



IEA HPP Annex 32

Monitoring of 9 conventional and 2 heat pump units for heating, cooling and ventilation in passive standard houses

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Overview



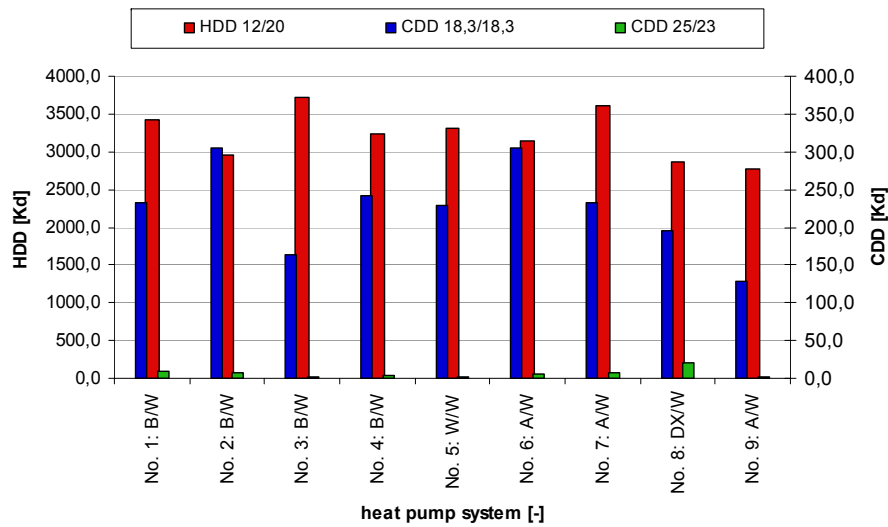
Quelle: Google Maps

No.	Location	Inhabitants	HP capacity [kW]	HP Type
Conventional Units				
1	Weinzierl	4	11,8	B/W
2	Lengenfeld	5	11,8	B/W
3	Felling	4	11,8	B/W
4	Behamberg	4	8,0	B/W
5	St. Peter/Au	6	19,4	W/W
6	Bad Vöslau	4	10,3	A/W
7	Klein Meiseldorf	5	33,0	A/W
8	Ohlsdorf	4	15,1	DX/W
9	Rutzenmoos	2	8,3	A/W
Compact Units				
10	Hitzendorf	2	3,3	B/W
11	Judendorf	2	3,3	B/W

Quelle: Eigendarstellung AIT

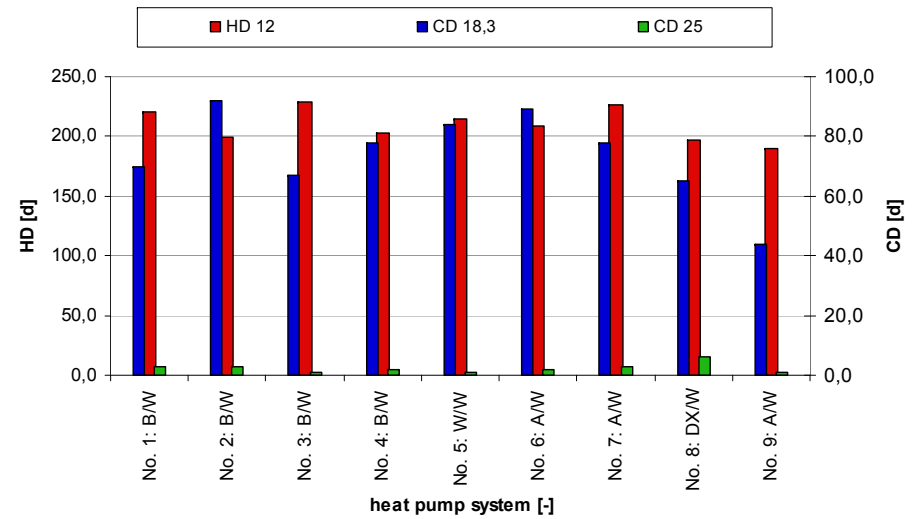
Climate conditions

Heating and cooling degree days



Quelle: Eigendarstellung AIT

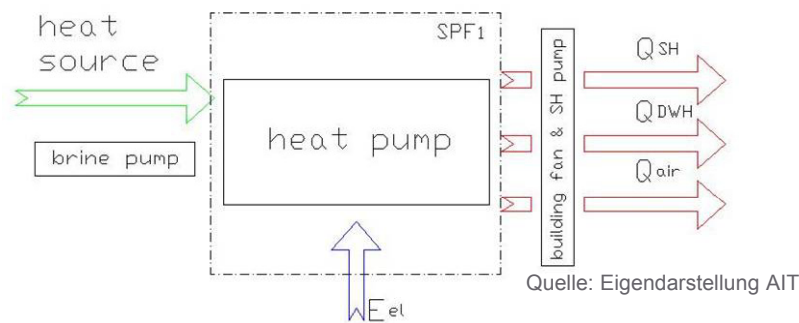
Heating and cooling days



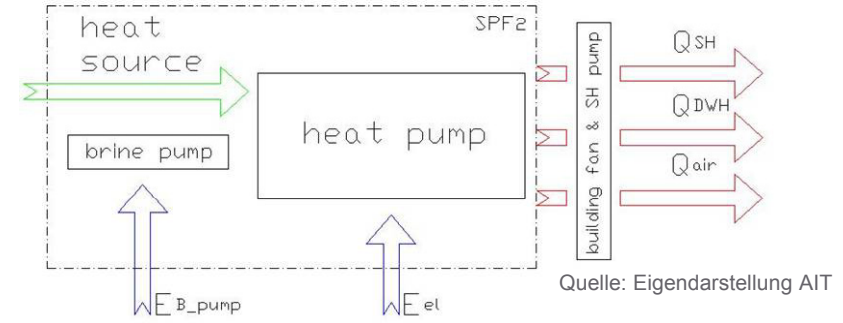
Quelle: Eigendarstellung AIT

System boundaries

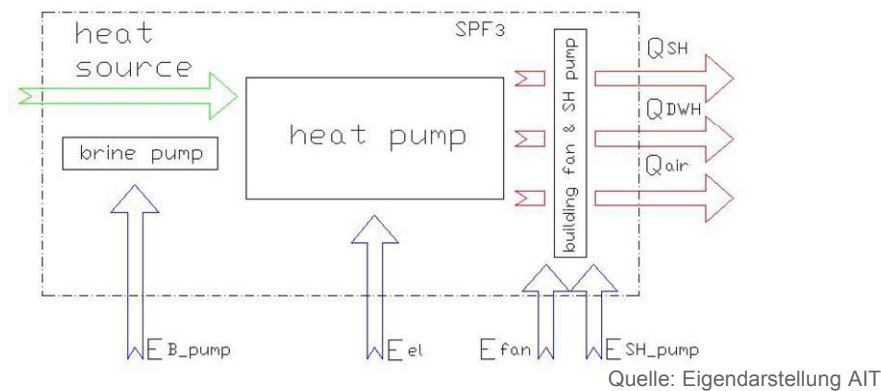
- SPF₂ used for comparison with other technologies
- SPF₁/SPF₃ calculated for compact units only



$$SPF_1 = \frac{Q_{SH} + Q_{DHW} + Q_{air}}{E_{el}}$$



$$SPF_2 = \frac{Q_{SH} + Q_{DHW} + Q_{air}}{E_{el} + E_{B_pump}}$$



$$SPF_3 = \frac{Q_{SH} + Q_{DHW} + Q_{air}}{E_{el} + E_{B_pump} + E_{fan} + E_{SH_pump}}$$

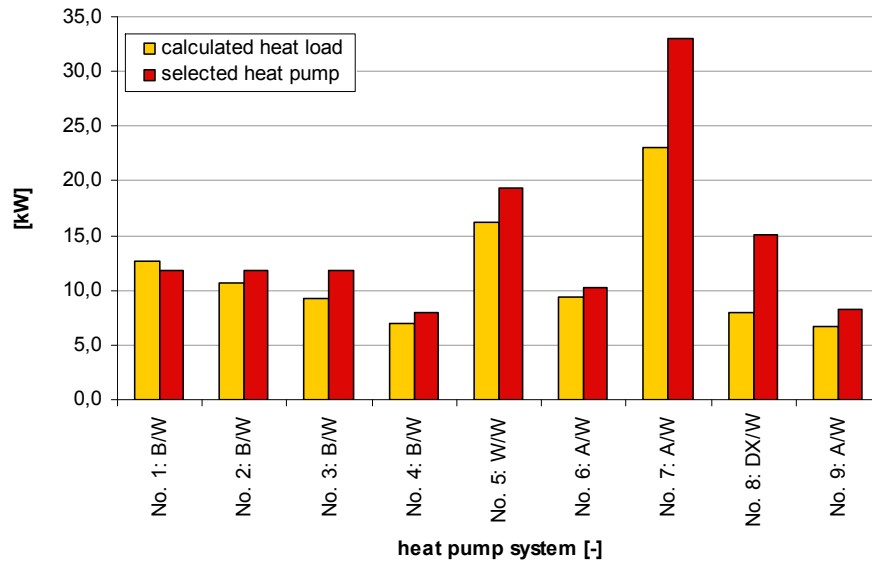
Overview – conventional units

object						heat pump					heat source		heat sink					
No.	spec. heat load	heat load	heating area	building construction	commissioning	Leistung der WP	A / W	B / W	W / W	DX / W	horizontal collector	vertical collector	floor heating	wall heating	radiators	DHW with heat pump	DHW with separate heat pump	Comfort ventilation
-	W/m ²	kW	m ²	-	-	kW	-	-	-	-	-	-	m ²	m ²	-	-	-	-
1	51	10,6	207	medium	2006	11,8		x				x	210,0	10,5			x	x
2	43	12,7	295	medium	2004	11,8		x			x		295,0	5,0			x	x
3	34	9,3	272	medium	2004	11,8		x				x	272,0			x		-
4	37	7,0	190	medium	2004	8,0		x			x		145,0				x	-
5	61	16,2	264	medium	2004	19,4			x				241,0			x		-
6	58	9,3	160	medium	2004	10,3	x						115,0			x		-
7	58	23,0	400	medium	2007	33,0	x								x		x	-
8	42	8,0	189	medium	2001	15,1				x	x		154,3				x	-
9	22	6,7	309	medium	2006	8,3	x						309,0			x		x

Quelle: Eigendarstellung AIT

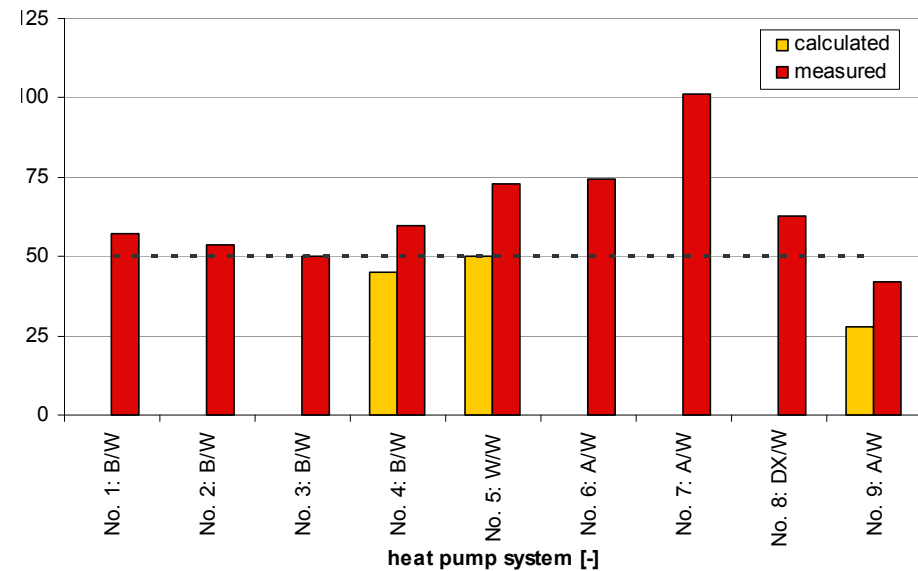
Conventional units

Heat load of heat pumps



Quelle: Eigendarstellung AIT

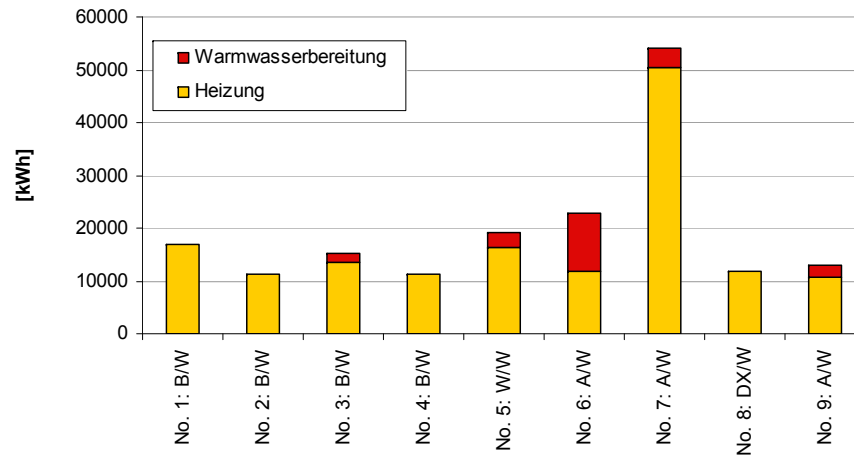
Specific heat energy demand



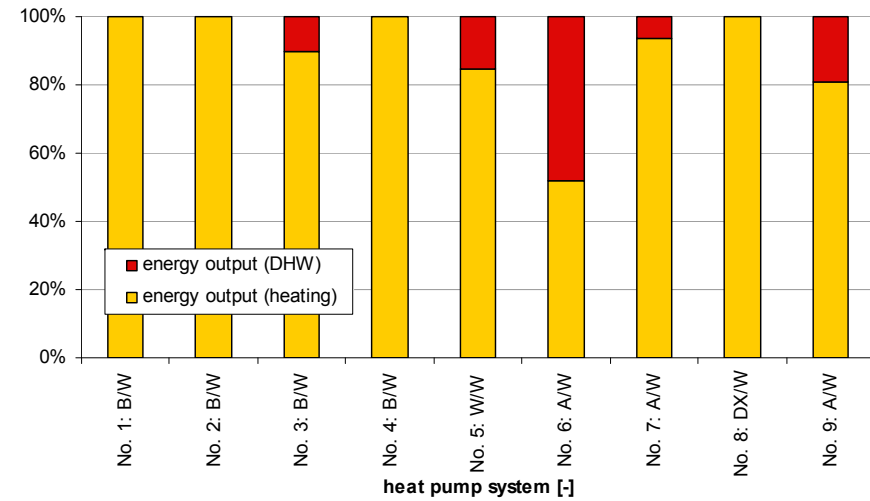
Quelle: Eigendarstellung AIT

Conventional units

Energy output

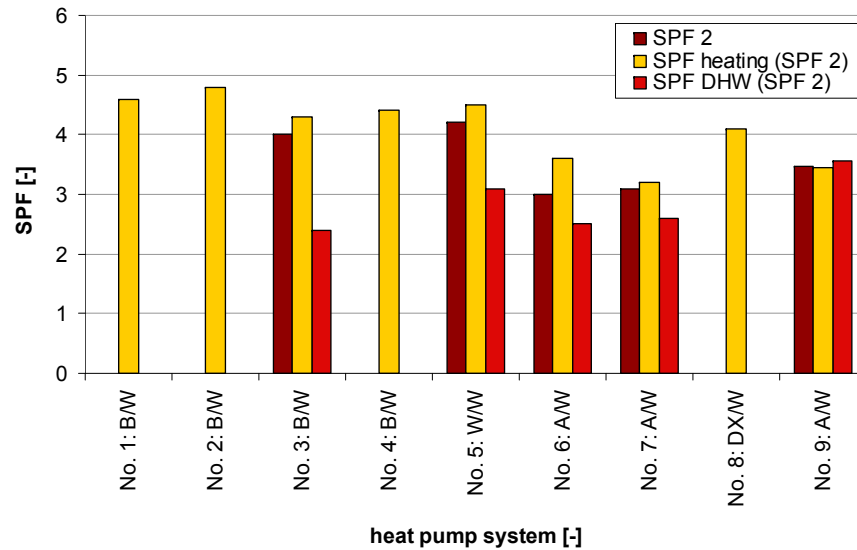


Heating / DHW ratio

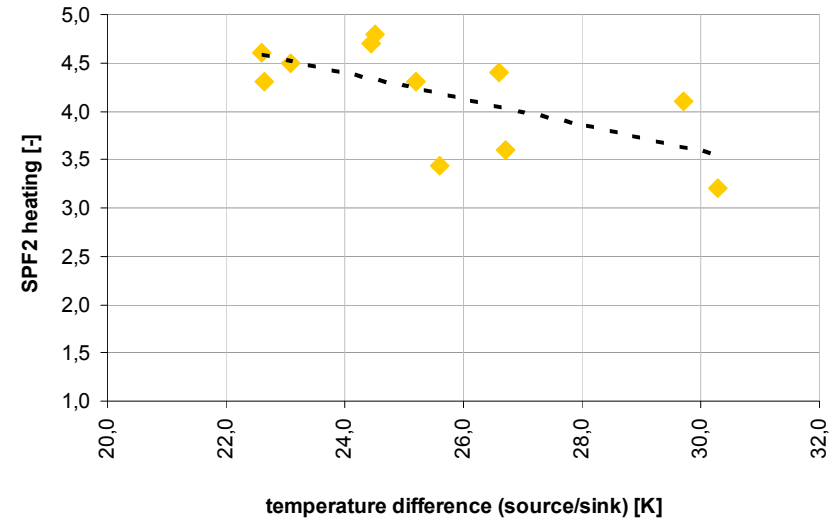


Conventional units

Seasonal Performance Factor (SPF) calculated according to system



Relation between SPF and temperature difference (source/sink)

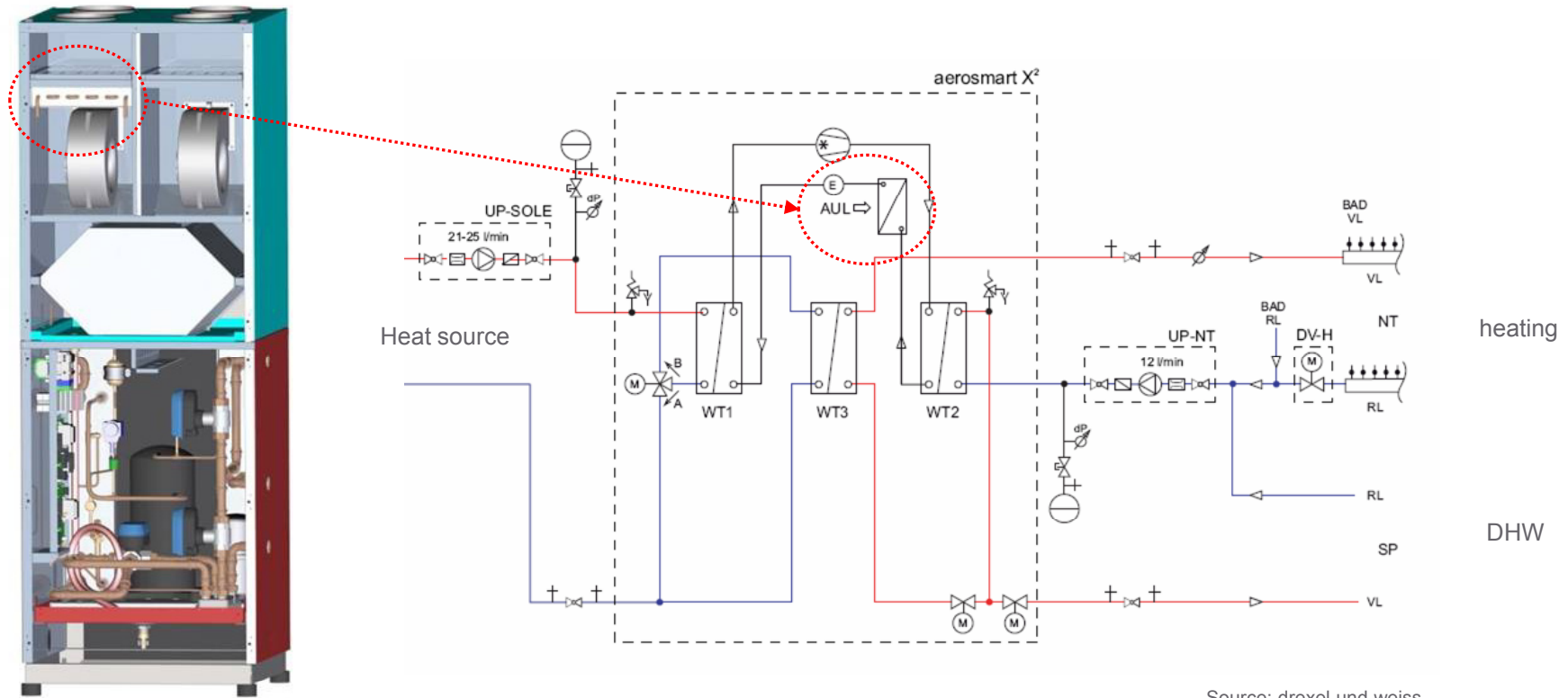


Results of the compact units' field testing

drexel und weiss x²: heating, DHW, ventilation and passive cooling

object						heat pump					heat source		heat sink					
Nr.	spec. heating load	heating load	heated area	building construction	commissioning	heat pump capacity	A/W	B/W	W/W	DX/W	horizontal collector	vertical collector	floor heating	wall heating	radiator	DHW with heat pump	DHW with seperate system	comfort ventilation
-	W/m ²	kW	m ²	-	-	kW	-	-	-	-	-	-	m ²	m ²	-	-	-	-
11	21	3.8	180	light	2008	3.3		x			x			80.0		x		x
12	17	3.5	210	light	2008	3.3		x			x		130.0			x		x

Compact units



Source: drexel und weiss

Compact unit

Monitoring Hitzendorf (10)

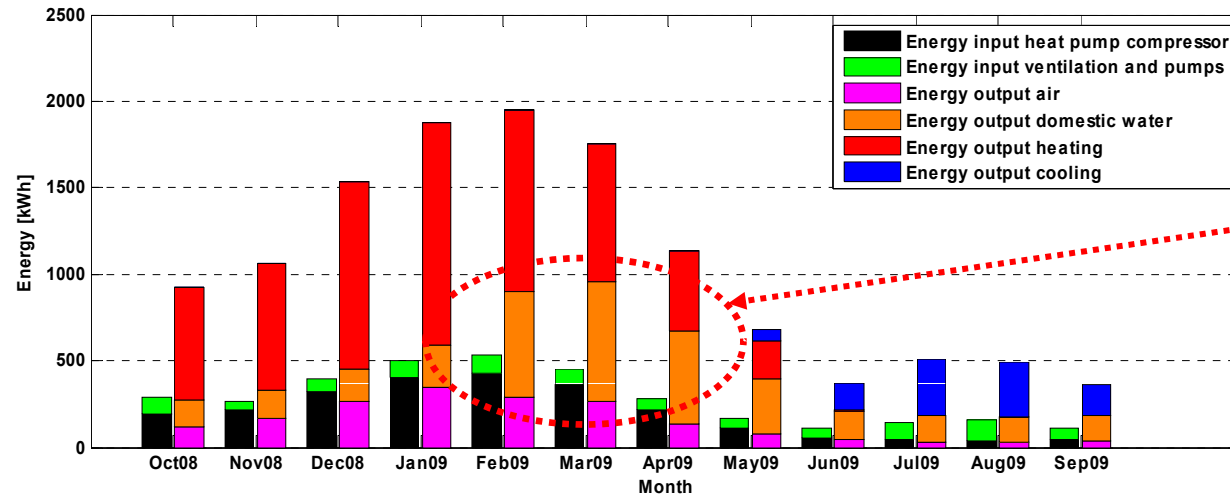
- Selected period: October 08 – September 09
- One family house
- Living space: 180 m²
- System: B/W + comfort ventilation
- Heat load: 3.8 kW
- Floor heating: -
- Wall heating: 80m²

- Energy input heat pump: 2425 kWh
- Energy input ventilation & pumps: 978 kWh
- Energy output heating: 6302 kWh
- Energy output domestic hot water : 3511kWh
- Energy output air : 1804 kWh



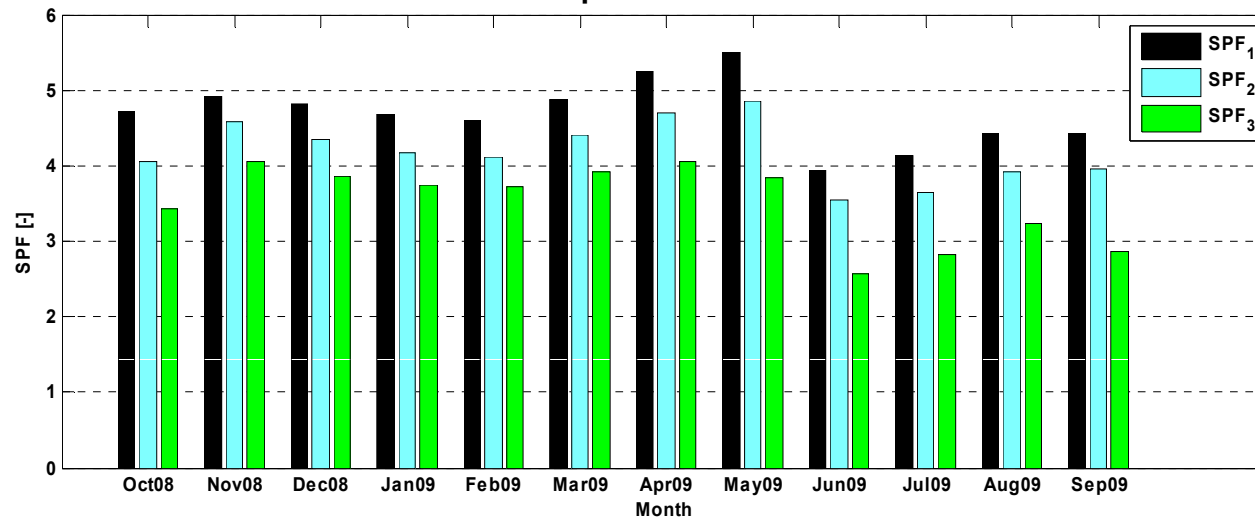
Source: drexel und weiss

Compact unit Monitoring Hitzendorf (10)



Bathroom heating via DHW-storage

Comparison of SPF



SPF1 total: 4.8

SPF2 total: 4.3

SPF2 heating: 4.7

SPF2 DHW: 3.6

SPF3 total: 3.7

Compact unit

Monitoring Judendorf (11)

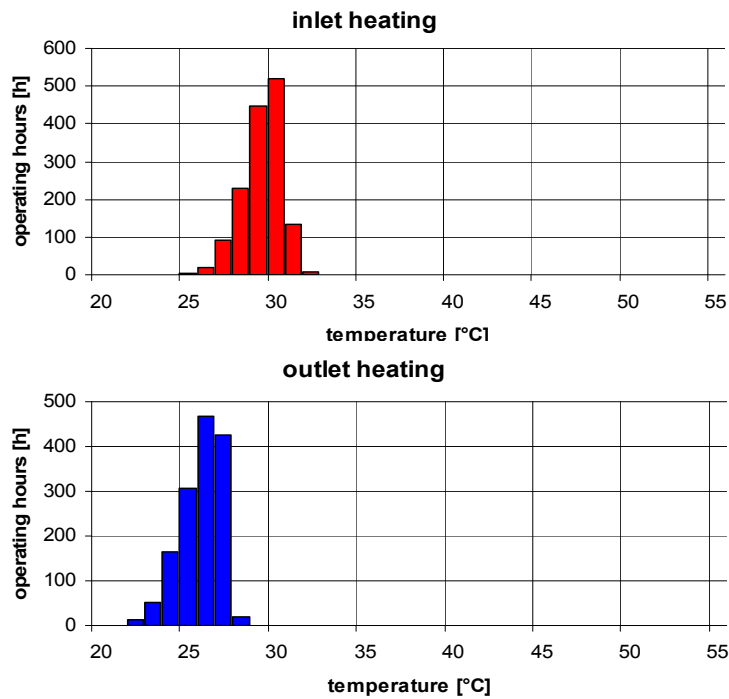
- Selected period : October 08 – September 09
- one family house
- Living space : 210 m² (144 m² + 66 m²)
- System: B/W + Comfort ventilation
- Heat load : 3,5 kW
- Floor heating : 130 m²
+ activation of thermal mass for cooling
- Energy input heat pump : 1816 kWh
- Energy input ventilation & pumps : 823 kWh
- Energy output heating : 5823 kWh
- Energy output domestic hot water : 1539 kWh
- Energy output air : 919 kWh



Source: drexel und weiss

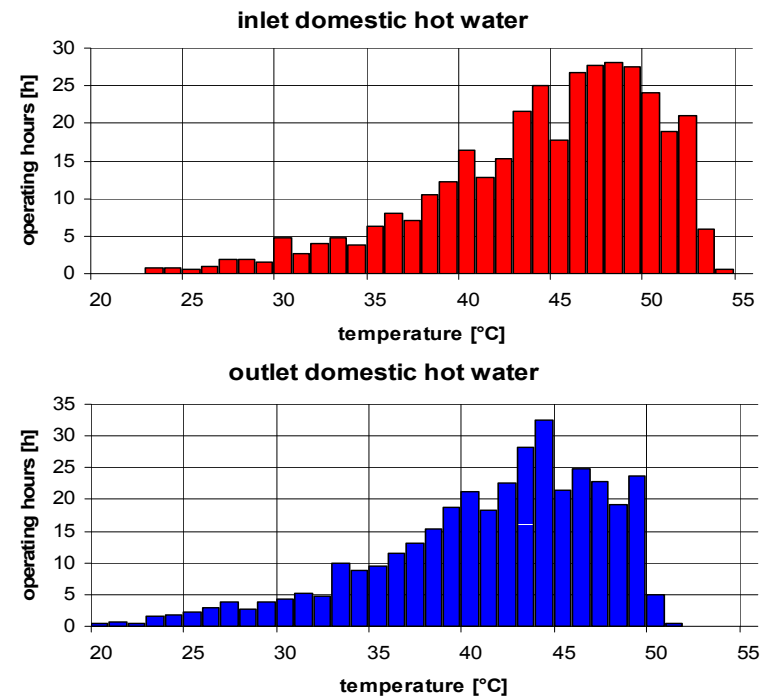
Compact unit Monitoring Judendorf (11)

Heating temperature - distribution



Total operating hours: 1450

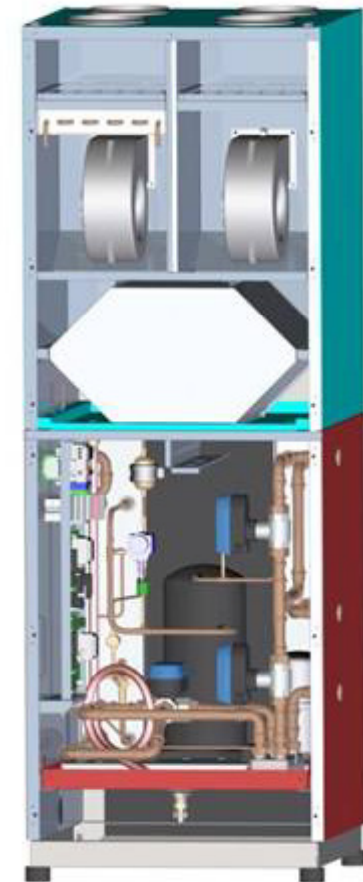
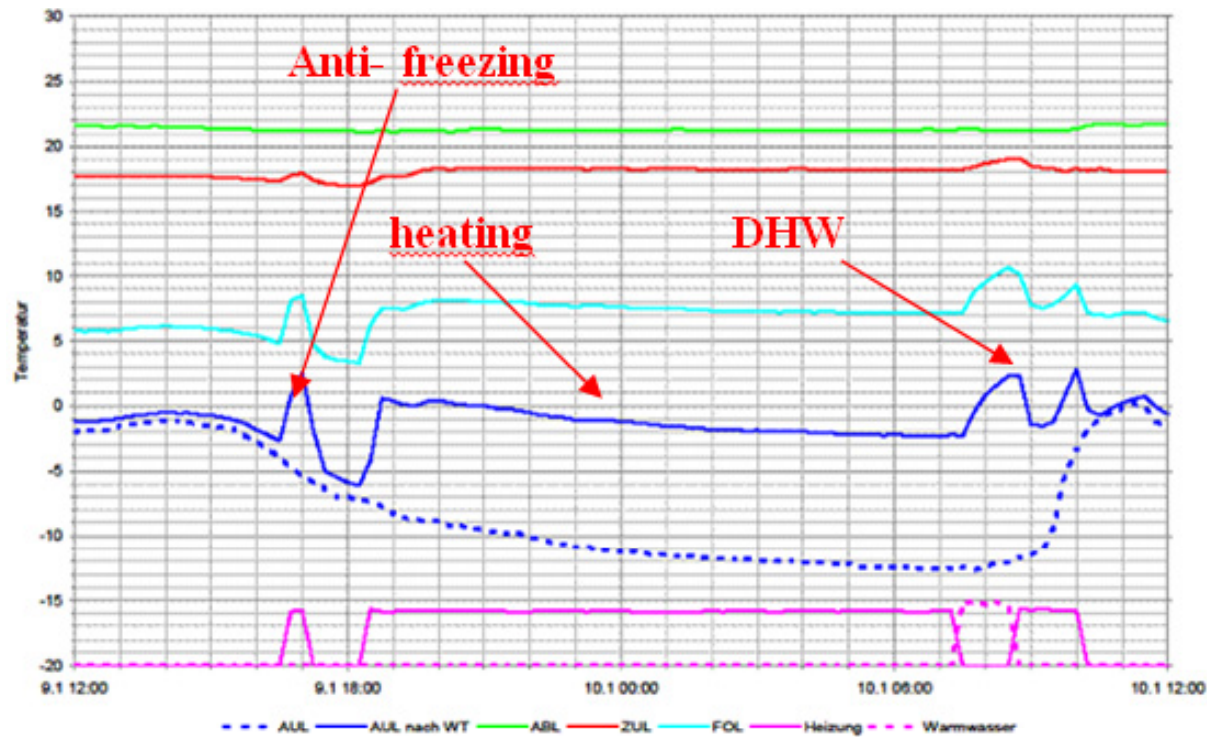
Hot water temperature - distribution



Total operating hours: 360

Compact unit Monitoring Judendorf (11)

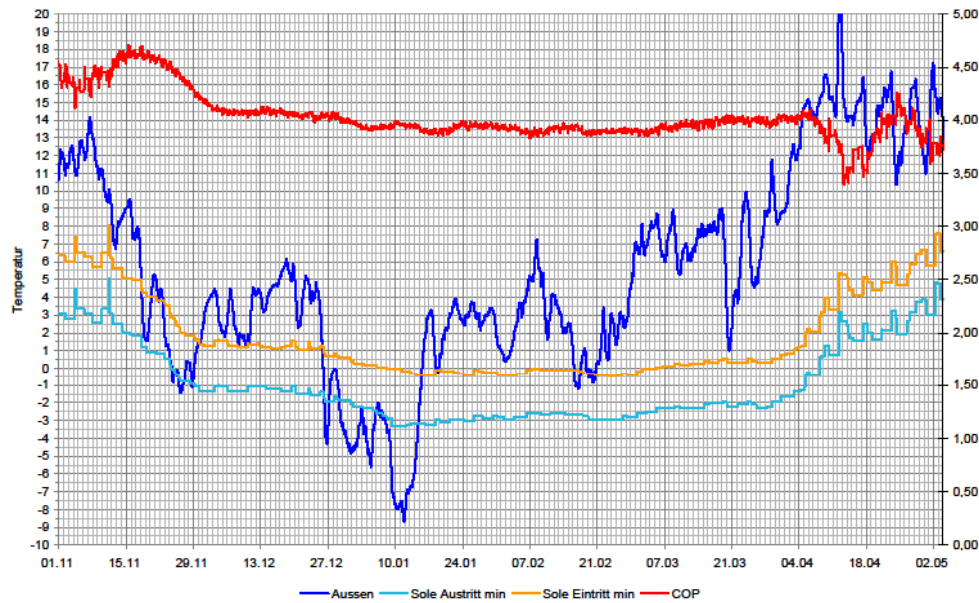
Ambient air pre heating with super cooler (09.01.09-10.01.09)



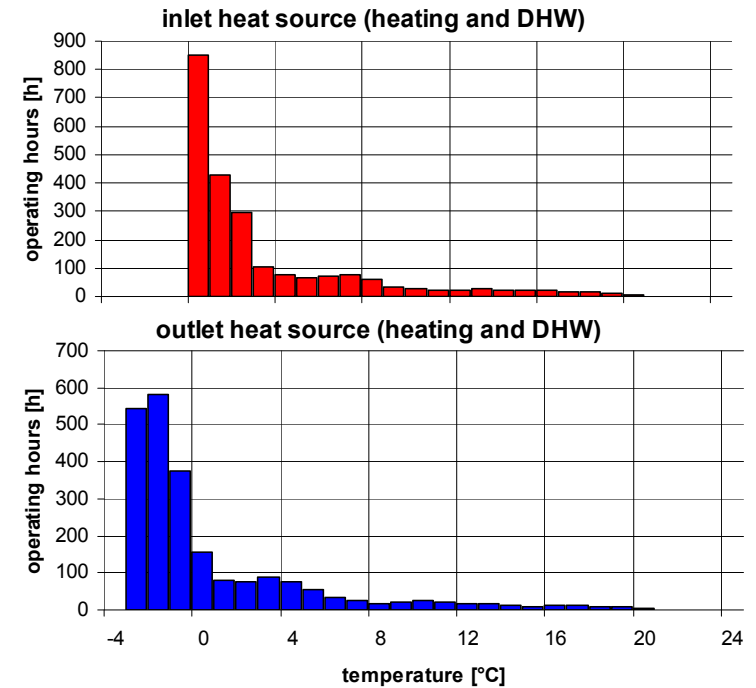
Source: drexel und weiss

Compact unit Monitoring Judendorf (11)

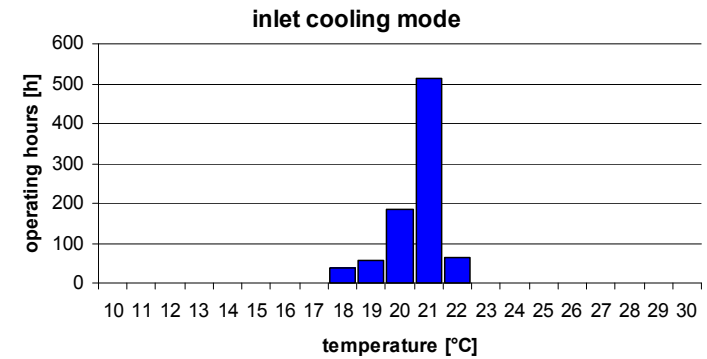
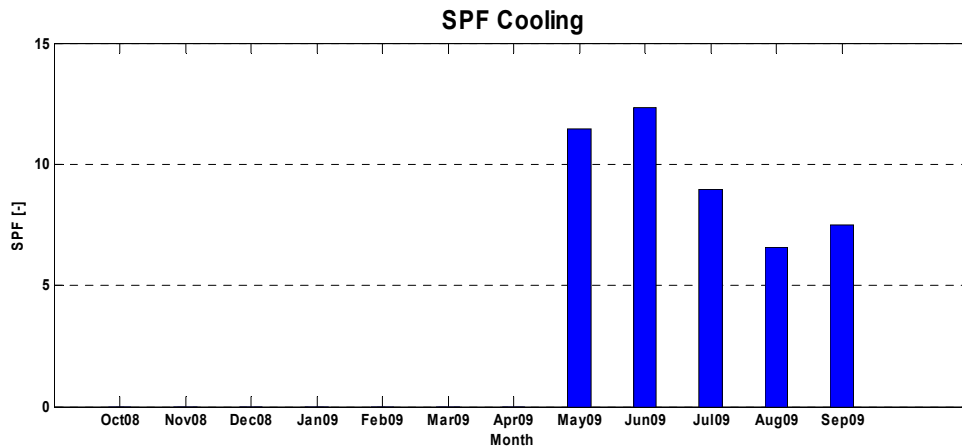
- Source temperature (December 08 – April 08)



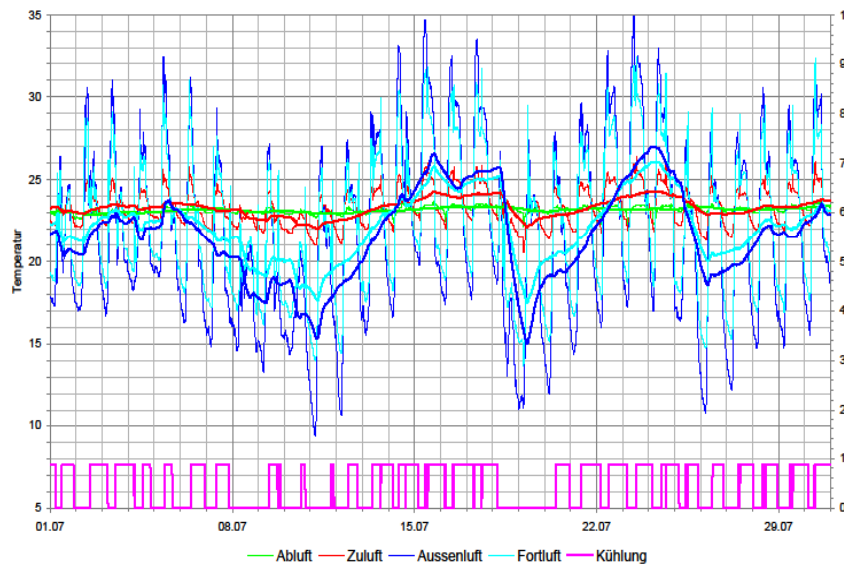
- Source temperature - distribution



Compact unit Monitoring Judendorf (11)



Juli 2009



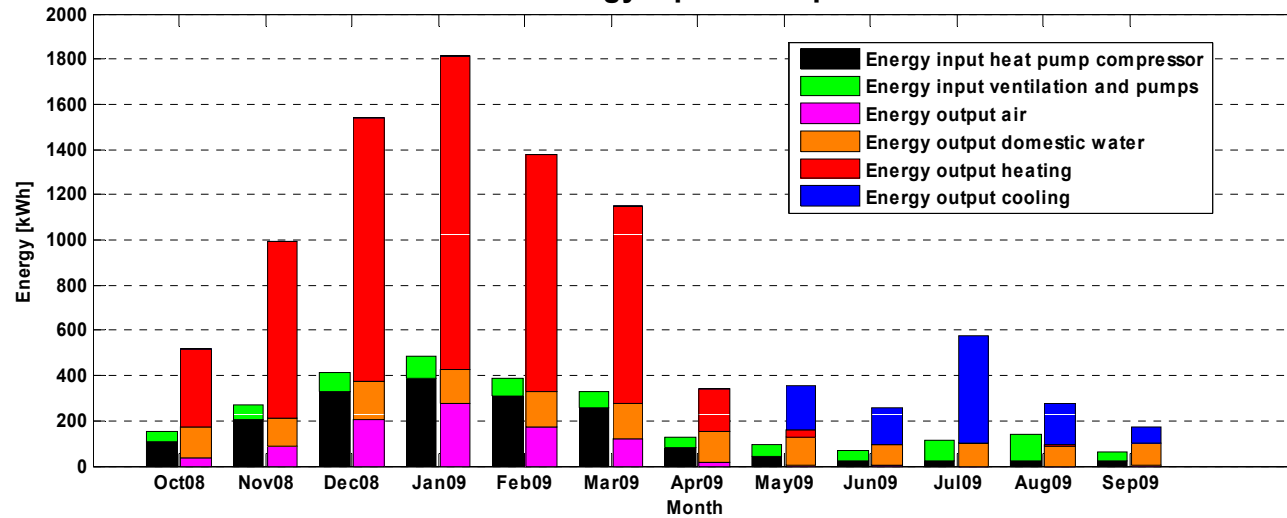
Passive cooling May 09 – Sept. 09:
1089 kWh



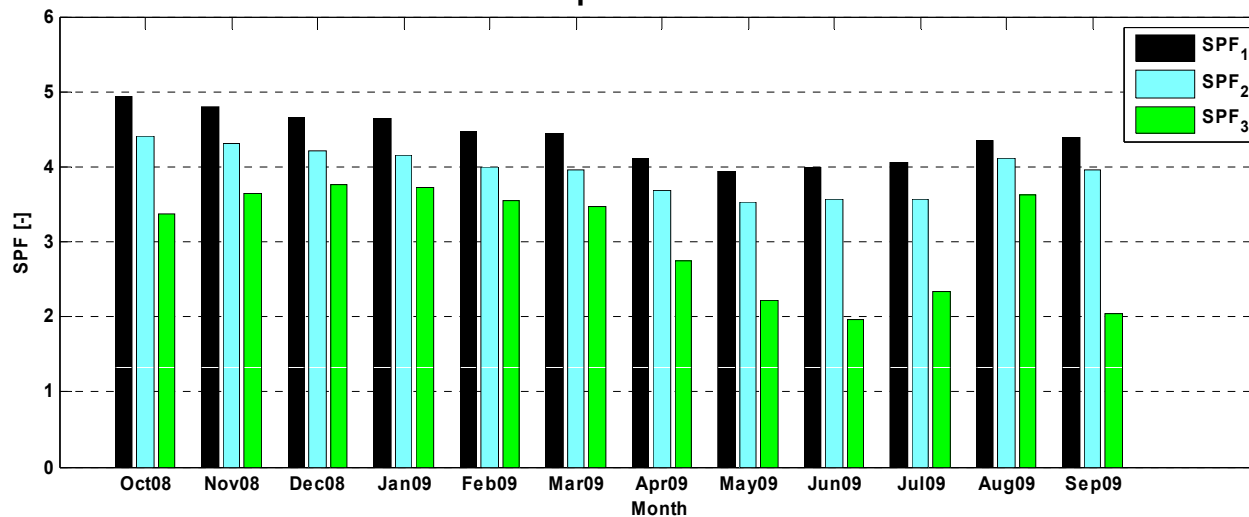
Compact unit

Monitoring Judendorf (11)

Energy input & output



Comparison of SPF



SPF1 total: 4.6

SPF2 total: 4.1

SPF2 heating: 4.3

SPF2 DHW: 3.7

SPF3 total: 3.4

Summary and conclusions

- 11 systems in low energy and passive standard houses in Austria monitored over a period of one year
- Oversizing of the equipment was detected as well as a strong influence of user behaviour
- The obtained results show good planing and installation quality and are comparable to other similar surveys
 - B/W: 4,5 (6 systems)
 - W/W: 4,5 (1 system)
 - DX/W: 4,1 (1 system)
 - A/W: 3,4 (3 systems)
 - B/W compact units: 4,2 (2 systems)
- The effect of passive cooling showed a positive effect on the soil regeneration and hence on the SPF



Thank you for your attention!

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