref. AHU postheating	0,84	0,82	0,82	0,82	0,82	0,82	0,82	0,82	0,33	1,05	1,04	1,03
COPel_y,tot	23,03											
COPel_m,tot	46,28	45,57	45,63	47,71	43,88	51,16	31,75	9,03	4,17	5,48	6,58	6,04

Second level: Basic monitoring procedure (kept simple in sense of calculation and necessary monitoring hardware)
 Solar heat management efficiency

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
ηcoll_util	0,23											
ηcoll_util_m	0,16	0,16	0,06	0,08	0,18	0,29	0,22	0,26	0,26	0,26	0,31	0,26
ηsys	0,83											
ηsys_m	0,32	0,34	0,35	0,36	0,37	0,33	0,69	0,73	0,71	0,80	0,77	0,63
ηsys	0,63											
ηsys_m	0,32	0,34	0,35	0,36	0,37	0,33	0,69	0,73	0,71	0,80	0,77	0,63
ηheat_coldrad	0,80											
ηheat_m	0,17	0,14	0,06	0,08	0,17	0,19	0,18	0,21	0,18	0,20	0,24	0,18

Solar Energy Source Management

Dieses Projekt wird im Rahmen der IEA-Forschungskooperation im Auftrag des Bundesministeriums für Verkehr, Innovation und Technologie durchgeführt.

Monitoring Subtask A: 13 Systems

- D-A3b:” Monitoring Results - A technical report of subtask A (Pre-engineered systems for residential and small commercial applications)”
- Monitored systems in Spain, France, Austria and Germany
- Office buildings, school building, laboratory building, gym, retirement home, canteen etc.

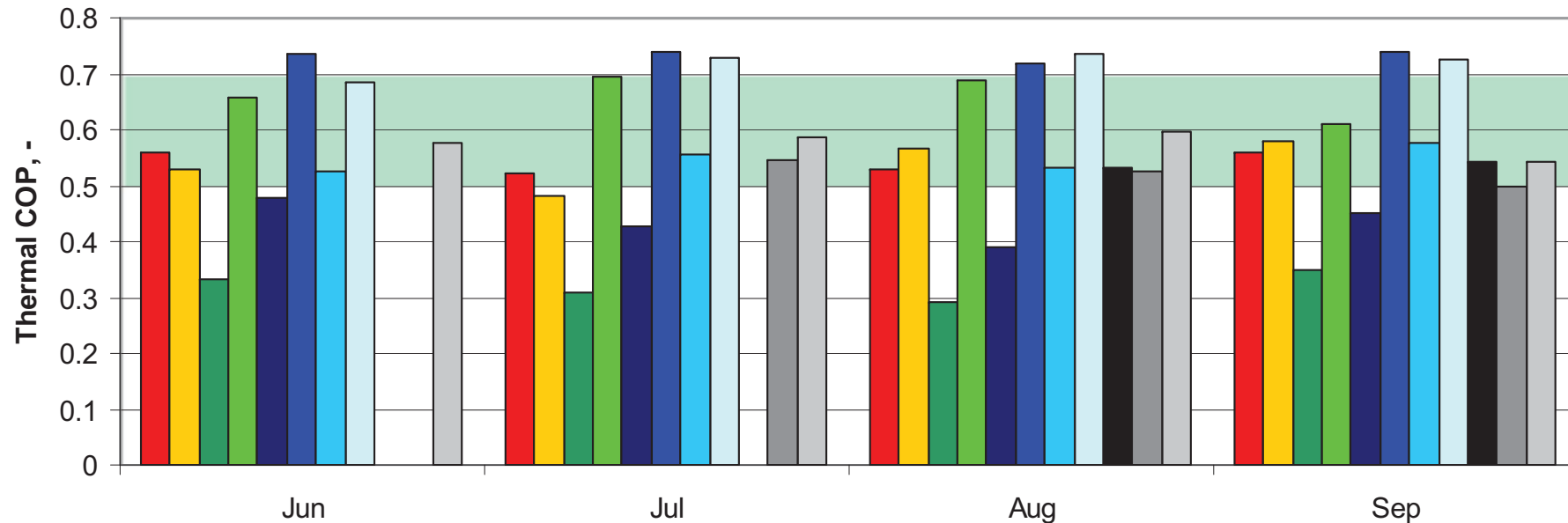


Picture source: S.O.L.I.D

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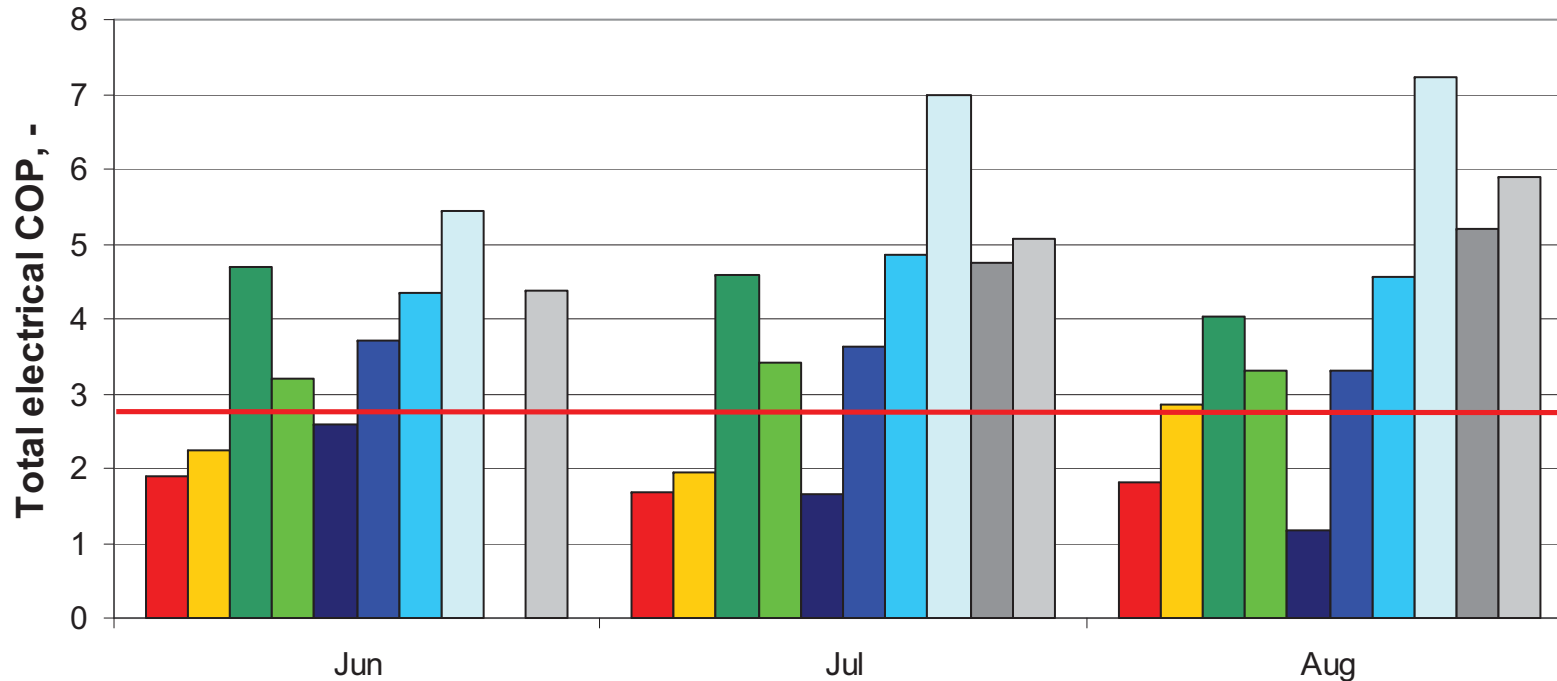
Thermal COP of Chiller

$$COP_{th} = \frac{\text{cold_output_from_chiller}}{\text{heat_input_to_chiller}}$$



- Values are mostly good (>55-73%)
- Low values only for 2 systems: High heat rejection temperature and low generator temperature

Total Electrical COP:
$$COP_{el} = \frac{total_useful_cold}{total_electricity_consumption}$$



- Below red line: Systems consume more electricity than a conventional chiller would
- Reasons: High electricity consumption of components (e.g. pumps, cooling tower), control strategy doesn't reduce running time or speed of components

Fractional Primary Energy Savings

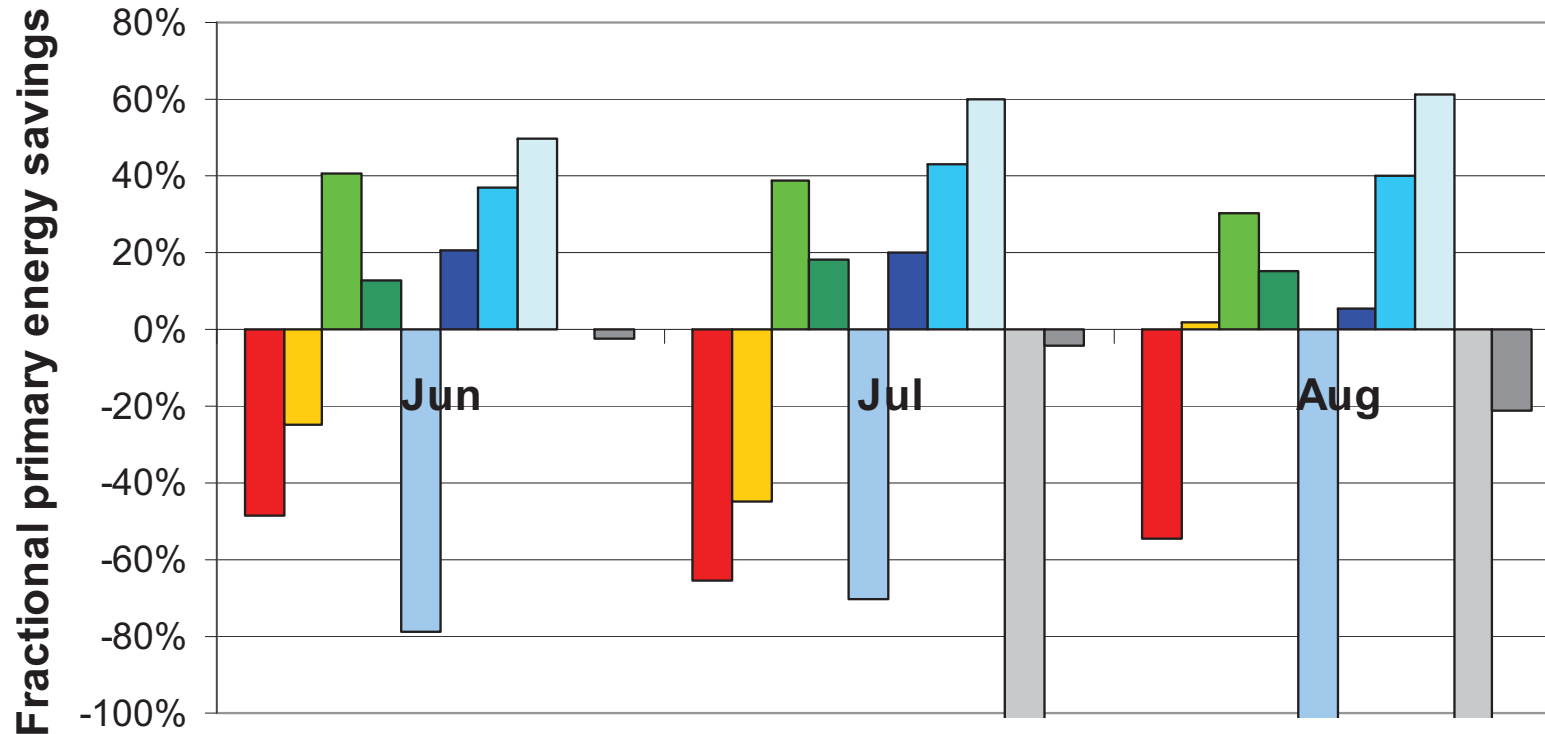
$$f_{sav,shc} = 1 - \frac{\frac{Q_{boiler}}{\epsilon_{fossil} \cdot \eta_{boiler}} + \frac{Q_{RES}}{\epsilon_{RES} \cdot \eta_{RES}} + \frac{E_{el}}{\epsilon_{elec}} + \frac{Q_{cooling,missed}}{SPF \cdot \epsilon_{elec}}}{\frac{Q_{boiler,ref}}{\epsilon_{fossil} \cdot \eta_{boiler,ref}} + \frac{E_{el,ref}}{\epsilon_{elec}} + \frac{Q_{cooling,ref}}{SPF_{ref} \cdot \epsilon_{elec}}}$$

- Compare primary energy consumption of the solar heating and cooling system with a conventional heating and cooling system
- Assumptions for conventional system:

$$\epsilon_{elec} = 2,5 \quad \epsilon_{fossil} = 0,9 \quad \eta_{boiler,ref} = 0,9$$

- Gas boiler without storage tank for space heating
- Gas boiler with storage tank for domestic hot water preparation
- Compression chiller for cooling: $SPF_{ref} = 2,8$

Fractional Energy Savings - Summer

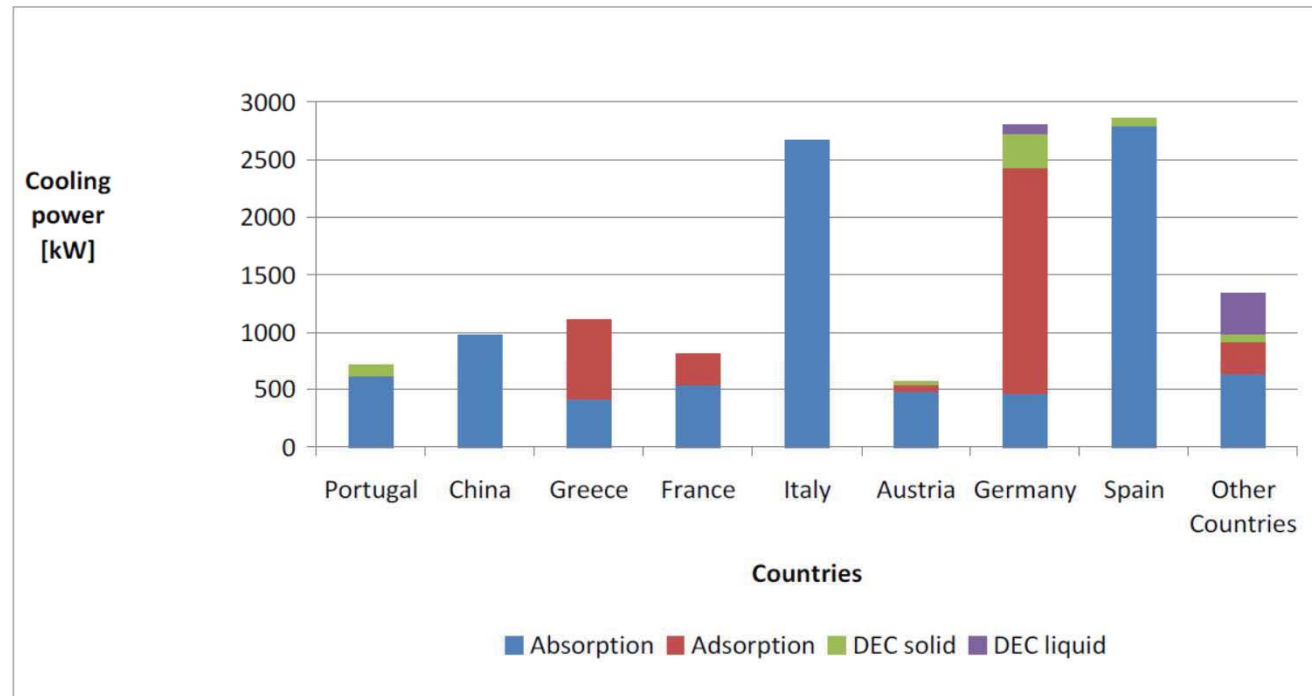


- Most systems without backup in summer
- Negative values:
 - Low electrical COP (red, orange, blue)
 - CHP unit or fossil boiler as backup system (grey), definition of primary energy factor, heat considered as waste heat?

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Activities Subtask B

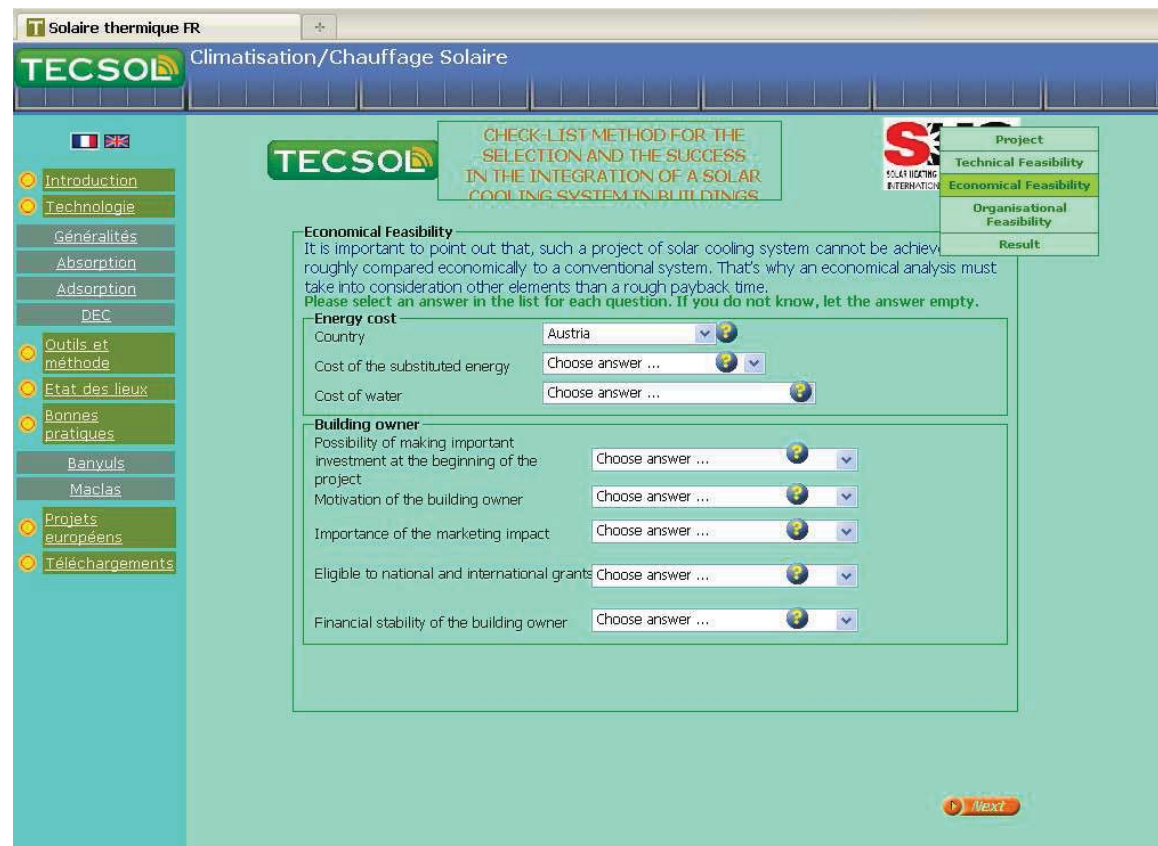
- D-B1: “State of the art on existing solar heating and cooling systems - A technical report of subtask B”



- D-B5: “Commissioning - A technical report of subtask B”

Activities Subtask B

Check-list method for the selection and the success in the integration of a solar cooling system in buildings: <http://www.tecsol.fr/checklist/>



TECSOL Climatisation/Chauffage Solaire

TECSOL CHECK-LIST METHOD FOR THE SELECTION AND THE SUCCESS IN THE INTEGRATION OF A SOLAR COOLING SYSTEM IN BUILDINGS

Economical Feasibility
It is important to point out that, such a project of solar cooling system cannot be achieved roughly compared economically to a conventional system. That's why an economical analysis must take into consideration other elements than a rough payback time.
Please select an answer in the list for each question. If you do not know, let the answer empty.

Energy cost

Country: Austria

Cost of the substituted energy: Choose answer ...

Cost of water: Choose answer ...

Building owner

Possibility of making important investment at the beginning of the project: Choose answer ...

Motivation of the building owner: Choose answer ...

Importance of the marketing impact: Choose answer ...

Eligible to national and international grants: Choose answer ...

Financial stability of the building owner: Choose answer ...

Next

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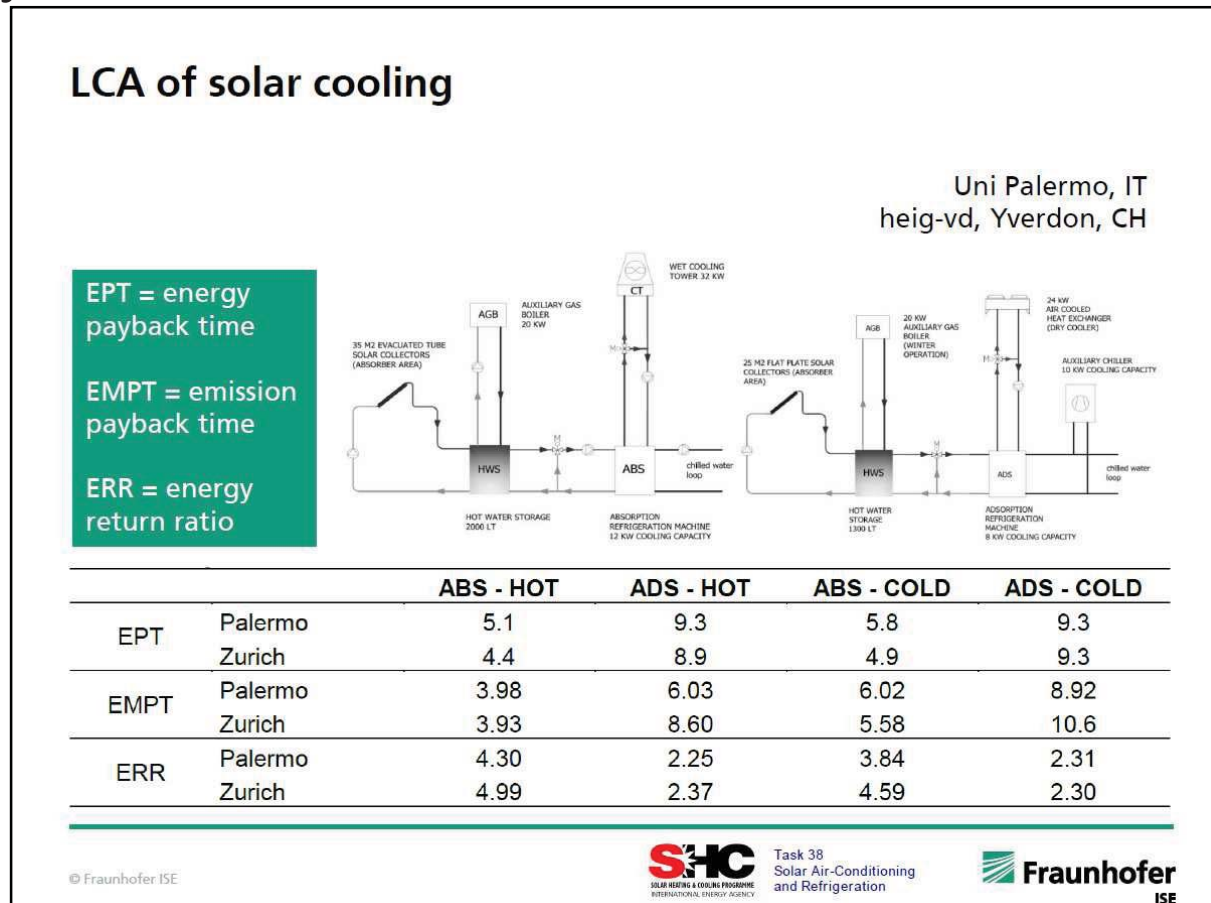


Activities Subtask C

- D-C1: “State of the art – Survey on new solar cooling developments
- D-C2a: “Description of simulation tools used in solar cooling - New developments in simulation tools and models and their validation: Solid desiccant cooling + Absorption chiller
- D-C2b: “Benchmarks for comparison of system simulation tools
- D-C3: “Exergy Analysis of Solar Cooling Systems
- D-C5: “Hygienic Aspect of Small Wet Cooling Towers

Activities Subtask D

- D-D3: “Life Cycle Assessment of Solar Cooling Systems



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Activities Subtask D

Hans-Martin Henning · Mario Motta
Daniel Mugnier (Ed.)

Solar Cooling Handbook

A Guide to Solar Assisted Cooling
and Dehumidification Processes

3rd Edition



SpringerWienNewYork



Ab ?? 2012

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Summary / Lessons Learned

- Parasitic electricity consumption is often the main problem that reduces or even prevents primary energy savings.
- System designs and control strategies could in many cases be improved. Results show how important system design and a correct choice of all system components is.
- Pre-engineering of systems can be the key to optimized system performance.
- Proper commissioning of all systems as well as a certain amount of monitoring at least during the first few years of operation is recommended.
- Some good examples (50-60% savings in summer)



Solares Heizen und Kühlen – IEA SHC Task 38 Ergebnisse



Activities Subtask D

<http://www.iea-shc.org/publications/task.aspx?Task=38>

bzw. unter:

<http://iea-shc-task38.org/reports>