Japan Business Council in Europe

EPEE
European Partnership for Energy and the Environment

Brussels, 19th of December, 2009

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CC:
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TOPIC: PROPOSAL ON PARTLOAD WEIGHTING AND SEASONAL PERFORMANCE FACTORS

Dear Sirs

Based upon the recent position papers isssued, and based on the latest meeting we had on 28/11/2008, we present you with

1. a proposal for part load calculation.
2. a proposal of calculating separate seasonal performance factors for cooling and heating.

The first proposal has been made, to tackle the concern of the heavy weighting factor for part load calculation on heating at -7°C.
The outcome of our investigation is similar to the conclusions made at the Eurovent meeting where the suggestion has been made to use the Strasbourg climate data, as presented by Armines on 25th of November.
The second proposal has been elaborated to give a solution to the problems we have raised in former positions, such as the fact that cooling only products have lower minimum efficiency requirements than reversible products, and the relation that needs to be investigated with lot 1.

We trust that the information contained in this position paper will be of relevance and interest to you. Should you have any questions or require any additional input, please do not hesitate to contact me.

Yours sincerely,

Lars Brückner
Chairman Envionment Committee
Japan Business Council in Europe (JBCE)

The Japan Business Council in Europe (JBCE) is an European representative organisation for companies of Japanese parentage that operate in the European Union. A large part of the JBCE membership consists of manufacturers of electrical and electronic equipment, including major producers of leading technology air-conditioning, ventilation and heating products.

Friedrich P Busch
Director General - EPEE

The European Partnership for Energy and the Environment (www.epeeglobal.org) was formed in September 2000 to represent the interests of the air-conditioning, heat pump and refrigeration industry. Our central mission is to contribute to the development of effective European policies which have the aim to reduce greenhouse gas emissions from the use of refrigerants.

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THE REPORT FOR WEIGHTING PROPOSAL

1. Background

We review the weighting values for SCOP and SEER calculation proposed by Armines in task 8 & task 4 final draft and found it quite questionable. Reasons are as follows.

1) Weighting of -7 °C is too high compared to the value experiences tell.
2) Weighting shape is unusual. It should be high in the middle range. Otherwise uncalculated part appears too large.
3) Sales value of countries such as Romania, Bulgaria and Baltic three countries appears too high based on their GDP per capita and summer temperature.
4) Operation hours are too short that exaggerates the thermo-off time and crankcase heater operation hours.
5) R factor used in calculation for supplemental heater effect is confusing.

As such, we have decided to provide a new proposal, which takes into account the issues that have been raised in previous comments during stakeholder consultations and other meetings.

2. Assumption

We calculate the weighting under following assumptions.

1) Building load for heating is assumed to be linear having 100% load at 2 °C and 0% at 15.5 °C. This value is decided from the data of the EuP lot 10 task 4 report annex B Figure 1; Heating and cooling EU average load curves. Only linear part is considered. Cooling load is 100% at 35°C and 0% at 13°C. Other building load considering sizing effect may be evaluated.

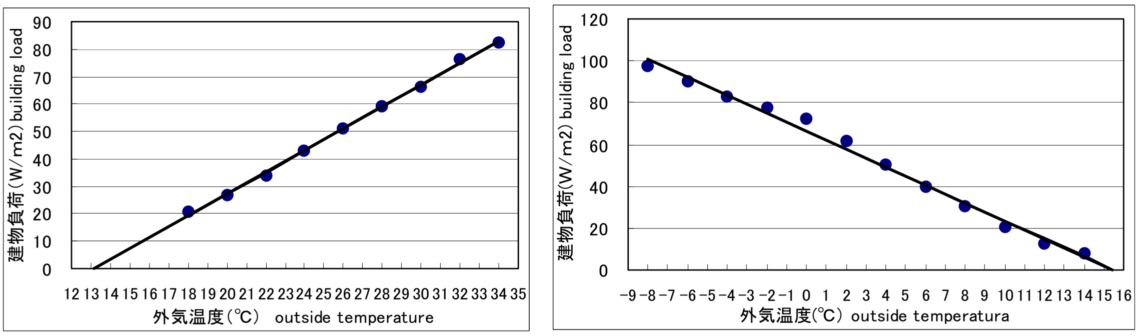

Figure 1 Cooling and Heating load

Load values are decided as follows;

Table 1. Cooling load

Ambient Outdoor (°C)	Cooling load (W/m²)	Load Ratio	Rounded Load (%)
0	27.15	0.31	30
25	47.01	0.54	55
30	66.88	0.77	75
35	86.74	1.00	100

Table 2. Heating load

Ambient Outdoor (°C)	Heating load (W/m²)	Load Ratio	Rounded Load (%)
-7	96.6	1.67	165
2	57.9	1.00	100
7	36.4	0.63	60
12	14.9	0.26	25

Not only heating but also cooling is to be calculated with the same method.

2) Sales volumes of some countries in the EUP – lot 10 report appear excessively high compared to their GDP per capita. Thereforewe estimate sales volumes of respective countries based on the JRAIA (Japan Refrigeration and Air conditioning Industry Association) 2007 sales data estimation. For data that is not available, simplified corrections have been done. For example, for Slovakia and Slovenia the values indicated in the task report are discounted to 1/3.
3) Weighting of each calculating bin is separated evenly between measuring points by temperature and not by energy (the US IPLV method). Performances is assumed to be the same in each bin.
4) The definition of season in the task report is used. Cooling season May 1st to 30th September. Heating season October to April. If there is no load in heating season, it is regarded as thermo-off time. If there is no load in cooling season, it is considered as stand-by.
5) Supplemental heater is directly involved to the performance at -7 °C. R factor is not used.
6) Hourly temperature data of cities are taken from US DOE EnergyPlus web. Capital cities are chosen in first priority. If only a city data other than capital is available, it is used instead of capital. Spain and Italy are divided into two regions and calculated with the same method of the task report.
   http://apps1.eere.energy.gov/buildings/energyplus/cfm/weather_data2.cfm/region=6_europe_wmo_region_6
   For some countries without available data, we calculate as follows; Sales weight of Malta is added to Cyprus. Baltic three countries are represented by Lithuania. The weight of Bulgaria is added to Romania.

Table 2. Weighting of each country

	JRAIA Estimation Weight (%)	Task report Weight (%)
Austria	0.30	0.22
Belgium	2.04	1.52
Bulgaria	2.51	3.62
Cyprus	0.92	0.54
Czech	0.53	0.40
Denmark	1.05	0.78
Estonia	0.27	0.20
Finland	0.53	0.39
France	9.46	8.89
Germany	2.55	2.49
Greek	9.89	7.42
Hungary	1.40	1.25
Ireland	0.42	0.31
Italy	29.29	25.34
Latvia	0.45	0.33
Lithuania	0.66	0.49
Luxembourg	0.10	0.07
Malta	0.25	0.19
Netherlands	1.09	2.37
Poland	0.65	0.48
Portugal	3.11	1.17
Romania	2.25	10.17
Slovakia	1.14	2.54
Slovenia	0.42	0.94
Spain	23.01	21.15

Sweden	1.57	0.67
UK	4.16	6.02
Total	100	100

3. Cooling Calculation results

Followings are the bin calculation and average results for cooling.

Table 3-1. Cooling City bin data (1)

Temp	Aut	Bel	Cyl	CZE	DEU	DNK	ESP	FIN	FRA	GBR	GRC	Hun
	Vienna	Brussels	Larnaka	Prague	Bremen	Copenhagen	Madrid	Helsinki	Lyon	London	Athens	Debrecen
	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr
13	127	170	1	215	168	175	135	138	138	203	17	112
14	256	374	8	303	321	361	148	327	218	377	18	224
15	298	383	16	301	312	394	139	279	223	367	32	249
16	269	321	27	287	339	342	161	246	253	286	52	224
17	258	288	47	248	302	307	189	203	260	268	80	231
18	276	222	81	232	197	236	228	159	300	209	123	280
19	273	221	100	157	122	157	223	133	249	161	157	263
20	223	143	136	156	131	109	232	101	268	149	151	253
21	202	114	215	145	93	77	209	81	199	135	215	225
22	178	95	265	116	89	60	206	73	174	104	228	199
23	143	83	337	89	69	37	191	56	158	80	326	139
24	125	59	341	73	54	24	170	40	158	66	339	130
25	96	57	346	66	42	29	150	32	124	37	341	120
26	82	49	285	61	47	7	145	14	110	27	317	110
27	84	31	286	20	42	5	149	10	86	15	266	75
28	53	24	311	15	24	0	115	8	65	7	269	64
29	30	8	294	8	25	0	112	2	62	5	214	59
30	27	10	210	9	14	0	108	0	40	2	155	60
31	11	7	149	8	11	0	70	0	30	2	114	36
32	2	8	98	1	2	0	70	0	21	0	93	23
33	0	1	59	0	0	0	72	0	11	0	58	4
34	0	2	29	0	0	0	56	0	1	0	37	0
35	0	2	14	0	0	0	49	0	0	0	23	0
36	0	0	5	0	0	0	30	0	0	0	19	0
37	0	0	1	0	0	0	19	0	0	0	3	0
38	0	0	0	0	0	0	14	0	0	0	0	0
39	0	0	0	0	0	0	7	0	0	0	0	0
40	0	0	0	0	0	0	2	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0
Cooling on total	3,013	2,672	3,661	2,510	2,404	2,320	3,399	1,902	3,148	2,500	3,647	3,080
Cooling off total	659	1,000	11	1,162	1,268	1,352	273	1,770	524	1,172	25	592
Cooling total	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672

Table 3-2. Cooling City bin data (2)

Temp	IRL	ITA	ITA	LTU	NLD	POL	PRT	SVK	SWE	Rom	SVN	ESP	Wei-ghted Average
	Dublin	Milan	Rome	Kaunas	Amsterdam	Warsaw	Lisboa	Bratislava	Goteborg	Bucharest	Ljubljana	Sevilla	
	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr
13	253	83	41	149	161	219	53	183	227	117	214	37	95
14	429	173	65	262	369	301	122	284	375	176	278	70	159
15	489	206	99	256	358	310	226	243	329	195	299	99	176
16	361	176	128	237	322	261	253	243	247	211	244	113	179
17	246	210	165	221	377	272	303	243	197	251	226	166	202
18	172	230	225	231	324	257	274	251	145	209	205	161	214
19	124	270	240	193	200	208	264	261	94	246	197	225	221
20	70	276	265	180	128	146	235	246	69	227	143	220	220
21	45	234	285	141	93	154	225	200	60	172	130	234	209
22	11	267	327	126	81	95	207	188	38	168	136	218	212
23	9	236	379	99	51	103	183	144	25	153	145	224	218
24	7	222	309	64	37	105	182	168	10	156	108	192	198
25	0	202	280	51	33	64	163	120	22	158	105	184	181
26	0	174	246	30	24	64	179	98	7	137	87	182	165
27	0	121	205	43	14	36	154	98	5	114	70	150	136
28	0	102	155	7	16	22	147	74	0	122	65	147	119
29	0	73	92	2	11	12	111	54	0	87	45	124	92
30	0	40	59	0	10	7	81	26	0	88	35	129	72
31	0	16	14	0	3	6	57	21	0	52	19	114	47
32	0	9	1	0	3	1	41	17	0	31	10	122	39
33	0	1	0	0	1	0	14	3	0	33	7	98	29
34	0	0	0	0	0	0	7	0	0	16	0	91	22
35	0	0	0	0	0	0	1	0	0	13	0	91	19
36	0	0	0	0	0	0	2	0	0	1	0	74	14
37	0	0	0	0	0	0	0	0	0	6	0	59	10
38	0	0	0	0	0	0	0	0	0	1	0	45	7
39	0	0	0	0	0	0	0	0	0	1	0	27	4
40	0	0	0	0	0	0	0	0	0	0	0	19	2
41	0	0	0	0	0	0	0	0	0	0	0	3	0
42	0	0	0	0	0	0	0	0	0	0	0	5	1
43	0	0	0	0	0	0	0	0	0	0	0	1	0
Cooling on total	2,216	3,321	3,580	2,292	2,616	2,643	3,484	3,165	1,850	3,141	2,768	3,624	3,263
Cooling off total	1,456	351	92	1,380	1,056	1,029	188	507	1,822	531	904	48	409
Cooling total	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672	3,672

Table 4. Weighting coefficient for cooling.

TEMP	Load	Hour	Load*Hr	Load*Hr Sub total	Weighting Coefficient	Rounded Coefficient
13	0%	95	0.0			
14	5%	159	7.2			
15	9%	176	16.0			
16	14%	179	24.4			
17	18%	202	36.6			
18	23%	214	48.7			
19	27%	221	60.2			
20	32%	220	70.0	426.0	0.330	33%
21	36%	209	75.9			
22	41%	212	86.9			
23	45%	218	98.9			
24	50%	198	98.9			
25	55%	181	98.9	480.9	0.372	37%
26	59%	165	97.3			
27	64%	136	86.8			
28	68%	119	80.9			
29	73%	92	67.2			
30	77%	72	55.8	276.6	0.214	21%
31	82%	47	38.6			
32	86%	39	34.1			
33	91%	29	26.7			
34	95%	22	21.0			
35	100%	19	19.2	108.8	0.084	9%
36	105%	14	14.7			
37	109%	10	10.4			
38	114%	7	7.8			
39	118%	4	4.7			
40	123%	2	3.0			
41	127%	0	0.4			
42	132%	1	0.8			
43	136%	0	0.2			
Total		3,263	1,292.3	1,292.3	1.000	100%

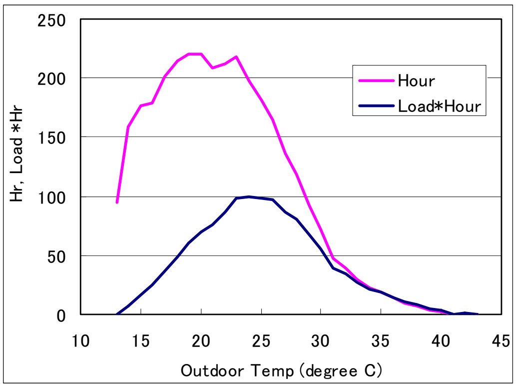

Figure 2. Cooling Hour and Hour x load distribution

4. Heating calculation results

Table 5-1 Heating City bin data (1)

Temp	Aut	Bel	Cyl	CZE	DEU	DNK	ESP	FIN	FRA	GBR	GRC	Hun
	Vienna	Brussels	Larnaka	Prague	Bremen	Copenhagen	Madrid	Helsinki	Lyon	London	Athens	Debrecen
	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr
-22	0	0	0	0	0	0	0	1	0	0	0	0
-21	0	0	0	0	0	0	0	6	0	0	0	3
-20	0	0	0	0	0	0	0	13	0	0	0	1
-19	0	0	0	0	0	0	0	17	0	0	0	0
-18	5	0	0	0	0	0	0	19	0	0	0	6
-17	8	0	0	0	0	0	0	26	0	0	0	1
-16	4	0	0	0	0	0	0	39	0	0	0	3
-15	2	0	0	1	0	0	0	41	0	0	0	3
-14	8	0	0	9	0	0	0	35	0	0	0	2
-13	12	0	0	17	0	0	0	52	0	0	0	8
-12	15	0	0	9	5	0	0	37	0	0	0	6
-11	12	0	0	33	4	0	0	41	0	0	0	10
-10	8	0	0	39	5	1	0	43	0	0	0	11
-9	9	2	0	54	6	10	0	54	0	0	0	17
-8	13	5	0	52	16	18	0	90	8	0	0	27
-7	21	12	0	88	16	21	0	125	6	0	0	60
-6	56	10	0	78	30	24	0	169	14	4	0	66
-5	84	13	0	122	44	29	2	195	32	27	0	53
-4	131	18	0	185	80	87	7	278	60	29	0	108
-3	242	43	0	262	108	111	28	306	79	42	0	244
-2	226	94	0	295	158	154	60	454	119	71	0	217
-1	204	190	0	293	205	191	102	382	146	126	0	224
0	280	211	0	431	301	302	124	483	174	158	0	322
1	359	300	3	334	358	458	124	520	232	223	0	418
2	376	289	4	338	461	494	129	359	235	214	3	346
3	344	301	10	234	424	504	218	196	237	265	22	337
4	339	317	26	246	458	521	240	209	333	298	63	285
5	332	367	48	241	412	479	356	213	332	391	63	254
6	271	414	49	301	389	389	356	148	313	429	175	253
7	253	443	88	307	293	340	363	150	311	441	162	257
8	186	426	154	225	267	222	347	117	381	462	259	228
9	170	370	243	179	230	151	341	96	356	470	360	246
10	199	344	299	135	228	168	306	110	346	431	428	206
11	216	211	359	121	183	132	300	35	293	325	430	172
12	151	153	373	111	132	131	280	12	259	254	505	158
13	131	162	385	87	92	65	246	7	209	166	458	131
14	89	119	353	70	65	41	237	4	172	123	409	92
15	81	78	396	48	36	26	225	1	126	71	344	92
Heating on total	4,837	4,892	2,790	4,945	5,006	5,069	4,391	5,083	4,773	5,020	3,681	4,867
Heating off total	251	196	2,298	143	82	19	697	5	315	68	1,407	221
Heating Total	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088

Table 5-2 Heating City bin data (2)

Temp	IRL	ITA	ITA	LTU	NLD	POL	PRT	SVK	SWE	Rom	SVN	ESP	Weighted
	Dublin	Milan	Rome	Kaunas	Amsterdam	Warsaw	Lisboa	Bratislava	Goteborg	Bucharest	Ljubljana	Sevilla	Average
	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr	Hr
-22	0	0	0	0	0	0	0	0	0	0	0	0	0
-21	0	0	0	0	0	0	0	0	0	0	1	0	0
-20	0	0	0	0	0	0	0	3	0	3	3	0	0
-19	0	0	0	4	0	0	0	3	0	6	2	0	0
-18	0	0	0	6	0	0	0	1	0	1	1	0	0
-17	0	0	0	15	0	0	0	9	0	3	0	0	1
-16	0	0	0	17	0	1	0	3	2	3	1	0	1
-15	0	0	0	23	0	0	0	2	7	4	1	0	1
-14	0	0	0	34	0	1	0	2	4	9	1	0	1
-13	0	0	0	36	0	14	0	7	5	12	7	0	2
-12	0	0	0	40	0	17	0	14	9	15	12	0	2
-11	0	2	0	31	0	32	0	15	13	24	12	0	3
-10	0	14	0	44	0	42	0	17	29	24	31	0	6
-9	0	17	0	68	0	49	0	31	68	29	42	0	8
-8	0	31	0	102	2	67	0	54	75	39	69	0	13
-7	0	39	0	131	4	87	0	45	94	106	69	0	19
-6	0	58	0	97	9	79	0	69	75	82	80	0	22
-5	0	43	0	174	18	70	0	120	81	96	82	0	26
-4	6	66	3	222	28	118	0	98	93	95	129	0	37
-3	4	121	7	254	36	170	0	76	211	156	189	0	61
-2	28	155	10	258	74	230	0	105	255	199	261	3	83
-1	54	191	11	311	116	273	0	303	298	242	245	4	108
0	114	221	27	394	193	446	0	334	661	292	364	9	141
1	144	290	52	475	217	408	0	329	580	344	400	10	172
2	198	293	58	351	243	400	0	357	394	307	369	23	170
3	263	304	99	291	270	332	0	342	335	318	287	38	190
4	343	326	164	222	424	297	2	299	375	354	272	90	230
5	415	329	197	292	494	314	12	302	321	308	274	107	253
6	520	273	218	241	569	287	38	240	254	250	323	123	257
7	571	259	247	213	564	264	142	243	212	197	278	181	263
8	606	274	341	169	451	240	237	221	204	170	279	230	297
9	530	262	328	154	348	165	377	212	123	186	189	216	298
10	443	243	298	125	227	158	539	231	97	196	147	299	303
11	272	207	365	109	201	121	537	220	98	172	137	366	298
12	214	206	448	73	157	92	537	202	52	151	102	405	307
13	152	208	413	38	151	86	499	151	11	129	77	362	274
14	62	151	416	26	107	71	479	110	12	102	79	333	245
15	55	121	340	23	75	37	416	87	6	88	73	375	215
Heating on total	4,994	4,704	4,042	5,063	4,978	4,968	3,815	4,857	5,054	4,712	4,888	3,174	4,304
Heating off total	94	384	1,046	25	110	120	1,273	231	34	376	200	1,914	784
Heating total	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088	5,088

Table 6. Weighting coefficients for heating.

TEMP	Load	Hour	Load*Hr	Load*Hr Sub total	Weighting Coefficients	Rounded Weighting Coefficients
-22	278%	0.0	0.0			
-21	270%	0.1	0.2			
-20	263%	0.3	0.7			
-19	256%	0.5	1.2			
-18	248%	0.3	0.9			
-17	241%	0.6	1.5			
-16	233%	0.7	1.7			
-15	226%	0.9	2.1			
-14	219%	1.3	2.8			
-13	211%	1.9	3.9			
-12	204%	2.2	4.5			
-11	196%	3.2	6.2			
-10	189%	5.6	10.6			
-9	181%	7.9	14.3			
-8	174%	13.0	22.6			
-7	167%	18.9	31.6	315.2	0.118	12%
-6	159%	21.8	34.7			
-5	152%	25.7	39.0			
-4	144%	37.3	53.9			
-3	137%	60.6	83.0			
-2	130%	82.7	107.2			
-1	122%	107.7	131.6			
0	115%	140.7	161.6			
1	107%	171.6	184.3			
2	100%	170.5	170.5	1,127.3	0.420	42%
3	93%	190.5	176.4			
4	85%	229.9	195.8			
5	78%	252.9	196.7			
6	70%	256.6	180.6			
7	63%	263.0	165.6	851.0	0.317	32%
8	56%	296.6	164.8			
9	48%	297.8	143.4			
10	41%	302.9	123.4			
11	33%	297.9	99.3			
12	26%	306.9	79.6	388.1	0.145	14%
13	19%	273.8	50.7			
14	11%	244.9	27.2			
15	4%	214.8	8.0			
Total		4,304	2,681.8	2,681.8	1.000	100%

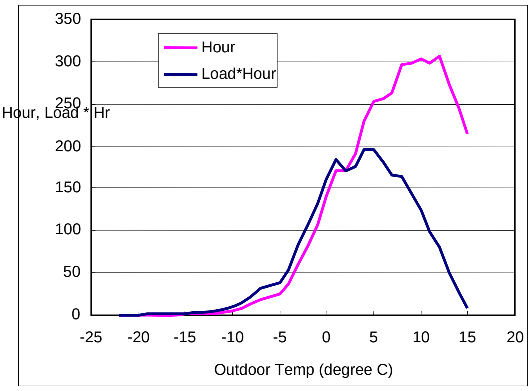

Figure 3. Hearing hours and Load*Hr

5. Operating Hours

These calculations lead to the following operation and non-operation hours.

Table 7. Cycle operation hours

	Air conditioners		Reversible heat pump		Heating only	
	NON-INV	INV	NON-INV	INV	NON-INV	INV
Cooling, H_C	1149	2434	1149	2434	0	0
Heating, H_H	0	0	2187	3468	2187	3468
Off mode, H_{OFF}	5,088		0		3,672	
Standby, H_{SB}	409			0		
Heating Thermo-off, H_{HTO}	0	0	2901	1620	2901	1620
Cooling Thermo-off, H_{CTO}	2114	829	2114	829		
Total	8,760	8760	8,760	8760	8,760	8760

Table 8. Crank case heater operation

		Crankcase, H_{CK}		
		Air conditioners	Reversible heat pump	Heating only
control	Non-Inv	2513	5424	2901
	Inv	1238	2858	1620
no control	Non-Inv	3,672	8,760	5,088
	Inv			

Note; no control; CH is always connected to power line.
control; CH is controlled by main thermo. (B contact of compressor relay)
smart control is evaluated by 8 hours test. Average power of 8 hours after stop is used for the calculation.

6. Conclusion

1) Cooling

Seasonal Efficiency should be calculated according to following formula and coefficients.

$$SEER_{on} = \frac{1}{\frac{A}{EER_A} + \frac{B}{EER_B} + \frac{C}{EER_C} + \frac{D}{EER_D}}$$

Testing Point	Measuring	Part Load Ratio (%)	Indoor Temperature		Outdoor Temperature Dry bulb(°C)	Weighting Coefficients (%)
			Dry bulb(°C)	Wet bulb(°C)		
A	EER_A, P_{CA}	100	27	19	35	9
B	EER_B, P_{CB}	75			30	21
C	EER_C, P_{CC}	55			25	37
D	EER_D, P_{CD}	30			20	33

2) Heating

$$SCOP_{on} = \frac{1}{\frac{A}{COP_A} + \frac{B}{COP_B} + \frac{C}{COP_C} + \frac{D}{COP_D}}$$

Testing Point	Measuring	Part Load Ratio (%)	Indoor Temperature Dry bulb(°C)	Outdoor Temperature		Weighting Coefficients (%)
				Dry bulb(°C)	Wet bulb(°C)	
A	COP_A, P_{HA}	100	20	2	1	42
B	COP_B, P_{HB}	60		7	6	32
C	COP_C, P_{HC}	165*		-7	-8	12
D	COP_D, P_{HD}	25		12	11	14

*If heat pump capacity at -7°C outdoor is less than 165% of the capacity at 2°C outdoor, that part of heating capacity is covered by resistive heating. This results in COP of 1 in no operation case. If operating range is limited at -7 °C, whole load below -7°C would be covered by resistive heater. In such case, this calculation results in 1-2% overestimate SCOP value.

$SCOP_C$ may be calculated from separate measurement of heatpump only operation and resistive heater effect as follows.

$$R = 1 - \frac{P_{HC-HP}}{1.65 \bullet P_{HA}}$$

$$COP_C = \frac{1}{\frac{1-R}{COP_{C-HP}} + R}$$

R; Supplement heater ratio at -7°C

P_{HC-HP}; Capacity measured with only heatpump operation

COP_{C-HP}; COP measured with only heatpump operation

PROPOSAL2: PROPOSAL FOR SEPARATE SEASONAL PERFORMANCE FACTORS FOR COOLING & HEATING.

In reviewing the task 8 report, EPEE & JBCE have raised sevarel issues. We believe that some of the problems can be solved by seperating the cooling function and heating function for both the rating (labeling) and definition of minimum efficiency requirements. instead of having separate minimum requirements for cooling only, heating only and reversible airconditioners. We feel that the latter approach is technology based, and it is best to define for these technologies the same efficiency requirements on their specific function for cooling and heating.

Therefore, instead of working with an APF factor, we propose to split up the efficiency factor into a seasonal performance factor for cooling (SPF_c) and a seasonal performance factor for heating (SPF_h), bearing in mind that both these factors need to incorporate the standby and off mode losses.

We believe that the following facts support our proposal and would make it easier for the commission to define the minimum efficiency requirements. It would also help customers to make selections based on the best possible information available to them.

1. **<u>APF is confusing and unclear for end users:</u>**
   The APF value is a very theoretical value, that gives the weighted average efficiency in cooling and heating of a reversible airconditioner. However, it does not show the actual efficiency of the product either in cooling and in heating, since it is only a weighted average of cooling and heating. It is suitable to compare reversible heatpumps in average European weather condition. However, end users cannot compare APF with SEER and SCOP. even if the task 8 report of Lot 10 proposes to indicate all APF, SEER and SCOP values in the label.
   The problem is that the APF value is always lower than the SEER value, since it is a weighted averaging of cooling and heating. endusers will be pushed to select cooling-only products, sincethe SEER value is higher than the APF value, although reversible heatpumps have higher SEER value. In the end they would buy products with lower efficiency. Moreover, they would not recognise the benefit of heat pump in heating.

2. **<u>Possible adjustment for cooling-only and reversible products on SPF_c</u>**
   Introducing a separate cooling factor and heating factor enables us to obtain separate minimum efficiency requirements which well reflect actual efficiency either in heating or cooling. It will solve the present problem that the minimum requirement for cooling-only products are less stringent than for reversible products.

3. **Possible adjustment for heating-only and reversible products on SPF_h**

   Having a separate heating performance enables us to compare the heating efficiencies of products in lot 10, with the efficiency of products in scope of lot 1. It should be noted that it also reflects contributions of heat pumps to providing certain amount of renewable energy.

   In view of the upcoming directive on renewable energy sources, the indication of SPF will be most important.

4. **Balancing heating and cooling performance**

   One thing that needs to be considered is to provide some allowance in the minimum efficiency criteria for cooling and heating in case of reversible heatpumps having excellent performance in one function (cooling/heating). Using the APF value allows a designer to have a certain freedom in order to choose where he selects the energy efficient solutions in cooling and heating.

   This is in line with the customer selections, that will choose the product best performing in heating or in cooling based on their personal needs and climate zone.

   EUP requirements are based on average European climate. As such, some allowance is required to optimise the products towards warmer or colder climate. In view of the EUP – methodology, this means that the unit, designed to perform very well in cooling, should get some allowance for performance in heating and vice versa.

Conclusion

The minimum efficiency requirements of task 8 need to be reviewed in line with this proposal. The energy label should be reviewed accordingly.

In practice, two energy labels should be attached to those products which have both cooling function and heating function.

➢**taking into account proposal 1, we propose the following calculation method for SPF_c and SPF_h**

NOTE: For the purpose of this paper, we use the terms SPF_c and SPF_h instead of SEER and SCOP used in the task 8 and task 4 report. In view of RES, it is necessary to redefine the terms.

General operation hours for cooling and heating

	Air conditioners		Reversible heat pump		Heating only	
	NON-INV	INV	NON-INV	INV	NON-INV	INV
Effective Cooling, H_{CE}	1149	2434	1149	2434	0	0
Effective Heating, H_{HE}	0	0	2187	3468	2187	3468
Off mode, H_{OFF}	5,088		0		3,672	
Cooling Standby, H_{SBC}	409					
Heating Standby, H_{SBH}			0			
Heating Thermo-off, H_{HTO}	0	0	2901	1620	2901	1620
Cooling Thermo-off, H_{CTO}	2114	829	2114	829		
Total	8,760	8760	8,760	8760	8,760	8760
Equivalent Hours cooling H_C*	1292					
Equivalent Hours heating H_H*	2682					

* based on 100% part load ratio equivalent hours.

		Crankcase, H_{CK}		
		Air Conditioners	Reversible Heat pump	Heating only
control	Non-Inv	2513	5424	2901
	Inv	1238	2858	1620
no control	Non-Inv	3,672	8,760	5,088
	Inv			

Calculation of SPF_c

1. determine $SEER_{on}$ of the appliance:

Testing Point	Measuring	Part Load Ratio (%)	Indoor Temperature		Outdoor Temperature Dry bulb(°C)	Weighting Coefficients (%)
			Dry bulb(°C)	Wet bulb(°C)		
A	EERA, PCA	100	27	19	35	9
B	EERB, PCB	75			30	21
C	EERC, PCC	55			25	37
D	EERD, PCD	30			20	33

$$SEER_{on} = \frac{1}{\frac{A}{EER_A} + \frac{B}{EER_B} + \frac{C}{EER_C} + \frac{D}{EER_D}}$$

2. Calculation of SPF_{cl}

$$SPF_c = \frac{H_C \times P_{CA}}{\frac{H_C \times P_{CA}}{SEER_{on}} + H_{CTO} \times P_{CTO} + H_{SBC} \times P_{SBC} + H_{OFF} \times P_{OFF} + H_{CK} \times P_{CK}}$$

Calculation of SPF_h

1. determine the $SCOP_{on}$ of the appliance:

Testing Point	Measuring	Part Load Ratio (%)	Indoor Temperature Dry bulb(°C)	Outdoor Temperature		Weighting Coefficients (%)
				Dry bulb(°C)	Wet bulb(°C)	
A	COPA, PHA	100	20	2	1	42
B	COPB, PHB	60		7	6	32
C	COPC, PHC	165*		-7	-8	12
D	COPD, PHD	25		12	11	14

$SCOP_C$ may be calculated from separate measurement of heatpump only operation and resistive heater effect as follows.

$$R = 1 - \frac{P_{HC-HP}}{1.65 \bullet P_{HA}}$$

$$COP_C = \frac{1}{\frac{1-R}{COP_{C-HP}} + R}$$

R; Supplement heater ratio at -7°C

P_{HC-HP}; Capacity measured with only heatpump operation

COP_{C-HP}; COP measured with only heatpump operation

$$SCOP_{on} = \frac{1}{\frac{A}{COP_A} + \frac{B}{COP_B} + \frac{C}{COP_C} + \frac{D}{COP_D}}$$

2. Calculation of SPF_h

$$SPF_h = \frac{H_H \times P_{HA}}{\frac{H_H \times P_{HA}}{SCOP_{on}} + H_{HTO} \times P_{HTO} + H_{SBH} \times P_{SBH} + H_{OFF} \times P_{OFF} + H_{CK} \times P_{CK}}$$

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