Retrofit controlling units and modern draught stabilizers for stoves

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Project ERA-NET Bioenergy "WoodStoves 2020"

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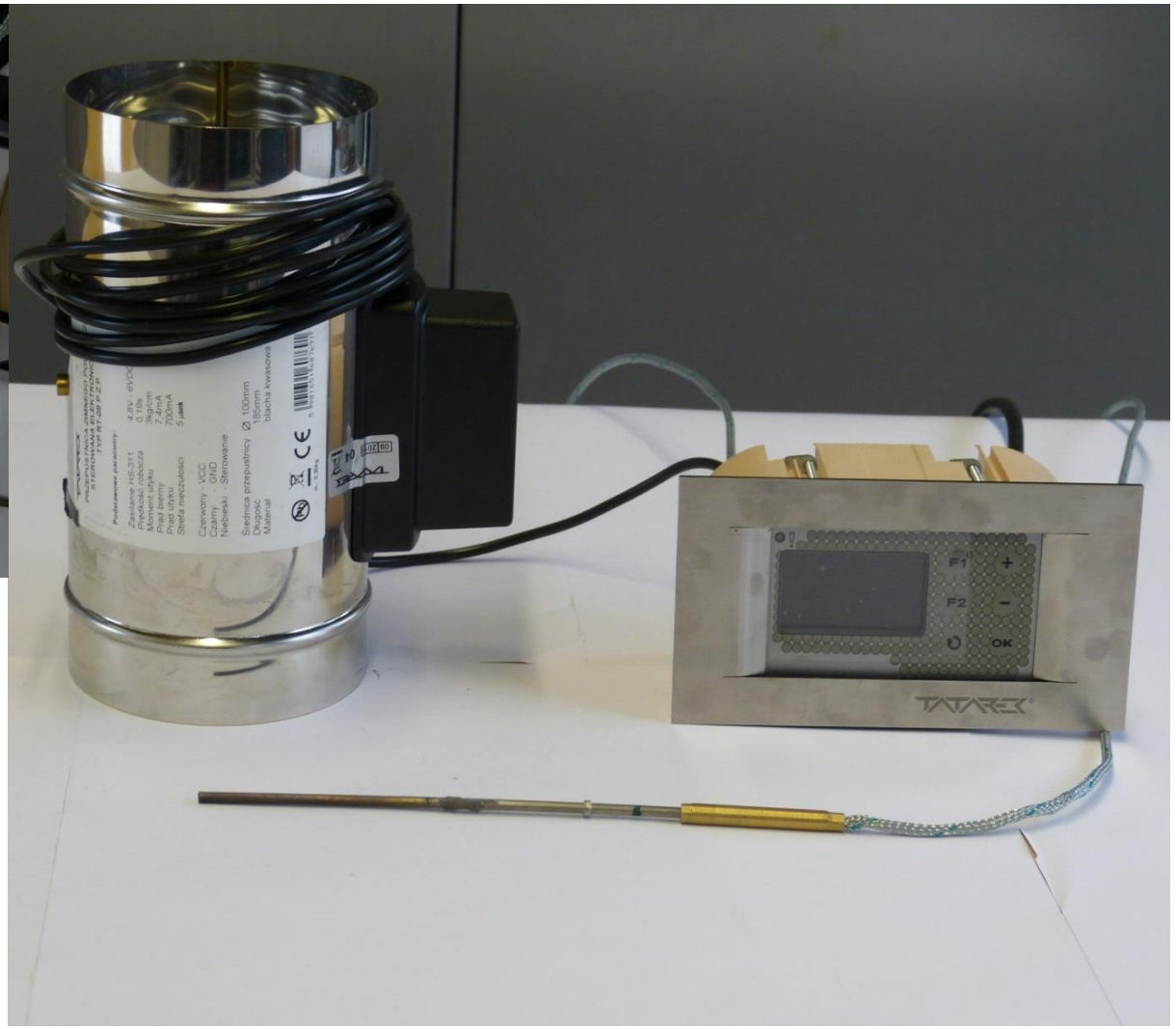
Methodology

- Testing cycle: 8 successive batches (5 full load, 3 part load) including ignition batch.
- Each combustion controller as well as the reference measurements (without controller) has been tested for 3 complete heating cycles (5 full load 3 part load batches).
- Heating losses have been measured after each heating cycle until the flue gas temperature has been cooled down to 50°C.
- Evaluation of emissions based on volume flow and fuel consumption (converted) in mg/MJ.
- For each controller and reference measurement one cycle out of 3 successive batches has been measured (without PM) including the cool down phase.
- Air valve settings:
  - **Without controller and for draught stabilizer: Bach 1-2 primary + secondary air open, batch 3-5 primary air closed, secondary air closed by 30%, batch 7-8 secondary air closed by 50%**
  - **With controller: Batch 1-2 primary + secondary air open, batch 3-8 primary air closed, secondary air open**

Overview on the combustion controllers used

Testing conditions	**Controlled draught**			**Natural draught**	
Type	TATAREK RT8OS-G-TD	Schmid SMR	K+W Compact	ATEC Florian	K+W draught stabilizer
Function principle	Thermocouple + electronical flap	Thermocouple + electronical flap	Thermocouple + electronical flap	Thermocouple + draught and velocity sensor + electronical flap + fan	Mechanical flap
Placed at	Air supply socked	Air supply socked	Air supply socked	Between chimney wall and flue gas pipe	Between chimney wall and flue gas pipe or at chimney sole
Approx. end costumer price incl. accessories	276 €	1,100 €	1070 € (without Display)	300 €	300 €

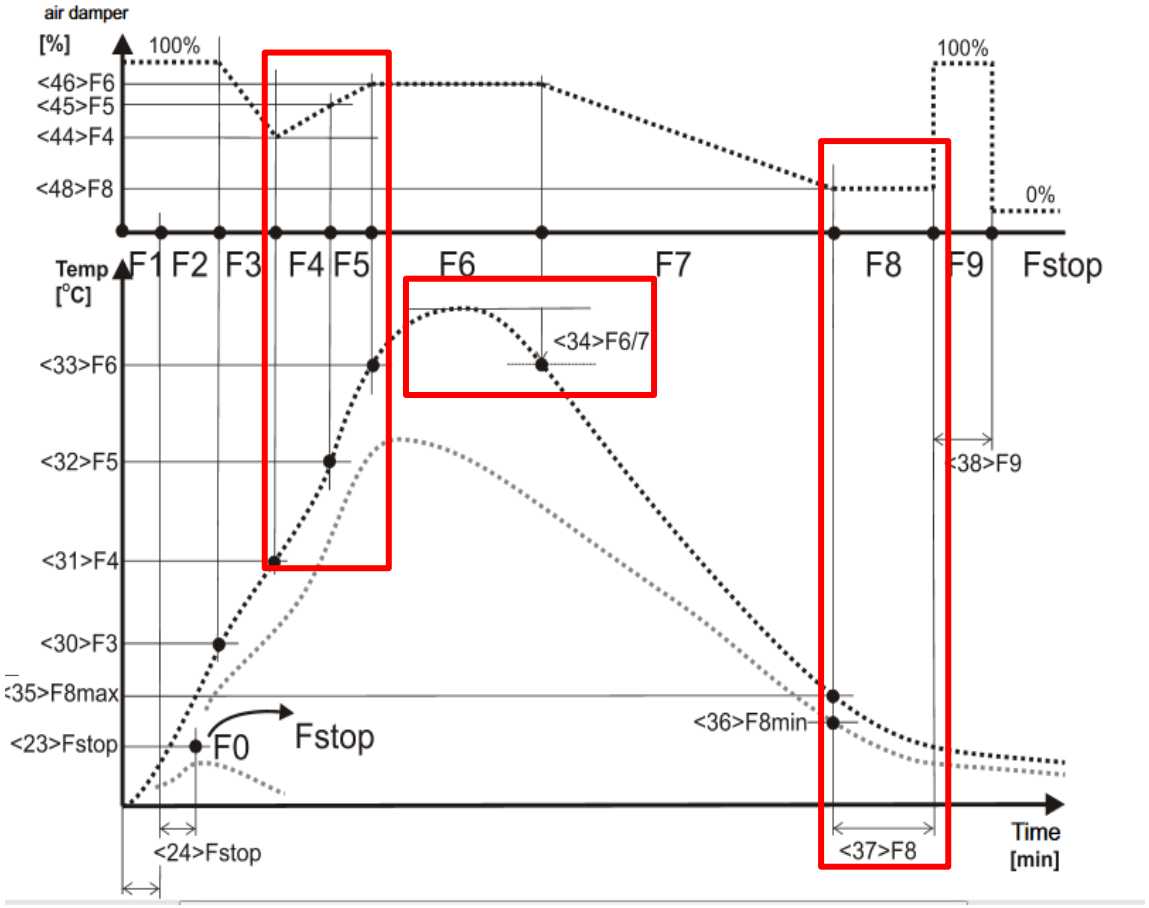
TATAREK RT8OS-G-TD



Free cross section:
6,2 cm²
8 % of the cross section
of the pipe

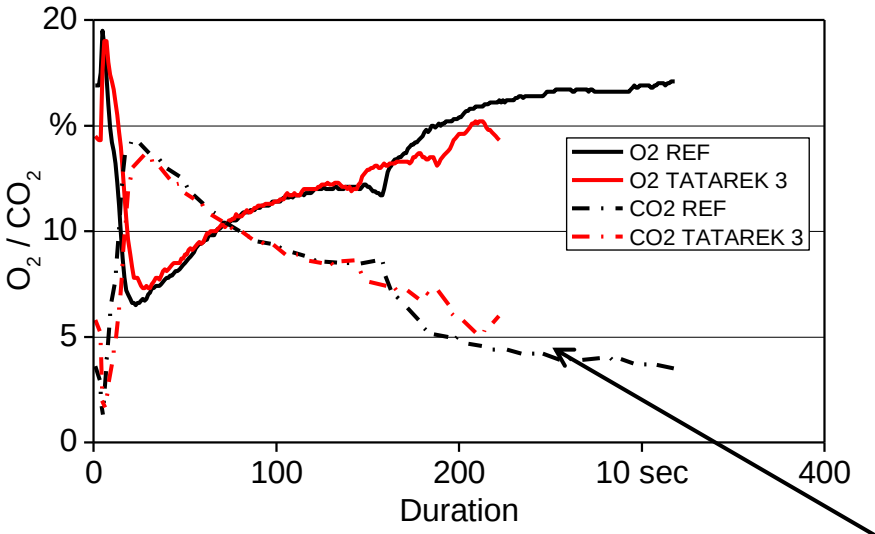
TATAREK RT8OS-G-TD: Parameter adjustment

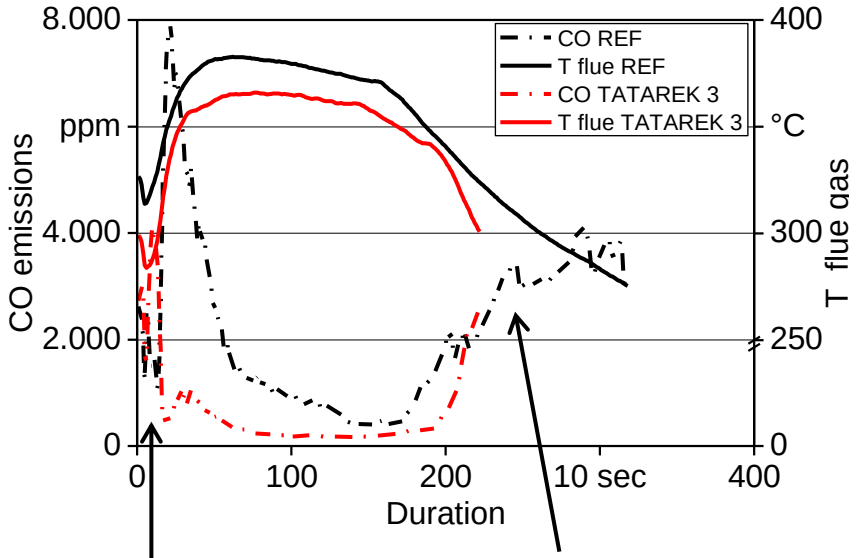
Combustion curve with marked control parameters

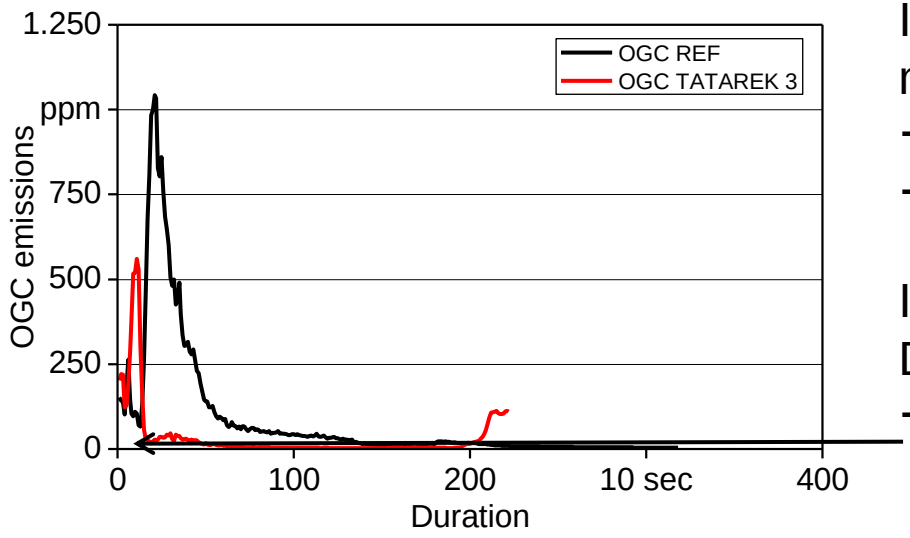


Source: http://tatarek.com.pl/files/img/eng_user_manual_rt08gos.pdf

TATAREK RT8OS-G-TD: Parameter optimization (burn-off-curves of batch 4)







Influence of parameter Temp. F8 max resp. min

→ Refilling signal closer at flame extinction

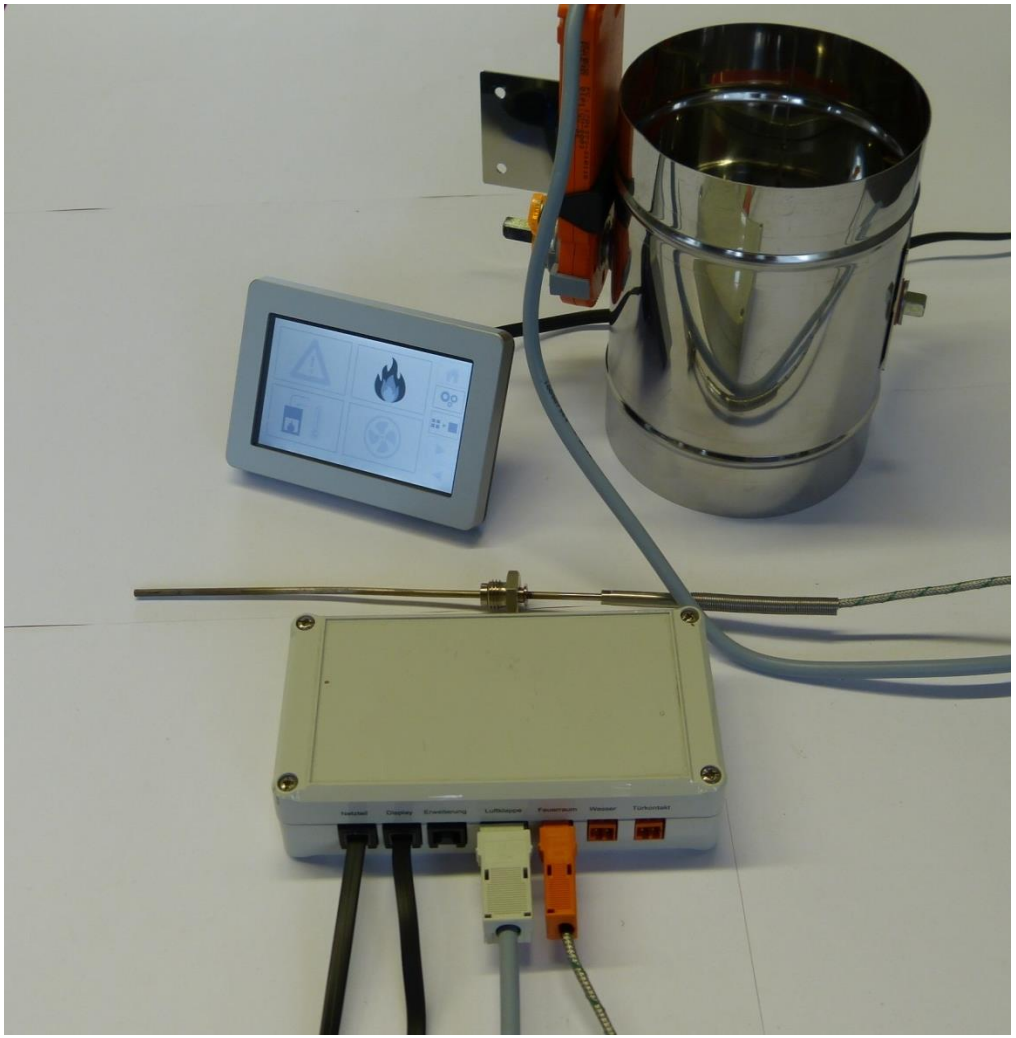
→ Less CO emissions during charcoal burnout

Influence of parameter F4+F5+F6 (Temp + Damper)

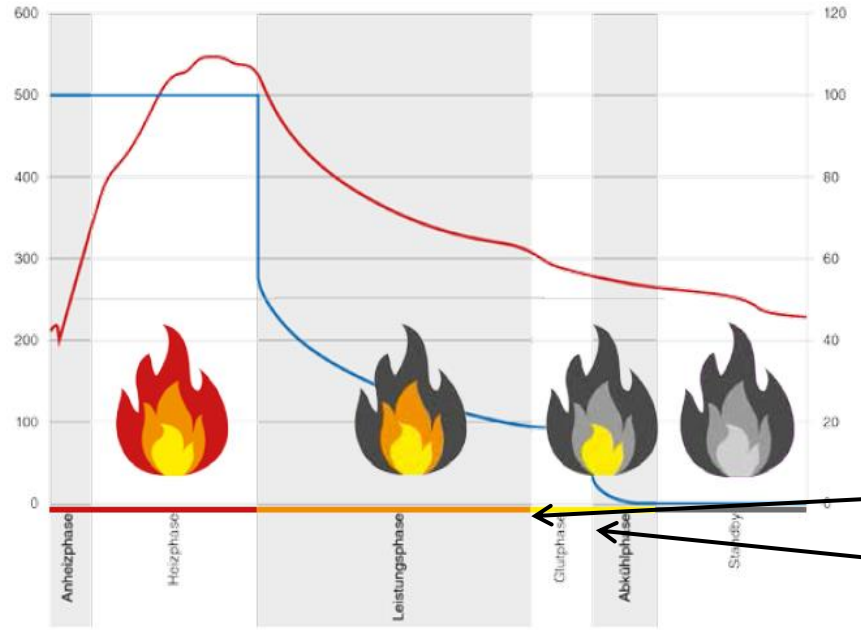
→ Less CO and OGC emissions during ignition phase after refilling due to restricted air supply

Schmid SMR

Air flap is closing completely



Schmid SMR



The controller has various deposited burn-off-curves which are selected by choosing the stove type per „questionnaire“

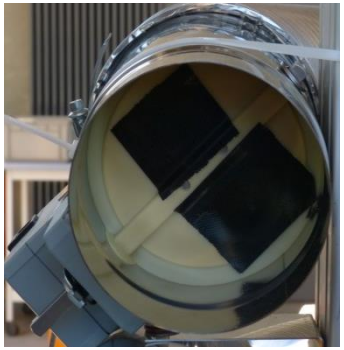
The end user can only adjust two temperatures:

- Glowing-phase-temperature
- Cool-down-temperature

The burn-off-curve has been chosen in agreement with the manufacturer (Schmid), the glowing phase (335°C) and cool down temperature (280°C) was set after some pretests. The thermocouple showed an offset of 20°C.

K+W Compact

Holes covered with air tight tape



Free cross section:
9 cm²
8% of the pipe

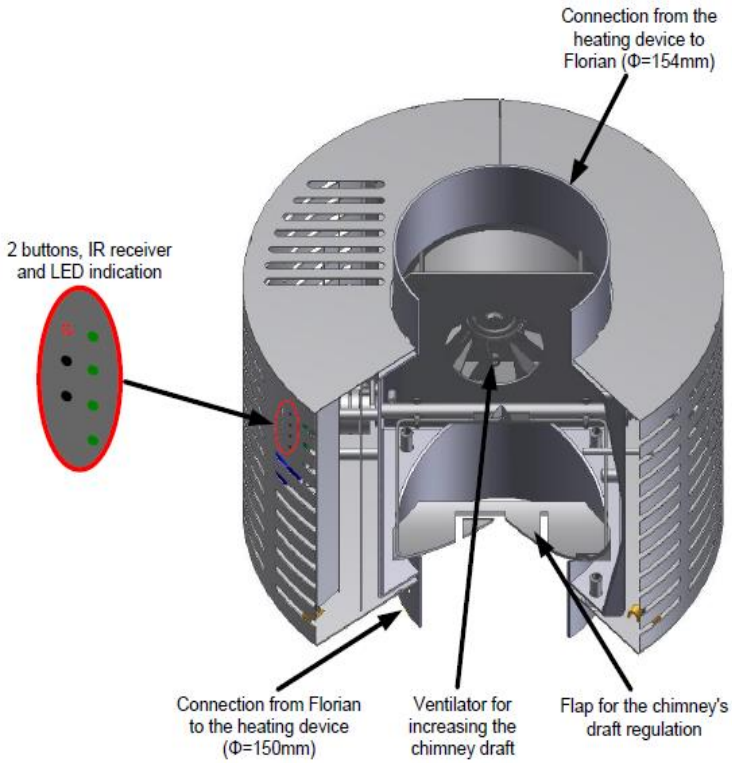
K+W Compact: Parameter adjustment

Turn-switch position	Curve	Maximum temperature	Cooldown temperature	Glowing phase temperature	Heat system
0	Type A	800 °C	220 °C	300 °C	log wood stove
1	Type A	800 °C	210 °C	290 °C	
2	Type A	800 °C	200 °C	280 °C	
3	Type A	800 °C	190 °C	270 °C	
4	Type B	800 °C	180 °C	260 °C	insert
5	Type B	800 °C	170 °C	250 °C	
6	Type B	800 °C	160 °C	240 °C	
7	Type B	800 °C	150 °C	230 °C	
8	Type C	800 °C	140 °C	220 °C	tiled stove
9	Type C	800 °C	130 °C	210 °C	
A	Type C	800 °C	120 °C	200 °C	
B	Type C	800 °C	110 °C	190 °C	
C	Type D	800 °C	100 °C	180 °C	slow heat release
D	Type D	800 °C	90 °C	170 °C	
E	Type D	800 °C	80 °C	160 °C	
F	Type D	800 °C	70 °C	150 °C	

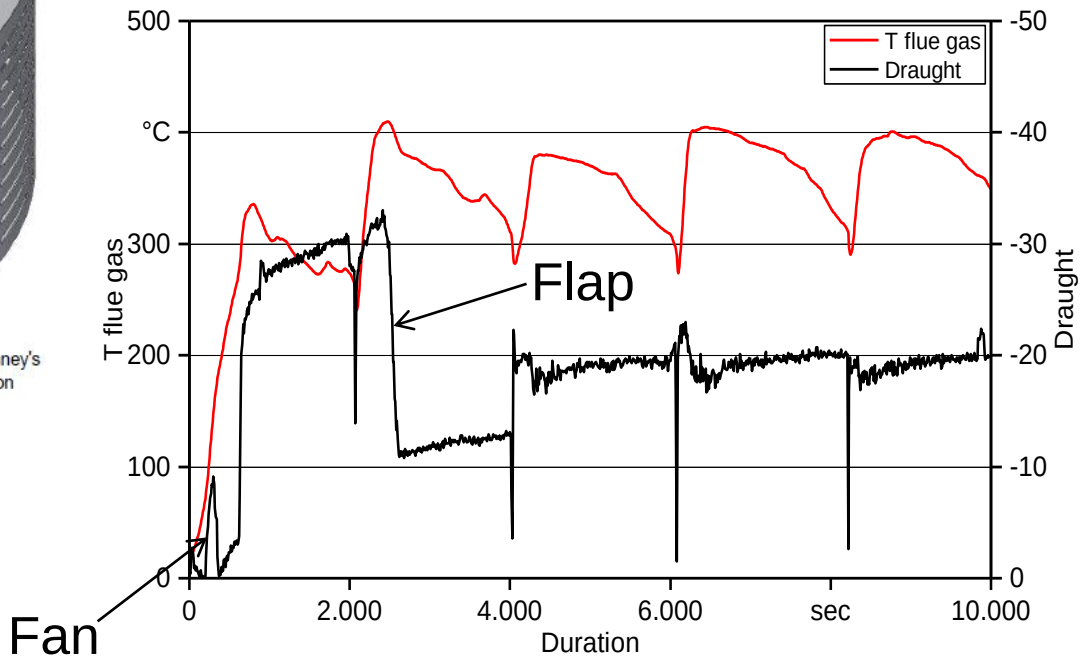
Sorce: User Manual K+W Compact

3 complete testing cycles has been executed with the flap in delivery status
1 testing cycle with the flap where the holes were covered with tape

ATEC Florian: Parameter adjustment



3 cycles have been executed on power level 1 („intelligent“ automatic mode)
Where the draught is regulated automatically
The fan was only used in the first 3 min of the ignition batch.



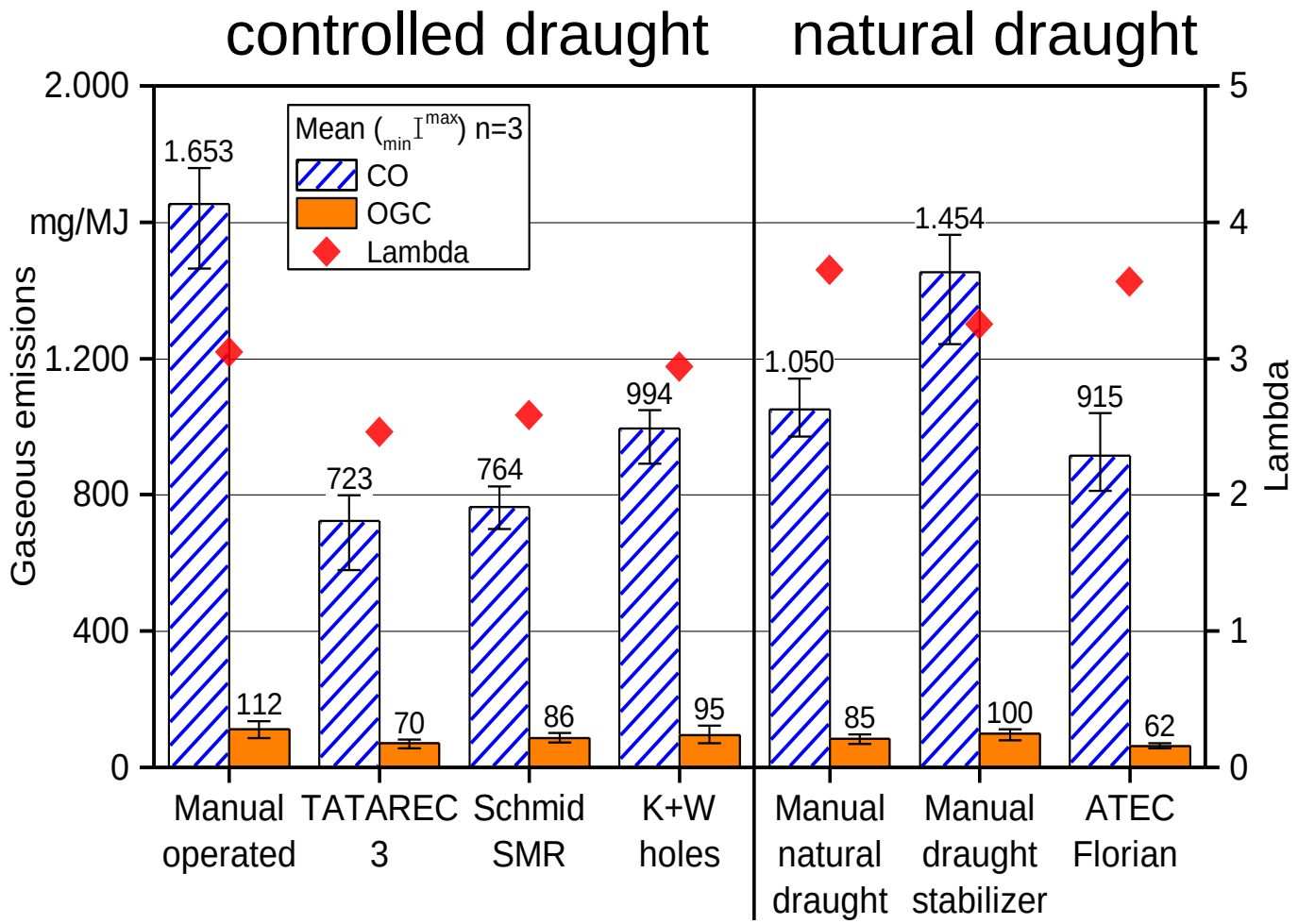
K+W draught stabilizer

Test stand and position of measurement points

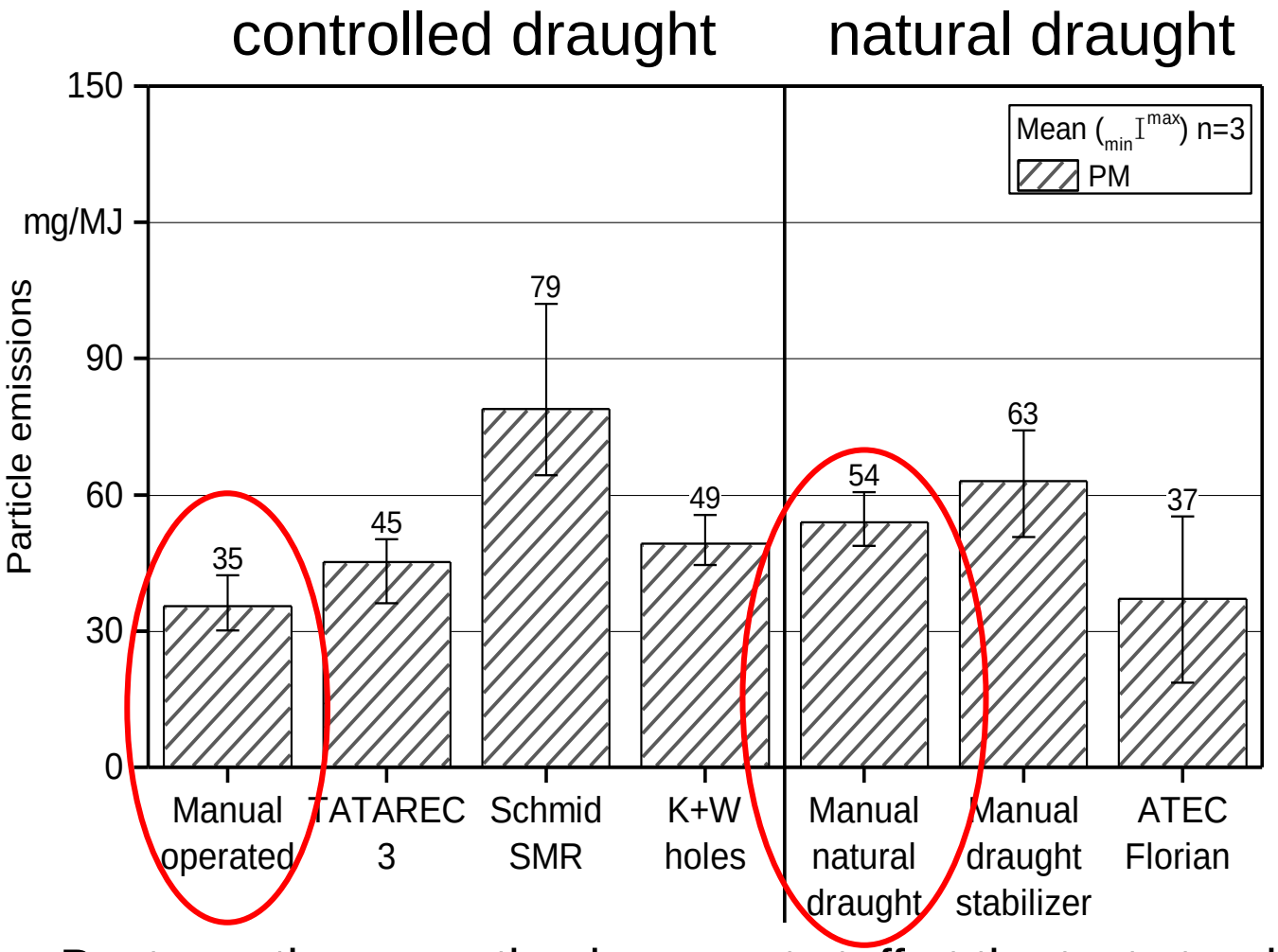
Velocity measurement at the draught stabilizer

Connection to the chimney

Comparison all controllers (Batch 1-8):
Gaseous emissions



Comparison all controllers (Batch 1-8):
Particle emissions



Best practice operation by expert staff at the test stand!
Optimally air adjustment through pretesting!

Efficiency evaluation

$\eta = 100 - q_a - q_b - q_r - q_{cool}$

q_a q_b q_{cool}

$$q_{cool} = \frac{Heat\ losses}{Energy\ of\ fuel\ used}$$

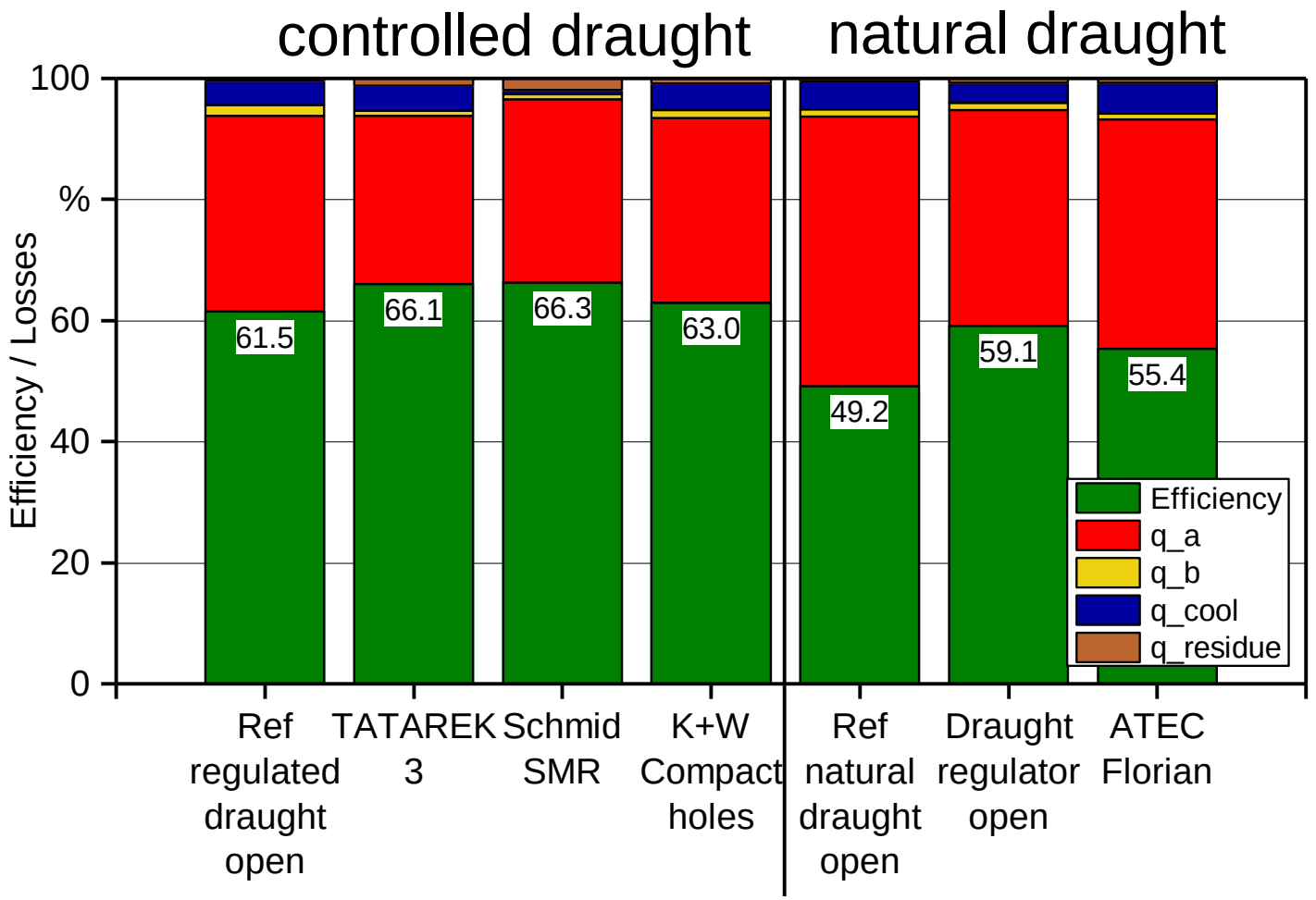
$$q_r = \frac{Energy\ of\ charcoal}{Energy\ of\ fuel\ used}$$

100 %

q_r

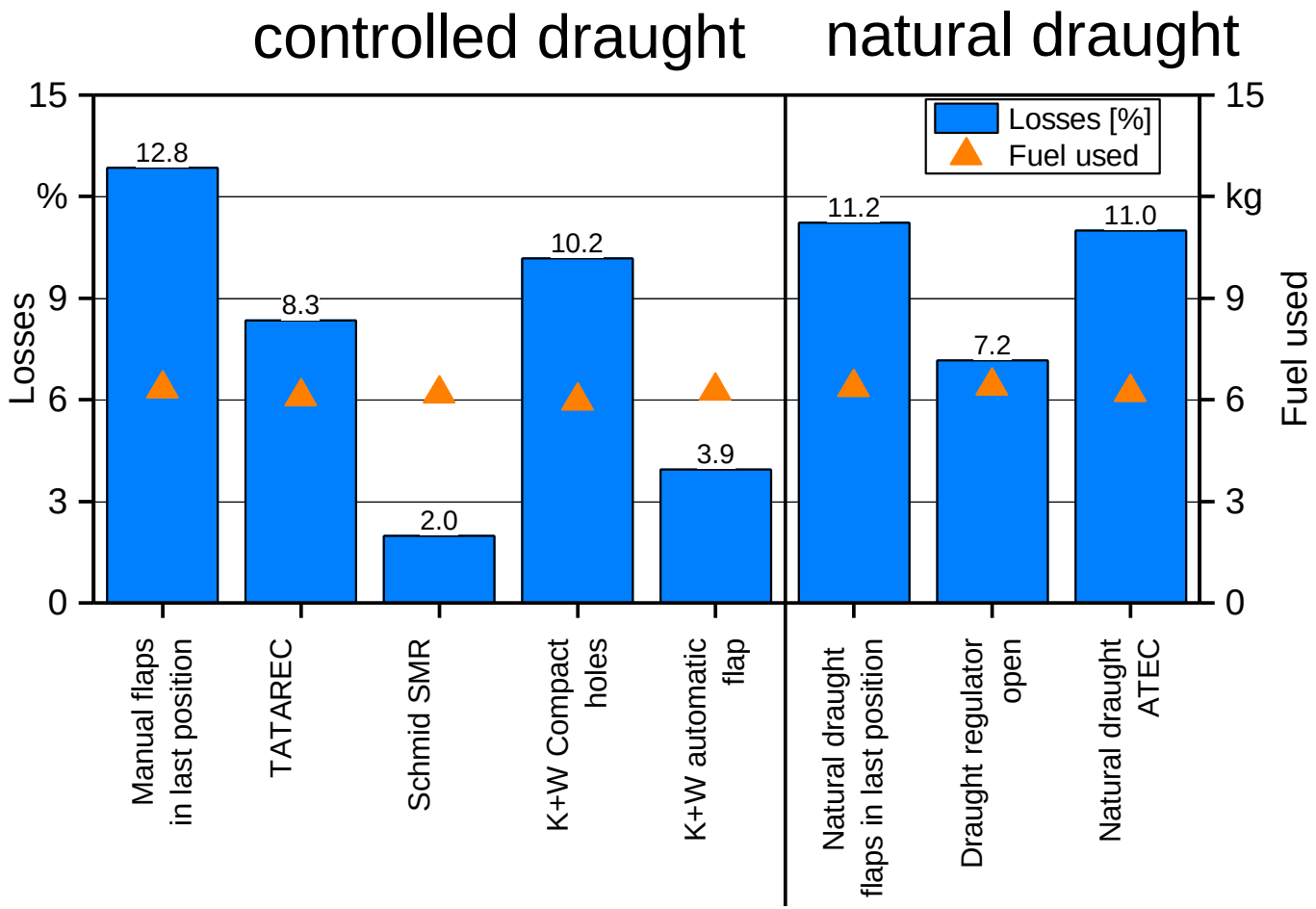
0.5 % accord. DIN EN 13240

Comparison all controllers (Batch 1-8)



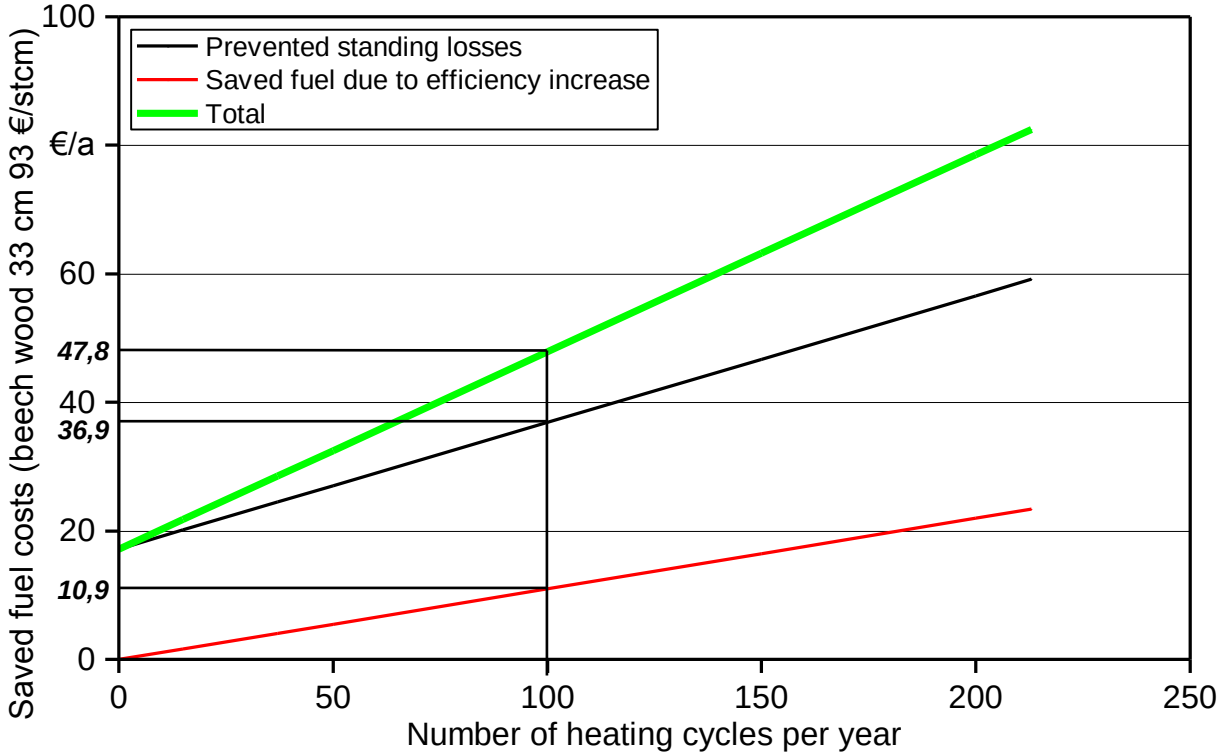
Prevention of „hot standing losses“

After 3 batches during the cool-down-phase



Additional to that the prevention of „cold standing losses“ when the stove is not operated has to be charged. This could be **approx. 32 – 54 kWh/month** for a 8 kW stove during the heating season (see presentation on standing losses).

Amortization Schmid SMR at actually log wood prices



With a end customer price of currently approx. **1.100 €** and a annual saving of approx. **48 €/a** at **100 heating cycles/a** results in a payback period of round about **23 years**. If the flap of the TATAREK controller which costs about 276 € will be tight, a payback period of approx. 6 years is feasible.

Final conclusions for retrofit controllers

- Reduction of gaseous emissions and increase of efficiency.
- No benefits for particle emissions can be claimed to the automated control units.
- Particle emissions could possibly be reduced by further technical improvement (air adjustment in the beginning of the batch, timing of refilling signal → compromise gaseous vs. particle emissions).
- Distribution and installation (parameter adjustment) of retrofit controllers should be executed only by stove manufacturer or expert staff.
- Biggest advantages of retrofit controllers:
  - **Prevention of heat- and standing losses**
  - **Reduction of maloperation by the user (air adjustment)**
- Air tight flaps are highly recommended (safety issues / admission ETA).

Many thanks for listening!

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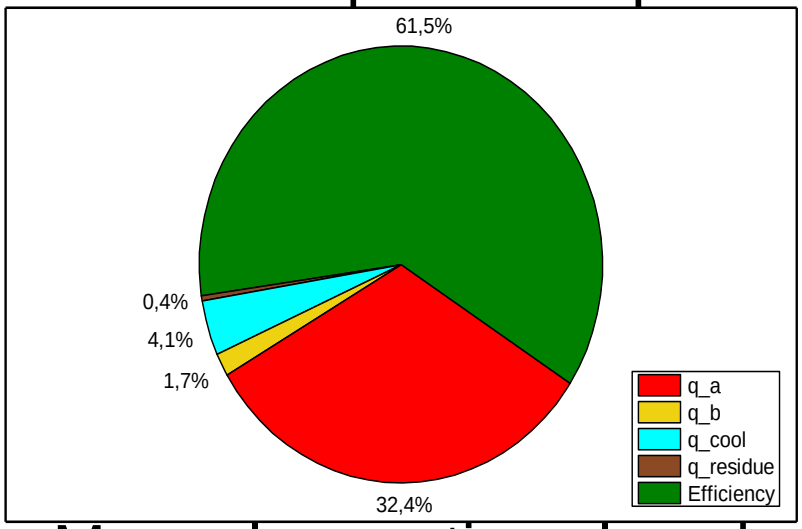
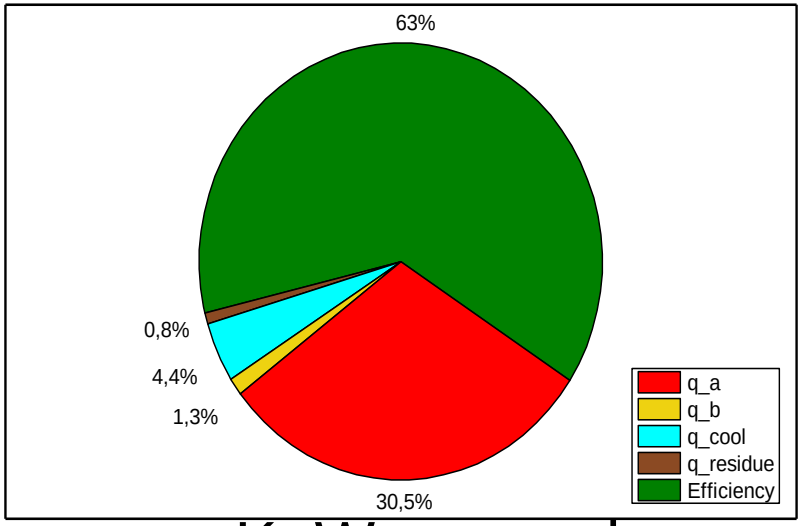
K+W Compact: Testing results (Batch 1-8)

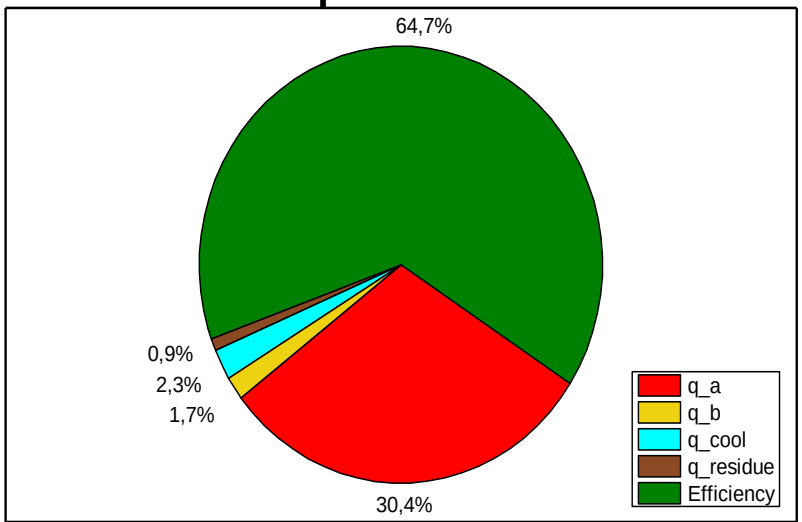
Manual operation open



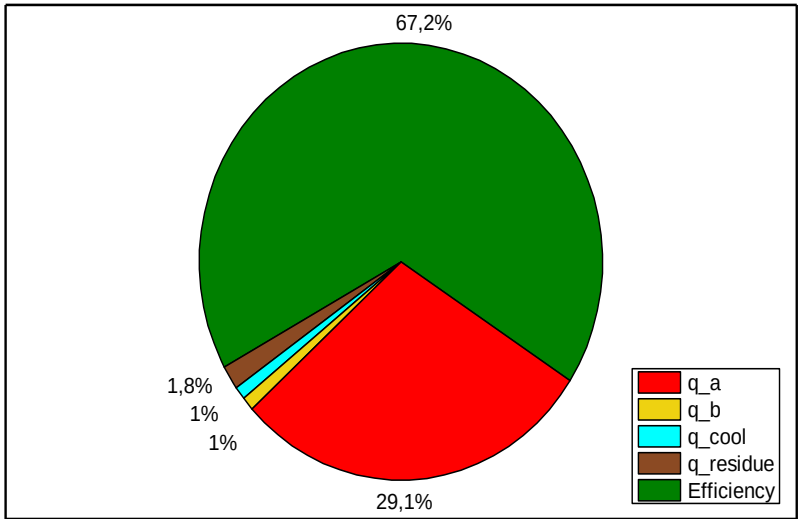
K+W holes



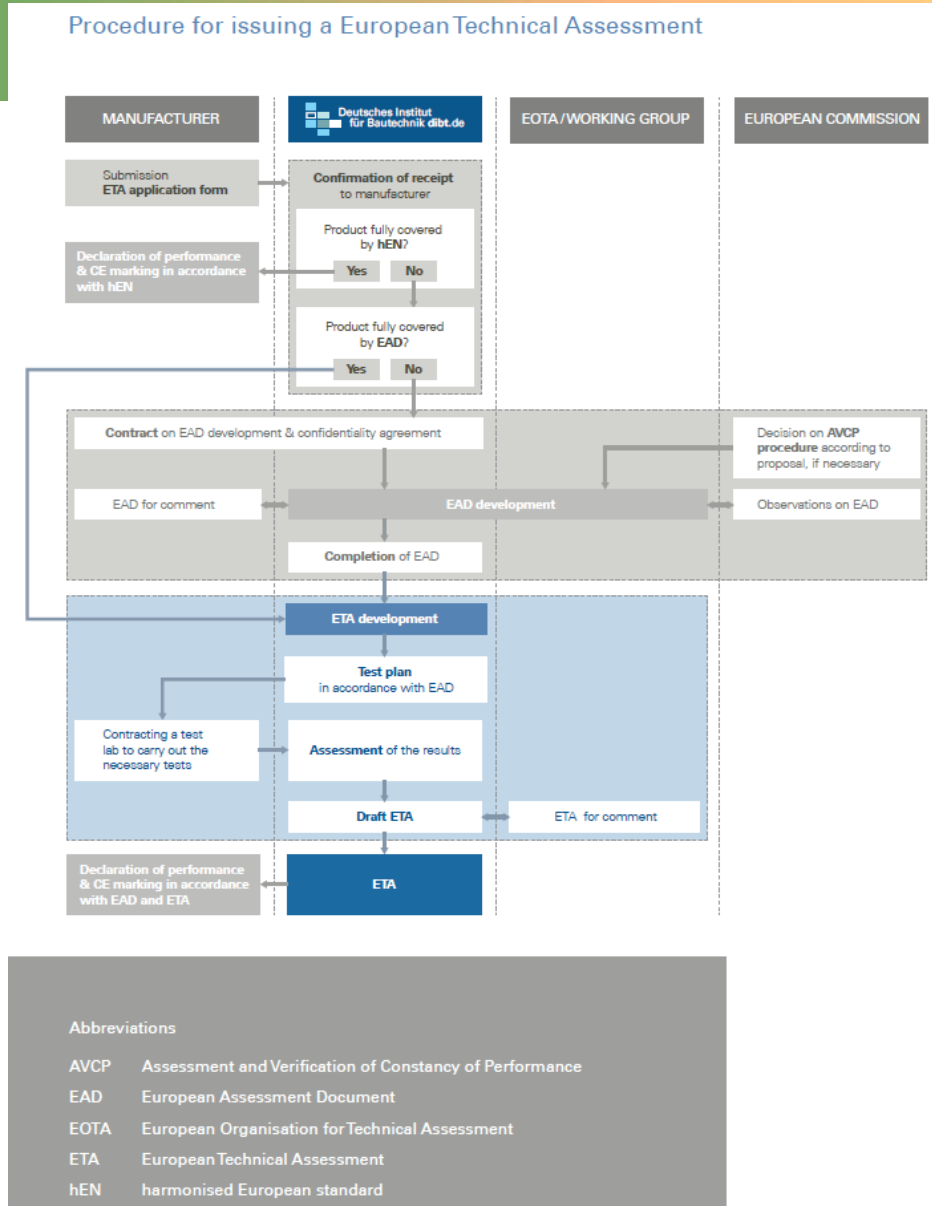
Manual operation closed



K+W covered



European Technical Assessment



List of **Technical Assessment Body's:** https://www.eota.eu/en-GB/content/how-to-find-a-tab/55/

Source: https://www.dibt.de/en/dibt/data/ETA_brochure.pdf