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In attention of Mr. Gino Tonello,

Energy efficiency measurement "*ηwh*" *and annual power consumption AEC of* Electrical water heater WA-BO Model NTA_75LT

Content

1. Introduction

The purposes of this activity were:

- The measurement of energetic efficiency *ηwh of the water heater* (according to: 239/13 ErP Regulation, prEN50440/13)
- Annual electric consumption AEC calculation (according to the 239/13 ErP Regulation, prEN50440/13).
- Establishing the energy class of the water heater (according to the 239/13 ErP Regulation).

2. Water heater features

The tested water heater model is NTA-75 l, presented in the picture below; Code: NTA1.B.C00.2A2

The water heater was tested with continuous power supply (NON Off-Peack);

The water heater is not equipped with function of auto-adaptation to the user conditions of use (NON Smart Control).

The water heater was tested by adjusting the device's thermostats during test cycle, according to the reference standard prEN50404 which states:
"If the product requires manual thermostat operation to obtain the temperatures in Table 4, this shall be done during the test".

3. Instruments used for testing

Description	No. Matr. Gas point	Brand	Model	No. Matr. Constr.	Measure
Network analysis	APA001-01	HIOKI	3169/21	150206091	Energy, electric power consumed
Thermometer chain, T probe	CTE005-01	LSI	-	-	Entry water temperature
Thermometer chain, T probe	CTE005-02	LSI	-	-	Exit water temperature
Transducer mass flow rate	TDP001-01	MICRO MOTION	F025S116CC ANIZZZZ	14001420/06	Water flow
Thermometer chain Pt100	CTE003-01	EP	TR103	408571	Ambiance temperature

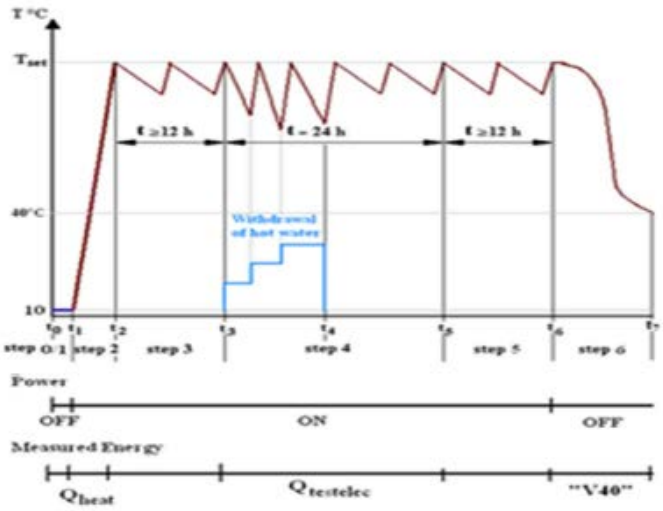
4. Measurements

The water heater was tested according to the withdrawal profile „M" presented in the attachment.

As mentioned before at point 2, the setpoint of the water heater had been adjusted initially at 45°C.

Subsequently it was set at 60°C an hour and a half before the withdrawals of 12.45h (5.45 hours after beginning step 4) and of 20.30h (13,3 hours after beginning step 4); withdrawals providing minimal temperatures of the output sanitary water at 55°C. After those two withdrawals mentioned before were finished, the setpoint was brought back to 45°C.

The water heater was submitted to test cycle illustrated in the following scheme, extracted from the reference normative, regarding the steps 1-2-3-4.



The attached chart 1158.01 shows the parameter progress requested by the normative for energy efficiency calculation, measured during the step 4 withdrawal period; that means starting with the first withdrawal at 7.00h until the last withdrawal at 21.45h.

The attached chart 1158.04 shows the parameter progress requested by the normative for energy efficiency calculation, measured during the period without withdrawals of the step 4; that means starting from the end of the last withdrawal at 21.45h until the expiration of 24 hours requested by the normative starting from the first withdrawal at 7.00 o'clock of the previous day.

Finally, the chart 1158.03 attached, shows the significant parameters progress during approx. 12 hours of the stabilisation period of the step 3 which comes before the sequence of withdrawals (where it can be observed that during each 65 minutes there are short heating periods through the electrical resistance of approx. 500 W used for temperature maintaining of the water heater).

The following charts indicate:

- Energy and temperature parameters measured during the tests (highlighted in yellow);
- The parameters inserted according to the water heater features (highlighted in blue);
- Obtained results according to the calculation methods provided by the normative (highlighted in green).

3. **Calculation of the water heating energy efficiency η_{wh}**

(a) Conventional water heaters and heat pump water heaters:

The water heating energy efficiency is calculated as follows:

$$\eta_{wh} = \frac{Q_{ref}}{(Q_{fuel} + CC \cdot Q_{elec})(1 - SCF \cdot smart) + Q_{cor}}$$

M profile

ηwh =	37,7%	
Qref =	5,845	kWh
Qfuel =	0	kWh

1.1.1 Reporting of Qelec

Qtestelec shall be corrected for any energy surplus or deficit outside the strict 24h tapping period, i.e. a possible energy difference before and after the tapping cycle is taken into account. Furthermore, any surplus or deficit in the delivered useful energy content of the hot water is taken into account in the following equations for *Qelec*.

(Eq. 6)
$$Q_{elec} = \left(\frac{Q_{ref}}{Q_{H2O}}\right) \times \left\{Q_{testelec} + \frac{1{,}163 \times C_{act} \times (T_3(t_3) - T_5(t_5))}{1000}\right\} \quad \text{[kWh]}$$

where T_3 and T_5 are water temperatures measured at the dome of water heater, respectively at t_3 and t_5.

T3 =	44,4	°C
T5 =	45	°C
Qelec =	6,30970599	kWh
Qtestelect =	6,3642	kWh

The difference of the two weights (m_{act}) is to be converted into the volume in litres. This volume is to be reported in litres to the nearest one-tenth litres.

(Eq. 3)
$$C_{act} = \frac{m_{act}}{0.9997} \quad \text{[l]}$$

Cact =	75	l
mact =	74,98	kg

Useful energy content of the hot water drawn-off *QH2O* [kWh] is determined as described below:

- follows from average in-/outlet temperature difference during the useful tapping period in [K], the tapped useful water volume in litre. and the specific heat of water *cw* (1,163x10^{-3} kWh/(litre x K)):

(Eq. 4)
$$Q_{H2O}[i] = \Delta T[i] \times V[i] \times c_w$$

where:

- *QH2O[i]* is the "Energy content" of one draw-off in [kWh];
- *ΔT[i]* is the average in-/outlet temperature difference during the useful tapping period in [K];
- *V[i]* is the tapped useful water volume [litres];
- *cw* (1,163x10^{-3} kWh/(litre x K)) is the specific heat of water.

For all the *n* draw-offs of one tapping profile the energy content is the sum:

(Eq. 5)
$$Q_{H2O} = \sum Q_{H2O}[i] \quad for\ i = 1\ to\ n$$

QH2O =	5,847	kWh

5. **Determination of the smart control factor *SCF* and of smart control compliance *smart***

(a) The smart control factor is calculated as follows:

$$SCF = 1 - \frac{Q_{fuel.week.smart} + CC \cdot Q_{elec.week.smart}}{Q_{fuel.week} + CC \cdot Q_{elec.week}}$$

SCF =	0
smart =	0

(b) If *SCF* ≥ 0,07, the value of *smart* shall be 1. In all other cases, the value of *smart* shall be 0.

6. Determination of the ambient correction term Q_{cor}

The ambient correction term is calculated as follows:

(a) for conventional water heaters using electricity:

$$Q_{cor} = -k \cdot (CC \cdot (Q_{elec} \cdot (1 - SCF \cdot smart) - Q_{ref}))$$

Qcor = -0,26720594 kWh

(13) 'conversion coefficient' (CC) means a coefficient reflecting the estimated 40 % average EU generation efficiency referred to in Directive 2012/27/EU of the European Parliament and of the Council (1); the value of the conversion coefficient is CC = 2,5;

CC = 2,5

the k-values are given in Table 8 for each load profile.

Table 8

k-values

	3XS	XXS	XS	S	M	L	XL	XXL
k	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,0

M profile

K = 0,23

4. Calculation of the annual electricity consumption AEC and the annual fuel consumption AFC

(a) Conventional water heaters and heat pump water heaters:

The annual electricity consumption AEC in kWh in terms of final energy is calculated as follows:

$$AEC = 0{,}6 \cdot 366 \cdot \left(Q_{elec} \cdot (1 - SCF \cdot smart) + \frac{Q_{cor}}{CC} \right)$$

AEC 1362 kWh

Table 1

Water heating energy efficiency classes of water heaters, categorised by declared load profiles, η_{wh} in %

	3XS	XXS	XS	S	M	L	XL	XXL
A***	$\eta_{wh} \geq 62$	$\eta_{wh} \geq 62$	$\eta_{wh} \geq 69$	$\eta_{wh} \geq 90$	$\eta_{wh} \geq 163$	$\eta_{wh} \geq 188$	$\eta_{wh} \geq 200$	$\eta_{wh} \geq 213$
A**	$53 \leq \eta_{wh} < 62$	$53 \leq \eta_{wh} < 62$	$61 \leq \eta_{wh} < 69$	$72 \leq \eta_{wh} < 90$	$130 \leq \eta_{wh} < 163$	$150 \leq \eta_{wh} < 188$	$160 \leq \eta_{wh} < 200$	$170 \leq \eta_{wh} < 213$
A*	$44 \leq \eta_{wh} < 53$	$44 \leq \eta_{wh} < 53$	$53 \leq \eta_{wh} < 61$	$55 \leq \eta_{wh} < 72$	$100 \leq \eta_{wh} < 130$	$115 \leq \eta_{wh} < 150$	$123 \leq \eta_{wh} < 160$	$131 \leq \eta_{wh} < 170$
A	$35 \leq \eta_{wh} < 44$	$35 \leq \eta_{wh} < 44$	$38 \leq \eta_{wh} < 53$	$38 \leq \eta_{wh} < 55$	$65 \leq \eta_{wh} < 100$	$75 \leq \eta_{wh} < 115$	$80 \leq \eta_{wh} < 123$	$85 \leq \eta_{wh} < 131$
B	$32 \leq \eta_{wh} < 35$	$32 \leq \eta_{wh} < 35$	$35 \leq \eta_{wh} < 38$	$35 \leq \eta_{wh} < 38$	$39 \leq \eta_{wh} < 65$	$50 \leq \eta_{wh} < 75$	$55 \leq \eta_{wh} < 80$	$60 \leq \eta_{wh} < 85$
C	$29 \leq \eta_{wh} < 32$	$29 \leq \eta_{wh} < 32$	$32 \leq \eta_{wh} < 35$	$32 \leq \eta_{wh} < 35$	$36 \leq \eta_{wh} < 39$	$37 \leq \eta_{wh} < 50$	$38 \leq \eta_{wh} < 55$	$40 \leq \eta_{wh} < 60$
D	$26 \leq \eta_{wh} < 29$	$26 \leq \eta_{wh} < 29$	$29 \leq \eta_{wh} < 32$	$29 \leq \eta_{wh} < 32$	$33 \leq \eta_{wh} < 36$	$34 \leq \eta_{wh} < 37$	$35 \leq \eta_{wh} < 38$	$36 \leq \eta_{wh} < 40$
E	$22 \leq \eta_{wh} < 26$	$23 \leq \eta_{wh} < 26$	$26 \leq \eta_{wh} < 29$	$26 \leq \eta_{wh} < 29$	$30 \leq \eta_{wh} < 33$	$30 \leq \eta_{wh} < 34$	$30 \leq \eta_{wh} < 35$	$32 \leq \eta_{wh} < 36$
F	$19 \leq \eta_{wh} < 22$	$20 \leq \eta_{wh} < 23$	$23 \leq \eta_{wh} < 26$	$23 \leq \eta_{wh} < 26$	$27 \leq \eta_{wh} < 30$	$27 \leq \eta_{wh} < 30$	$27 \leq \eta_{wh} < 30$	$28 \leq \eta_{wh} < 32$
G	$\eta_{wh} < 19$	$\eta_{wh} < 20$	$\eta_{wh} < 23$	$\eta_{wh} < 23$	$\eta_{wh} < 27$	$\eta_{wh} < 27$	$\eta_{wh} < 27$	$\eta_{wh} < 28$

M profile

ηwh = 37,7

Class C

5. Conclusions

Electrical water heater model NTA_75LT has the following features and performances, to be inserted in the energetic label.

Profile	**M**		
Water heating energy efficiency	ηwh	**37,7**	**%**
Annual energy consumption	**AEC**	**1362**	**kWh**
Class	**C**		

At your disposal,
Claudio Zatti

6. Attachments

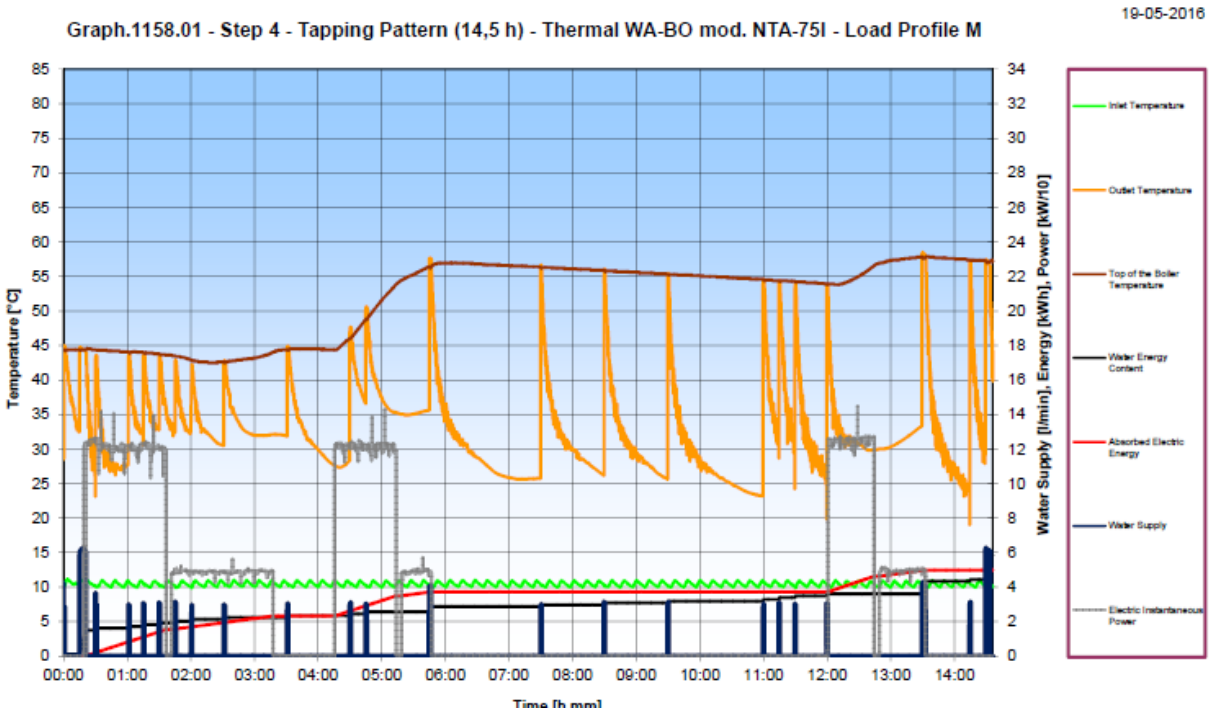
6.1 prEN50440 Withdrawal profiles

h	XXS Qtap kWh	XXS f l/min	XXS Tm °C	XXS Tp °C	XS Qtap kWh	XS f l/min	XS Tm °C	XS Tp °C	S Qtap kWh	S f l/min	S Tm °C	S Tp °C
07.00	0,105	2	25						0,105	3	25	
07.05												
07.15												
07.26												
07.30	0,105	2	25		0,525	3	35	-	0,105	3	25	
07.45												
08.01												
08.05												
08.15												
08.25												
08.30	0,105	2	25						0,105	3	25	
08.45												
09.00												
09.30	0,105	2	25						0,105	3	25	
10.00												
10.30												
11.00												
11.30	0,105	2	25						0,105	3	25	
11.45	0,105	2	25						0,105	3	25	
12.00	0,105	2	25									
12.30	0,105	2	25									
12.45	0,105	2	25		0,525	3	35	-	0,315	4	10	55
14.30												
15.00												
15.30												
16.00												
16.30												
17.00												
18.00	0,105	2	25						0,105	3	25	
18.15	0,105	2	25						0,105	3	40	
18.30	0,105	2	25									
19.00	0,105	2	25									
19.30	0,105	2	25									
20.00	0,105	2	25									
20.30					1,050	3	35	-	0,420	4	10	55
20.45	0,105	2	25									
20.46												
21.00	0,105	2	25									
21.15	0,105	2	25									
21.30									0,525	5	45	
21.35	0,105	2	25									
21.45	0,105	2	25									
Qref	2,100				2,100				2,100			

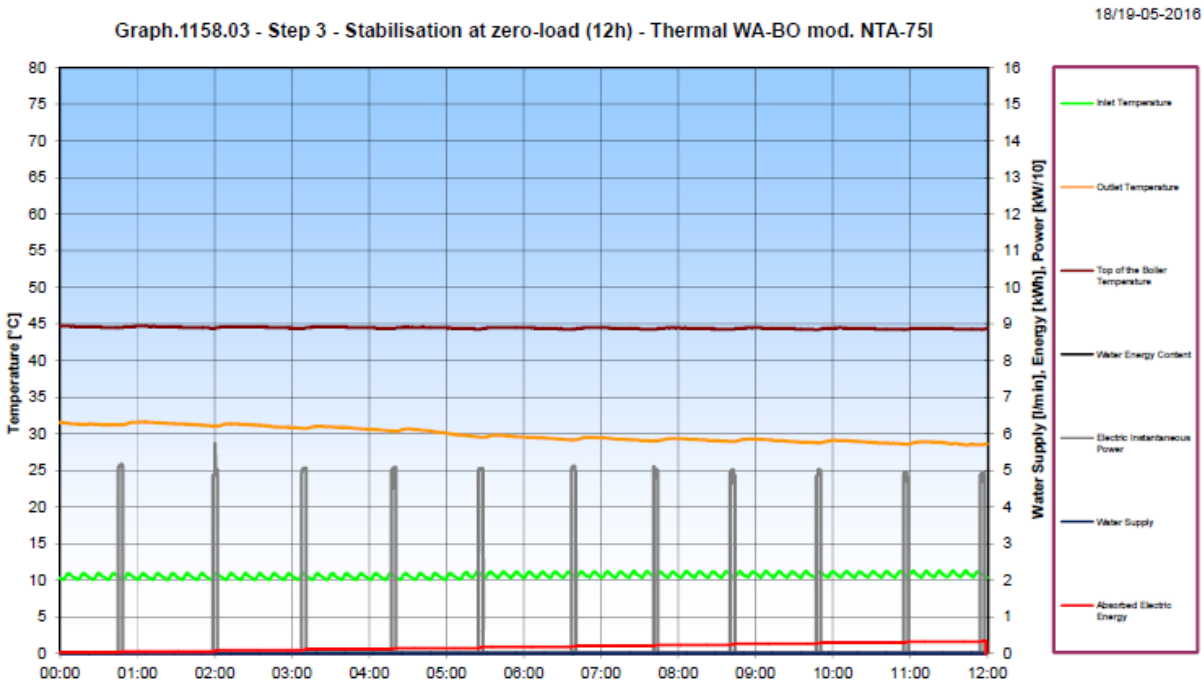
h	M Qtap kWh	M f l/min	M Tm °C	M Tp °C	L Qtap kWh	L f l/min	L Tm °C	L Tp °C	XL Qtap kWh	XL f l/min	XL Tm °C	XL Tp °C
07.00	0,105	3	25		0,105	3	25		0,105	3	25	
07.05	1,400	6	40		1,400	6	40					
07.15									1,820	6	40	
07.26									0,105	3	25	
07.30	0,105	3	25		0,105	3	25					
07.45					0,105	3	25		4,420	10	10	40
08.01	0,105	3	25						0,105	3	25	
08.05					3,605	10	10	40				
08.15	0,105	3	25						0,105	3	25	
08.25					0,105	3	25					
08.30	0,105	3	25		0,105	3	25		0,105	3	25	
08.45	0,105	3	25		0,105	3	25		0,105	3	25	
09.00	0,105	3	25		0,105	3	25		0,105	3	25	
09.30	0,105	3	25		0,105	3	25		0,105	3	25	
10.00									0,105	3	25	
10.30	0,105	3	10	40	0,105	3	10	40	0,105	3	10	40
11.00									0,105	3	25	
11.30	0,105	3	25		0,105	3	25		0,105	3	25	
11.45	0,105	3	25		0,105	3	25		0,105	3	25	
12.00												
12.30												
12.45	0,315	4	10	55	0,315	4	10	55	0,735	4	10	55
14.30	0,105	3	25		0,105	3	25		0,105	3	25	
15.00									0,105	3	25	
15.30	0,105	3	25		0,105	3	25		0,105	3	25	
16.00									0,105	3	25	
16.30	0,105	3	25		0,105	3	25		0,105	3	25	
17.00									0,105	3	25	
18.00	0,105	3	25		0,105	3	25		0,105	3	25	
18.15	0,105	3	40		0,105	3	40		0,105	3	40	
18.30	0,105	3	40		0,105	3	40		0,105	3	40	
19.00	0,105	3	25		0,105	3	25		0,105	3	25	
19.30												
20.00												
20.30	0,735	4	10	55	0,735	4	10	55	0,735	4	10	55
20.45												
20.46									4,420	10	10	40
21.00					3,605	10	10	40				
21.15	0,105	3	25						0,105	3	25	
21.30	1,400	6	40		0,105	3	25		4,420	10	10	40
21.35												
21.45												
Qref	5,845				11,655				19,070			

h	XXL Qtap kWh	XXL f l/min	XXL Tm °C
07.00	0,105	3	25
07.05			
07.15	1,820	6	40
07.26	0,105	3	25
07.30			
07.45	6,240	16	10
08.01	0,105	3	25
08.05			
08.15	0,105	3	25
08.25			
08.30	0,105	3	25
08.45	0,105	3	25
09.00	0,105	3	25
09.30	0,105	3	25
10.00	0,105	3	25
10.30	0,105	3	10
11.00	0,105	3	25
11.30	0,105	3	25
11.45	0,105	3	25
12.00			
12.30			
12.45	0,735	4	10
14.30	0,105	3	25
15.00	0,105	3	25
15.30	0,105	3	25
16.00	0,105	3	25
16.30	0,105	3	25
17.00	0,105	3	25
18.00	0,105	3	25
18.15	0,105	3	40
18.30	0,105	3	40
19.00	0,105	3	25
19.30			
20.00			
20.30	0,735	4	10
20.45			
20.46	6,240	16	10
21.00			
21.15	0,105	3	25
21.30	6,240	16	10
21.35			
21.45			
Qref	24,530		

6.2 Chart 1158.01: Consumed and Produced Energy During the Withdrawal Periods – Step 4 – „M" profile.



6.3 Chart 1158.03 – Stabilisation (Step 3)



6.4 Chart 1158.04 – Consumed Energy During Maintenance Period – step 4 – „M" profile