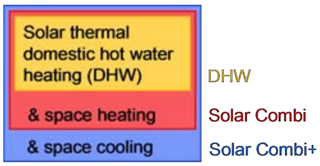
Assessment of Standard Small-Scale Solar Cooling Configurations

What is a Solar Combi plus system:



Statement of the Problem:

Costs of the investment and lack of experience of designers and installers are the most important barriers for a broad diffusion of solar combi+ applications. The assessment of standard system configurations might reduce considerably the design effort for single applications and is the basis for the development of package solutions possibly manufactured at a large scale level.

Aim of the work presented is the definition of a reduced number of system configurations, which can be promoted and applied similarly to the standardized systems for domestic hot water production, which work reasonably well in common applications and are independent of the specific products considered.

Methods:

The study started from an extensive campaign of numerical simulations carried out in TRNSYS on a basic plant configuration detected through market and technical analysis. Each industrial partner of the consortium opted for one of the two plant layouts represented in Figure 1, which suites best the working features of its own chiller. Within the basic systems, a number of parameters were varied:

- Geographical location of the solar combi+ plant
- Building in which the solar combi+ plant is installed
- Chiller brand.
- Collectors' type (flat plate, evacuated tube collectors)
- Heat rejection system's type (wet cooling tower, dry air cooler and hybrid cooler)
- Chilled/Warm water distribution system (fan coils and chilled ceiling).
- Collectors' area between 2 and 5 $m^2/kW_{Ref.\ Pow.\ cold}$
- Warm water storage volume between 25 and 75 l/m^2 collectors' area

Results:

The comparison of the three datasets in Table 1 shows that the chilled ceiling, wet cooling tower and evacuated tubes collectors' configuration allows the solar combi+ system to perform best from a purely technical and environmental point of view. This outcome is applicable to all chillers investigated, leading to a "best" standard system configuration, chiller independent. Moreover, the best solutions are obtained when the biggest collectors area and storage volume are used.

When the solutions close to the best are regarded, the effect of both exchanging technologies and varying components size is not clearly chiller and application independent. This aspect and cost issues – raw investment costs are considered together with cost of primary energy saved when planning a system - leave a certain freedom to the manufacturers when designing a standard system configuration.

The CO_2 emissions avoided range between 2 and 4 tons/year in all studied cases. Primary energy savings between easily above 60% are reported in case of well-designed solar combi+ systems.

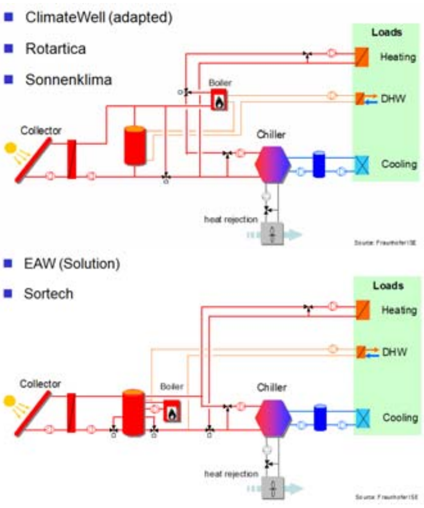


Figure 1 – Solar Combi+ Systems Selected

	Coll. type	H.R. type	Coll. area [m2/kW]	Storage Vol. [l/m2]	TOT. Solar Fraction [%]	Electrical Efficiency [-]	Relative PE Saved [%]	Specific PE Saved [(kWh/year)/m2]	Specific CO_2 Saved [(kg/year)/m2]
1	ET	WCT	4.27	50	70	20.3	38	168	65
	ET	WCT	4.27	75	73	20.2	45	196	72
	ET	WCT	5.00	25	67	20.7	34	136	51
	ET	WCT	5.00	50	76	20.4	49	184	65
	ET	WCT	5.00	75	80	20.3	56	209	71
2	FP	WCT	4.27	50	64	20.1	29	128	46
	FP	WCT	4.27	75	68	20.0	36	157	46
	FP	WCT	5.00	25	61	20.3	23	86	54
	FP	WCT	5.00	50	70	20.0	39	146	54
	FP	WCT	5.00	75	75	20.1	47	175	54
3	ET	HC	4.27	50	68	20.2	35	153	38
	ET	HC	4.27	75	71	20.0	39	175	36
	ET	HC	5.00	25	68	20.6	35	127	41
	ET	HC	5.00	50	71	20.4	38	147	41
	ET	HC	5.00	75	77	20.3	50	192	43

Table1 – Energetic performance of the Systems Selected for a Domestic Application located in Naples

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