EcoBoiler Model Comments (1)

Edward Harris, Standards Manager, Bosch Thermotechnology Ltd, with minor additional comments by Alan Black, Technical Director, OFTEC, & Dr. Ernst-Moritz Bellingen, IWO, Germany

Brussels, 14th August 2009

Summary of points

- ❑ Concerns about the bin distribution have been identified
    - The average external temperature should be independent of the selection for the setback time. The bin temperatures for “with” and “without setback” are not consistent with each other.
    - The difference between “the average temperature for day and night” and “the average night time temperature” in the model does not reflect the differences experienced in Europe.
    - An assessment of the bin distribution should be made to ensure its validity

❑ Inconsistencies in the system efficiencies have been noticed when inputting different eta efficiencies. Better appliance efficiency gave a worse system efficiency.

❑ The pump overrun value does not change when the on time is reduced by timer setback and therefore the comparison between boilers running with and without setback is inconsistent.

❑ The model is still too complicated as it contains elements which have little or no effect on the calculated system efficiency.

Summary of points, ctd

There are UK specific issues with the proposal and model that have not been addressed.

Examples are :

- ❑ Modelling a programmer into the controls

- ❑ Consumers will not be able to make an informed comparison and choice between some types of hot water systems in the UK because some of them are not modelled or covered by the proposed labelling system

Average external temperature

We have reviewed the average external temperature, used by the model when the set back timer is turned on or off.

We have calculated the average temperature from the bin distribution.

We observed that the average external temperature changes with the setting of the setback timer. (Options are Y or N)

This should not happen as the setback timer should be independent of the external temperature.

Climate	Timer	No Timer
Warm	*10.49ºC*	*11.92ºC*
Average	*4.60ºC*	*5.56ºC*
Cold	*1.39ºC*	*1.72ºC*

Average temperature during the heating season should not be different when the timer is turned on and off. Of course we would expect the average temperature to change between climates (ie rows)

Average external temperature

To calculate the average we have had to make an assumption about the average temperature during the time the external temperature is above 15 degrees C.

We have repeated our calculations representing averages for these time periods with average temperatures between 16 and 21 degree C. The results shown are based on a setting of 17 deg C for all bins greater than 15 deg C

Our observation is not altered and average external temperature still changes when the setback timer is changed from Y to N. Which is not acceptable.

Average external temperature

		With Setback (TIM=1)			Without Setback (TIM=0)		
j	T_j	$hrdW_j$	$hrdA_j$	$hrdC_j$	$hrsW_j$	$hrsA_j$	$hrsC_j$
#	°C	hrs	hrs	hrs	hrs	hrs	hrs
	night[1, 2,3]	1464	1708	2184			
9	-22			0			1
10	-21			1			6
11	-20			4			13
12	-19			11			17
13	-18			12			19
14	-17			15			26
15	-16			29			39
16	-15			32			41
17	-14			24			35
18	-13			29			52
19	-12			23			37
20	-11			27			41
21	-10		0	28		1	43
22	-9		2	28		25	54
23	-8		13	55		23	90
24	-7		12	79		24	125
25	-6		18	118		27	169
26	-5		35	137		68	195
27	-4		44	199		91	278
28	-3		56	195		89	306
29	-2		101	286		165	454
30	-1		100	2469		173	385
31	0		121	243		240	490
32	1		170	364		280	533
33	2	0	193	247	3	320	380
34	3	2	218	142	22	357	228
35	4	22	1918	150	63	356	261
36	5	19	190	182	63	303	279
37	6	71	211	138	175	330	229
38	7	79	213	179	162	326	269
39	8	129	253	174	259	348	233
40	9	181	235	165	360	335	230
41	10	1717	236	192	428	315	243
42	11	294	163	156	430	215	191
43	12	330	144	116	503	169	146
44	13	312	123	134	444	151	150
45	14	279	86	93	384	105	97
46	15	238	66	58	294	74	61
	>15	719	203	34*	802	214	106*
total		4392	5124	4368	4392	5124	6552

Definitions in the model - As defined in document 3 page 8 :-

Average Night temperatures are 1ºC, 6ºC and 0ºC in Average, Warm and Cold climate respectively

In the example on this slide the bin temperature over 15ºC have been fixed at 17ºC. This assumption does not affect the result tendency whatever is this temperature in a range of 16ºC to 21ºC.

Calculated Aver. temperature during the heating season

Climate	setback	No setback
Warm	*10.49ºC*	*11.92ºC*
Average	*4.60ºC*	*5.56ºC*
Cold	*1.39ºC*	*1.72ºC*

This shows the bin temperatures for “with” and “without setback” are not consistent with each other.

Night external temperature

We suggest that the inconsistency in the bin temperatures for "with" and "without setback" may be due to an inconsistency between the average night temperature described in the document 3 page 8 and the average values used in the model.

We have compared the average night external temperature, used by the model with those described in the document 3 page 8.

The average night temperature calculated from tables used in the model differ from the ones quoted in the document 3 page 8 which are Average 1deg C, Warm 6deg C, Cold 0deg C

Climate	Calculated
Warm	***10.23ºC***
Average	***3.86ºC***
Cold	***0.97ºC***

To make the comparison we created a third distribution representing hours between 23h00 and 7h00 (night hours) using the "with" and "without setback" bin distribution (See slide 7)

Night external temperature

However, the calculated average night temperature are really close to the calculated heating season average outdoor temperature (day and night).

Therefore the bin distribution should be assessed to ensure it really correspond to observed temperatures by a recognised authority through the heating season and that the averages for day and night are consistent with the real world of cooler temperatures at night.

Average day & night temperature during the heating season

Climate	Setback	No Setback
Warm	*10.49ºC*	*11.92ºC*
Average	*4.60ºC*	*5.56ºC*
Cold	*1.39ºC*	*1.72ºC*

The calculated average night temperature

Climate	Calculated
Warm	***10.23ºC***
Average	***3.86ºC***
Cold	***0.97ºC***

The difference between “the average temperature for day and night” and “the average night time temperature” in the model does not reflect the differences experienced in Europe.

Night external temperature

j #	Tj °C	With Setback (TIM=1) hrdWj hrs	hrdAj hrs	hrdCj hrs	Without Setback (TIM=0) hrsWj hrs	hrsAj hrs	hrsCj hrs	Night bin distribution Tj	hrWj hrs	hrAj hrs	hrCj hrs
	night[1,2,3]	1464	1708	2184							
9	-22			0			1	-22			1
10	-21			1			6	-21			5
11	-20			4			13	-20			9
12	-19			11			17	-19			6
13	-18			12			19	-18			7
14	-17			15			26	-17			11
15	-16			29			39	-16			10
16	-15			32			41	-15			9
17	-14			24			35	-14			11
18	-13			29			52	-13			23
19	-12			23			37	-12			14
20	-11			27			41	-11			14
21	-10		0	28		1	43	-10		1	15
22	-9		2	28		25	54	-9		23	26
23	-8		13	55		23	90	-8		10	35
24	-7		12	79		24	125	-7		12	46
25	-6		18	118		27	169	-6		9	51
26	-5		35	137		68	195	-5		33	58
27	-4		44	199		91	278	-4		47	79
28	-3		56	195		89	306	-3		33	111
29	-2		101	286		165	454	-2		64	168
30	-1		100	285		173	385	-1		73	100
31	0		121	243		240	490	0		119	247
32	1		170	364		280	533	1		110	169
33	2	0	193	247	3	320	380	2	3	127	133
34	3	2	218	142	22	357	228	3	20	139	86
35	4	22	210	150	63	356	261	4	41	146	111
36	5	19	190	182	63	303	279	5	44	113	97
37	6	71	211	138	175	330	229	6	104	119	91
38	7	79	213	179	162	326	269	7	83	113	90
39	8	129	253	174	259	348	233	8	130	95	59
40	9	181	235	165	360	335	230	9	179	100	65
41	10	253	236	192	428	315	243	10	175	79	51
42	11	294	163	156	430	215	191	11	136	52	35
43	12	330	144	116	503	169	146	12	173	25	30
44	13	312	123	134	444	151	150	13	132	28	16
45	14	279	86	93	384	105	97	14	105	19	4
46	15	238	66	58	294	74	61	15	56	8	3
	>15	719	203	34	802	214	106	16	83	11	72
total		2928	3416	4384	4392	5124	6552		1464	1708	2168
								Average T	10.23	3.86	0.97

A B C B – A = C

C is the bin distribution corresponding to night hours.

Average night temperature

Climate	Kemna
Warm	***6ºC***
Average	***1ºC***
Cold	***0ºC***

Climate	Calculated
Warm	***10.23ºC***
Average	***3.86ºC***
Cold	***0.97ºC***

eta inconsistencies

Inconsistencies in the system efficiencies have been noticed when inputting different eta efficiencies.

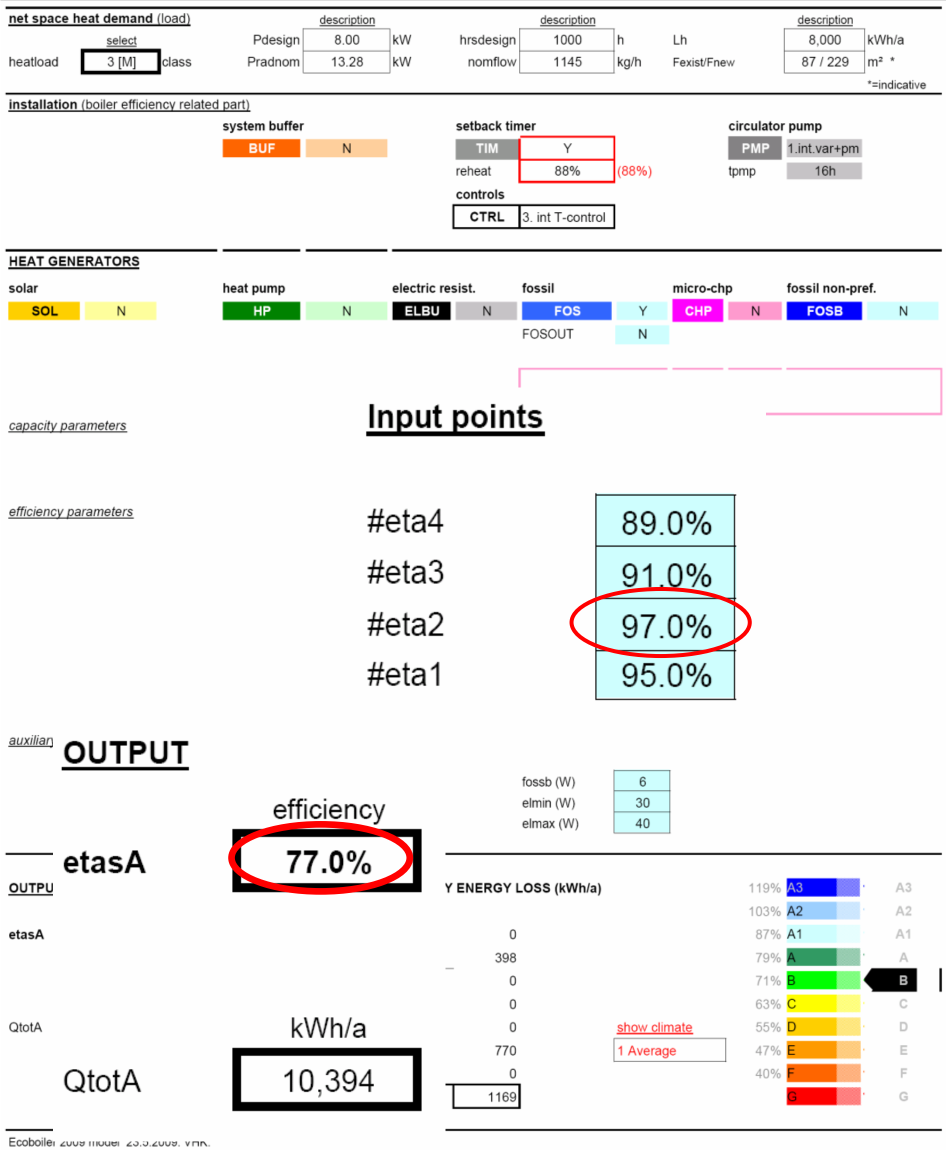
An example is given on the following slide:

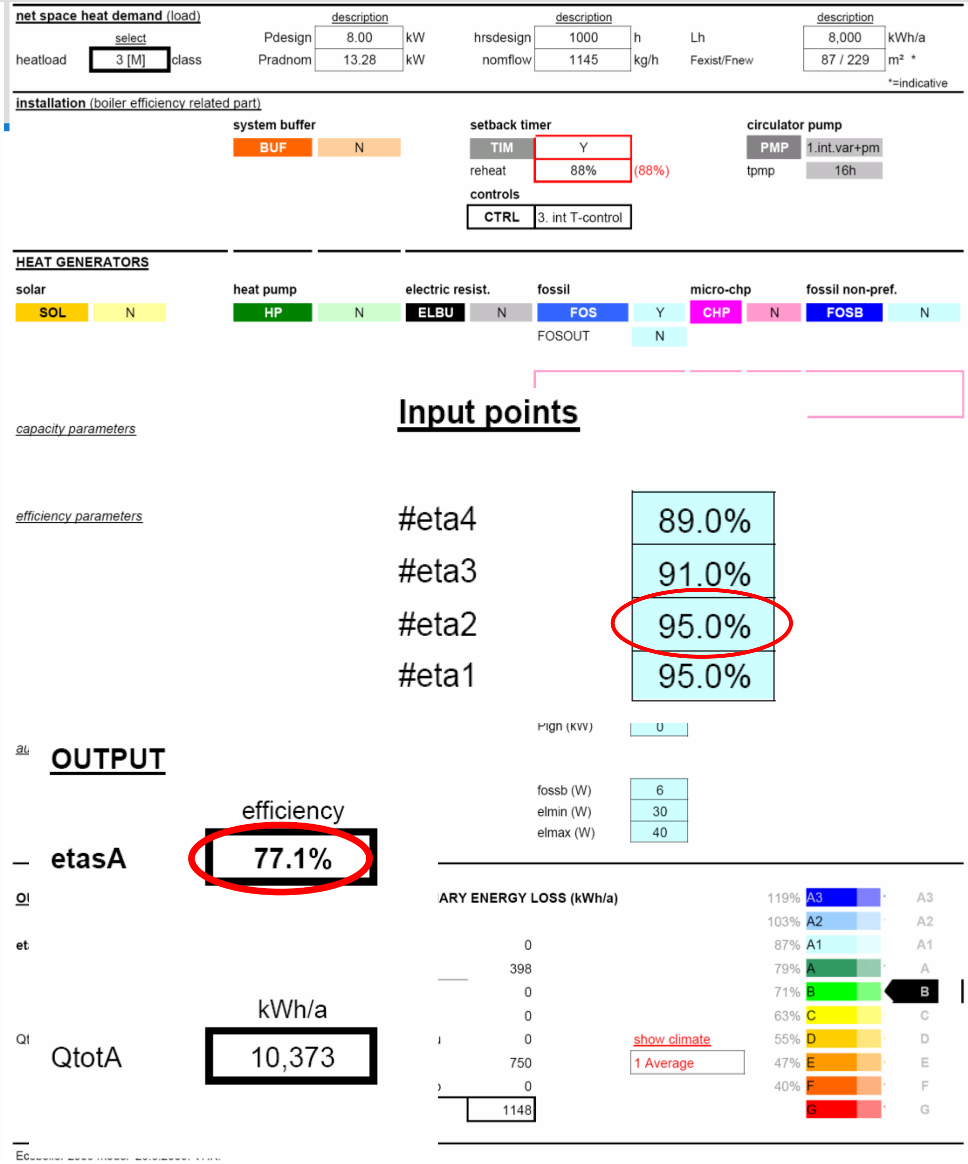
When setting a default heat exchanger at (89, 91, 95, 95) respectively (eta4, eta3, eta2, eta1)

A better heat exchanger (89, 91, 97, 95) gives a lower system efficiency (77.0%) than the default heat exchanger (77.1%)

This behaviour cannot be accepted in a final version of the model

eta inconsistencies





Pump overrun

Equation 168 of the model shows

tpump=CHOOSE(tpmp;(MAX(hponhrs;onhrs)+200)/allhrs; (allhrs-0,33*(allhrs-MAX(hponhrs;onhrs)))/allhrs; 1)

The 200 hours, is believed to represent the pump overrun time in the heating season when tpmp is set to less than 5 minutes.

200*60/5 =2400 switch offs by the boiler under control of the room stat or programmer (not from cycling).

Which corresponds to :-
2.135 hours cycle with no setback (5124 hours (page 9) boiler on / 2400 cycles)
1.423 hours cycle with setback (3416 hours (page 9) boiler on / 2400 cycles)

Pump overrun

The overrun value does not change when the on time is reduced by timer setback and therefore the comparison between boilers running with and without setback is inconsistent.

The value 200 should change to 133 for setback
3416/2.135 = 1600 cycles equivalent to 133 hours

Complexity of the model

Complexity of the model - example pump overrun
W have adjusted the time from 200 hrs to zero and it had no effect on the efficiency value , reducing the Qaux by 19kW which is too small to have an effect on the system efficiency.

Therefore the model is still too complicated as it contains elements which have little or no effect on the calculated system efficiency which should be removed.

UK-specific issues

There are UK specific issues with the proposal and model that have not been addressed.

UK use of a programmer / timer which is a requirement under the Building Regulations, Part L, is not modelled in the ECO-model circulated, (There is only a night set-back).

It could be argued that there are more efficient ways, (from a CO_2 emission point of view), of operating the system using a time clock than a similar system without a timer. For example for a non modulating boiler it is better to run for short periods in the day.

UK-specific issues

How will the customer know that the appliance is capable of providing hot water when coupled to an indirect cylinder. 30 % of the UK market are system and regular boilers, how will the label communicate that these boilers can be used for water heating through an indirect cylinder.

We believe the label will not tell them.

Therefore consumers will not be able to make an informed comparison and choice between some types of hot water systems in the UK. The indirect cylinder (where fitted) is a part of the hot water system and should be included in the mathematical model.

Favouring Modulating Burners – Comparison with Single Stage Combustion Burners

The EcoBoiler model appears to be orientated towards modulating burners and controls. This approach is questionable, regarding the appropriateness of application (even in a testing house, re. modulating burners), which may penalise single stage combustion processes.

The above issue needs to be addressed (as pointed out by Eurofuel's UK member, OFTEC, in the June 2009 Lot 1 EuP Consultation Forum).

Once the above issue has been addressed, clarification on the minimum EcoBoiler model appliance/ system efficiency values is required, so that Best Available Technology (i.e., high efficiency condensing boilers - with single stage burners) can still be realistically and legally brought to market.