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Optimization of the seasonal efficiency of heat pumps by varying the bivalent temperature

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- Energy Labeling of space heating heat pumps
- SCOP comparison of Air/Water heat pumps
- Seasonal efficiency in dependency on bivalent temperature

AIT heat pump laboratory

- History
  - First tests at AIT in 2000
  - New Laboratory 2005
  - Expansion of the Laboratory 2010 and 2014

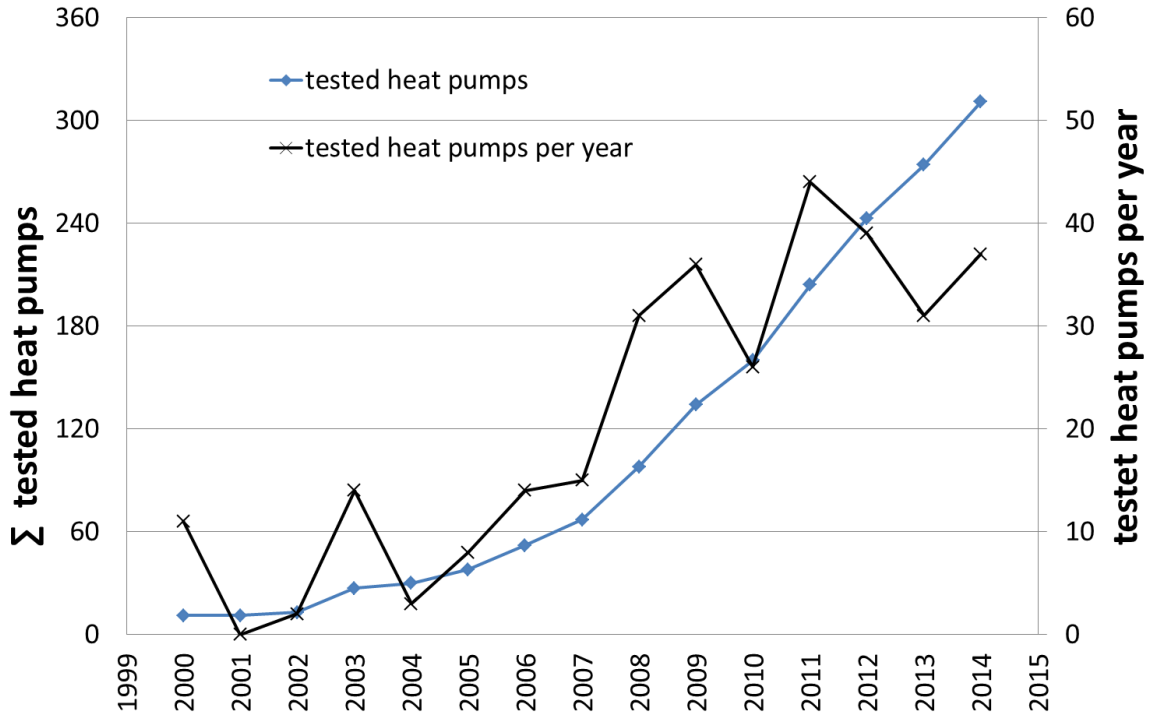
- Capacity
  - 2 Air/Water test rigs
  - 1 ground source test rig
    - BW/WW
    - DX
  - 1 Test rig for Domestic hot water heat pumps

AIT heat pump laboratory

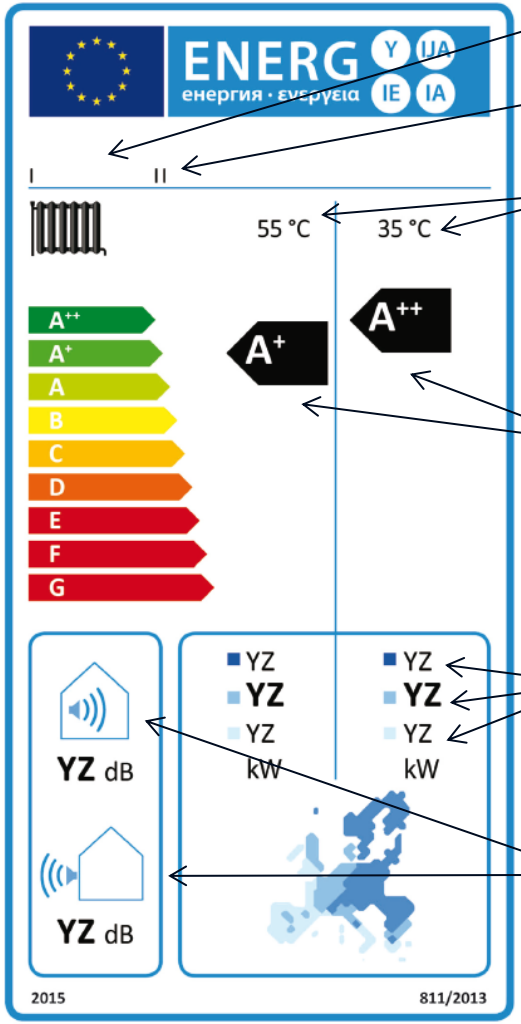
- applied procedures
  - EN 14511
  - EN 15879
  - EN 16147
  - EN 14825
  - EN 12309

  - EHPA-Quality Label
  - NF-PAC
  - MCS

- 2000 – 2014:
  - 311 tested units



Energy Labeling of space heating heat pumps



Suppliers name or trade mark

Suppliers identifier

Spaceheating function by means of low and medium temperature

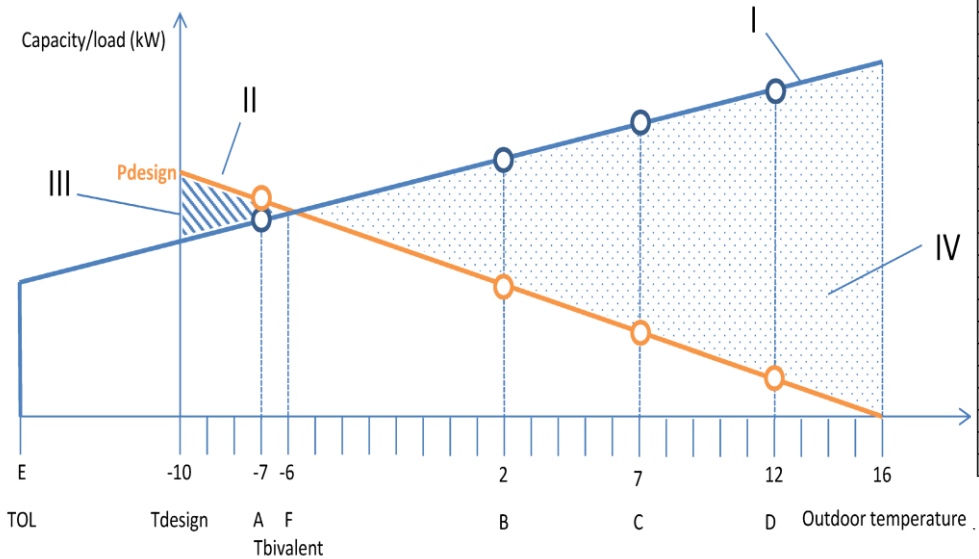
Seasonal space heating efficiency

Rated heat out put under average, colder and warmer climate condition and in medium and low temperature application

Sound power level indoor and outdoor measurement

Energy Labeling of space heating heat pumps

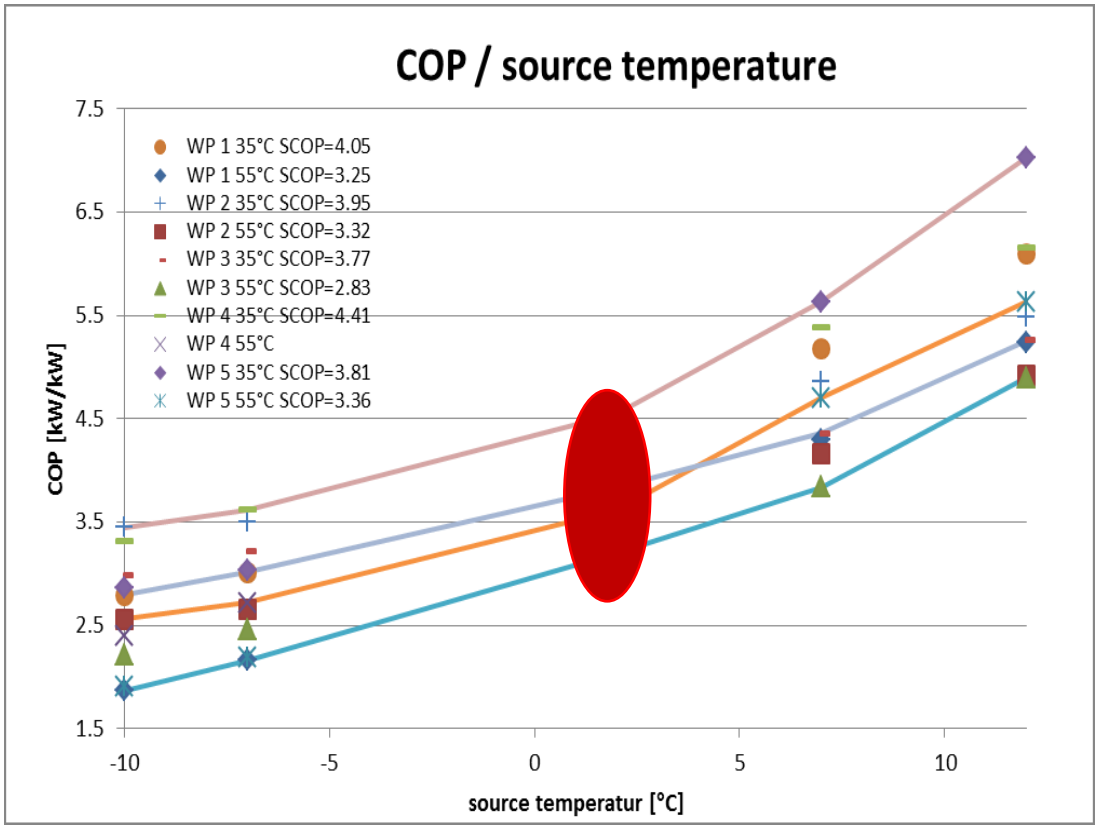
- Bin hours
- Capacity curve for average climate
- COP values at
  - 12° C, 7° C, 2° C, -7° C
  - Operation limit



j	T_j	Warmer (W)	Average (A)	Colder (C)
		hjW	hjA	hjC
#	°C	h	h	h
1 to 8	-30 to -23	0	0	0
9	-22	0	0	1
10	-21	0	0	6
11	-20	0	0	13
12	-19	0	0	17
13	-18	0	0	19
14	-17	0	0	26
15	-16	0	0	39
16	-15	0	0	41
17	-14	0	0	35
18	-13	0	0	52
19	-12	0	0	37
20	-11	0	0	41
21	-10	0	1	43
22	-9	0	25	54
23	-8	0	23	90
24	-7	0	24	125
25	-6	0	27	169
26	-5	0	68	195
27	-4	0	91	278
28	-3	0	89	306
29	-2	0	165	454
30	-1	0	173	385
31	0	0	240	490
32	1	0	280	533
33	2	3	320	380
34	3	22	357	228
35	4	63	356	261
36	5	63	303	279
37	6	175	330	229
38	7	162	326	269
39	8	259	348	233
40	9	360	335	230
41	10	428	315	243
42	11	430	215	191
43	12	503	169	146
44	13	444	151	150
45	14	384	105	97
46	15	294	74	61
	total	3 590	4 910	6 446

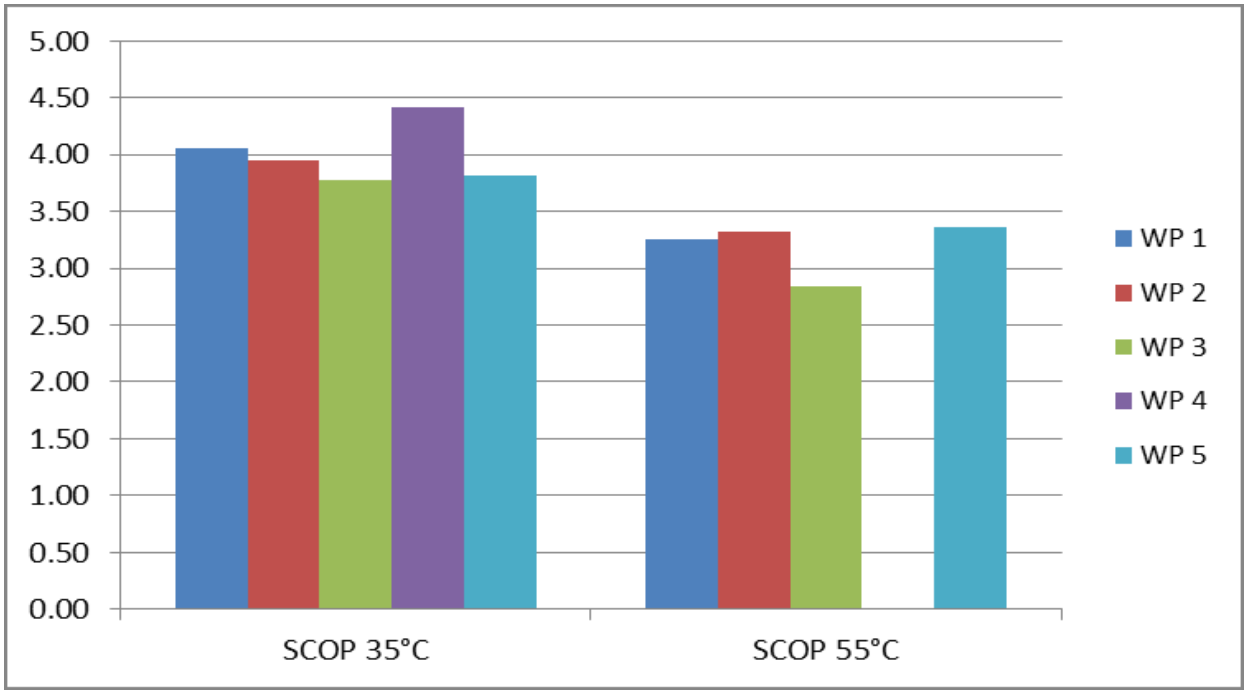
Energy Labeling of space heating heat pumps

- COP values at
  - Bivalent temperature (-7° C)
  - Operation limit
  - 12° C
  - 7° C
  - 2° C
  - -7° C
- SCOP in the range
  - 3.77 and 4.41
  - 2.83 and 3.36
- Air 2° C has highest influence on SCOP



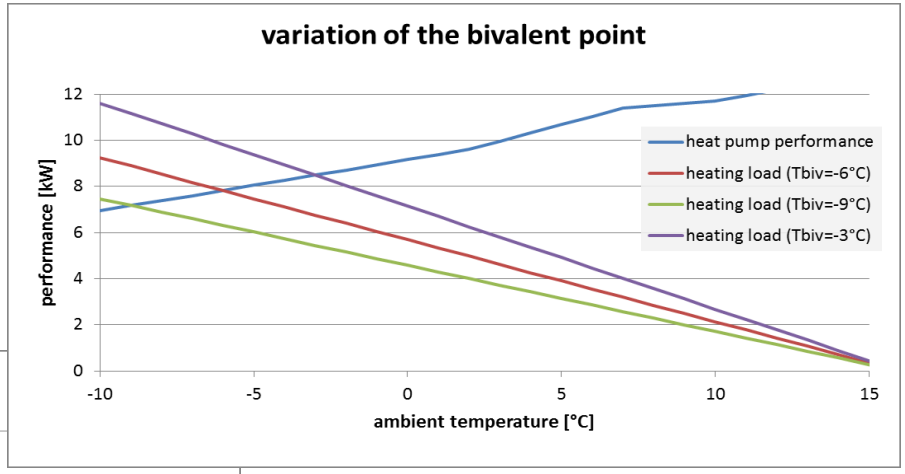
SCOP Comparison

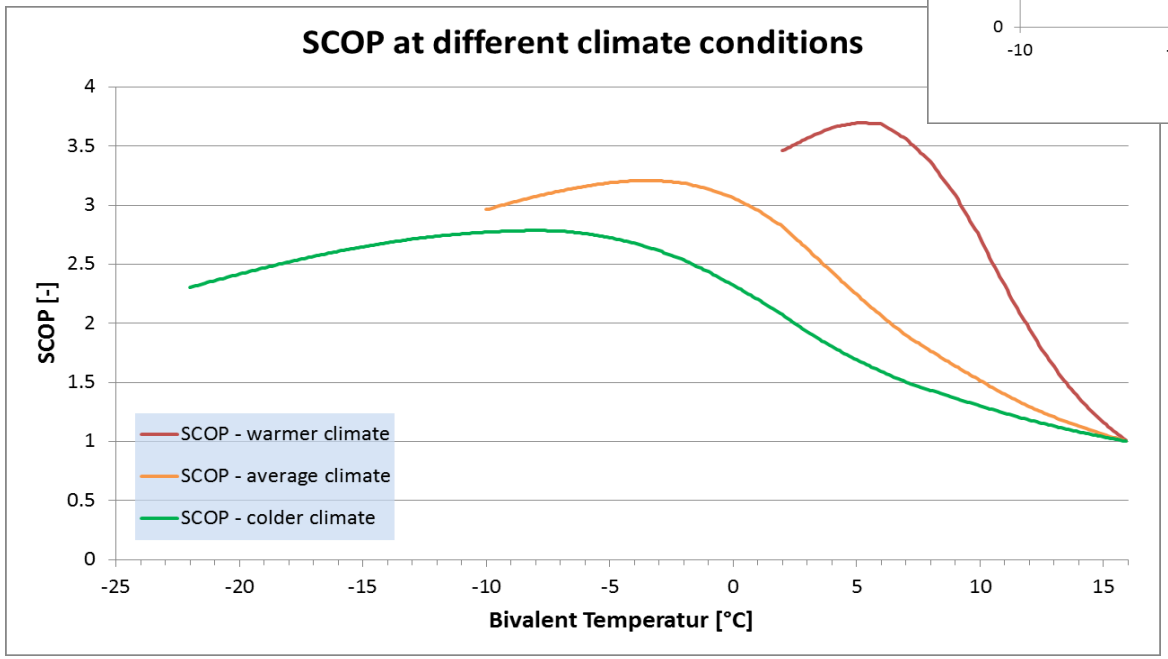
- SCOP in the range of
  - 3.77 and 4.41 at low temperature application
  - 2.83 and 3.36 at medium temperature application



SCOP in dependency on bivalent temperature

- $P_{designh}$ for T_{biv} -9° C, -6° C and -3° C
- SCOP for T_{biv} in the range of -22° C and 15° C





SCOP in dependency on bivalent temperature

- Comparison of 5 air/water heat pumps

	SCOP monovalent	lowest outdoor temperature	SCOP-Optimum	optimal bivalent temperatur	ΔSCOP	ΔSCOP relativ
	[-]	[°C]	[-]	[°C]	[-]	[%]
warmer climate	3.46	2	3.70	5	0.24	6.79
average climate	2.96	-10	3.21	-4	0.25	8.29
colder climate	2.30	-22	2.79	-8	0.48	20.89
warmer climate	3.30	2	3.44	5	0.14	4.30
average climate	2.85	-10	3.09	-4	0.24	8.57
colder climate	2.11	-22	2.70	-8	0.59	
warmer climate	3.78	2	3.97	5	0.19	5.07
average climate	3.39	-10	3.58	-4	0.20	5.83
colder climate	2.87	-22	3.20	-10	0.34	
warmer climate	3.84	2	3.95	3	0.11	2.86
average climate	3.48	-10	3.56	-9	0.08	2.16
colder climate	2.75	-22	3.11	-12	0.37	13.33
warmer climate	3.48	2	3.65	5	0.17	4.99
average climate	3.07	-10	3.30	-4	0.23	7.48
colder climate	2.47	-22	2.88	-8	0.41	16.65

SCOP in dependency on bivalent temperature

- Comparison of 5 brine/water heat pumps

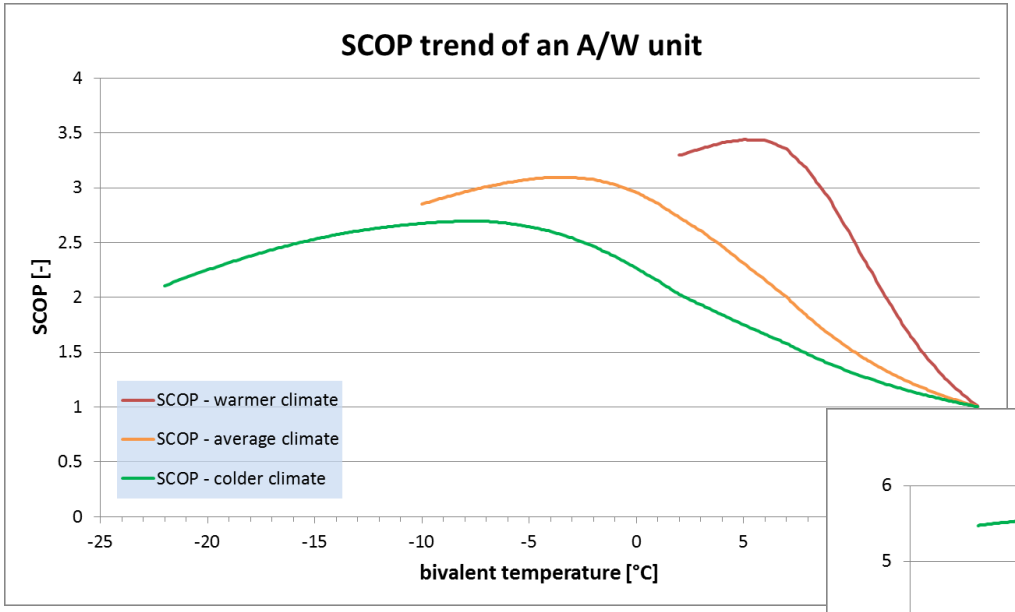
	SCOP monovalent	lowest outdoor temperature	SCOP-Optimum	optimal bivalent temperatur	ΔSCOP	ΔSCOP relativ
	[-]	[°C]	[-]	[°C]	[-]	[%]
warmer climate	4.06	2	4.21	5	0.15	3.60
average climate	4.28	-10	4.40	-5	0.12	[illegible]
colder climate	4.23	-22	4.36	-14	0.14	3.22
warmer climate	3.98	2	4.12	5	0.15	3.66
average climate	4.20	-10	4.31	-5	0.11	2.74
colder climate	4.14	-22	4.28	-14	0.14	3.27
warmer climate	3.65	2	3.79	5	0.14	3.88
average climate	3.85	-10	3.97	-5	0.11	[illegible]
colder climate	3.80	-22	3.93	-14	0.13	3.46
warmer climate	4.07	2	4.22	5	0.15	3.62
average climate	4.30	-10	4.41	-5	0.12	2.70
colder climate	4.24	-22	4.38	-14	0.14	3.22
warmer climate	3.82	2	3.96	5	0.14	3.73
average climate	4.03	-10	4.14	-5	0.11	2.80
colder climate	3.97	-22	4.11	-14	0.13	3.35

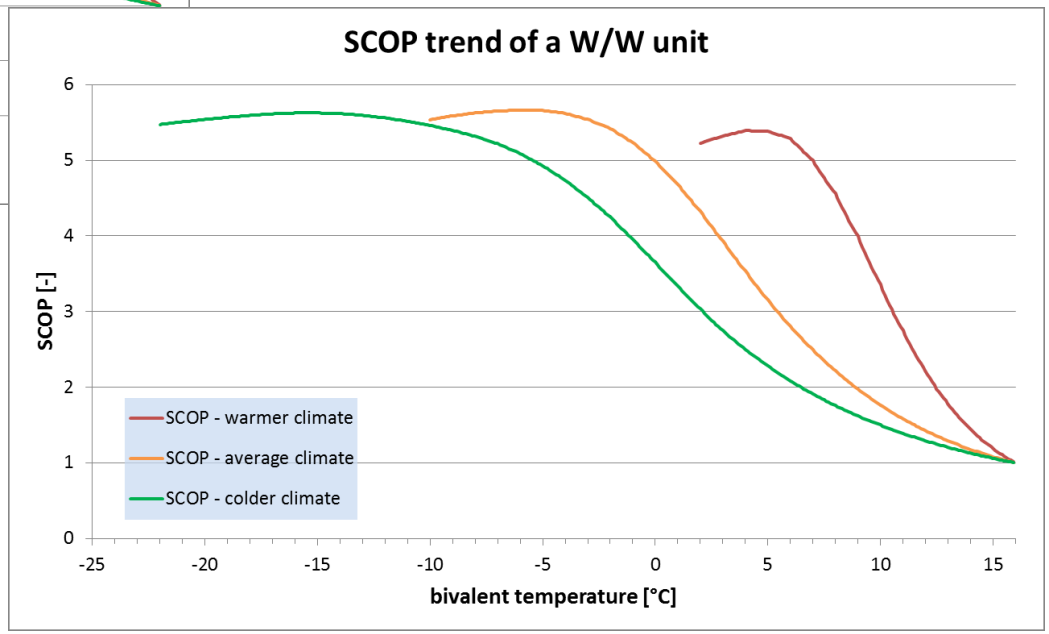
SCOP in dependency on bivalent temperature

- Comparison of 5 water/water heat pumps

	SCOP monovalent	lowest outdoor temperature	SCOP-Optimum	optimal bivalent temperatur	ΔSCOP	ΔSCOP relativ
	[-]	[°C]	[-]	[°C]	[-]	[%]
warmer climate	5.09	2	5.26	4	0.17	3.25
average climate	5.41	-10	5.53	-6	0.12	2.28
colder climate	5.35	-22	5.50	-15	0.15	2.85
warmer climate	4.28	2	4.43	5	0.15	[illegible]
average climate	4.53	-10	4.64	-5	0.12	2.62
colder climate	4.47	-22	4.61	-15	0.14	3.13
warmer climate	4.70	2	4.86	5	0.15	3.28
average climate	4.98	-10	5.10	-5	0.12	2.41
colder climate	4.92	-22	5.06	-15	0.15	2.97
warmer climate	5.23	2	5.39	4	0.17	[illegible]
average climate	5.54	-10	5.66	-6	0.12	2.22
colder climate	5.47	-22	5.63	-15	0.15	2.78
warmer climate	4.98	2	5.14	4	0.16	3.24
average climate	5.28	-10	5.40	-6	0.12	2.30
colder climate	5.22	-22	5.37	-15	0.15	2.88

SCOP in dependency on bivalent temperatur





Conclusion

- Marketing tool Energy Label
- Outdoor temperature of 2° C has the highest influence on the SCOP
- Improvement of the SCOP up to 28% compared to monovalent

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THANK YOU!!

Questions:

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