Quantification of energy losses during wood combustion in stoves

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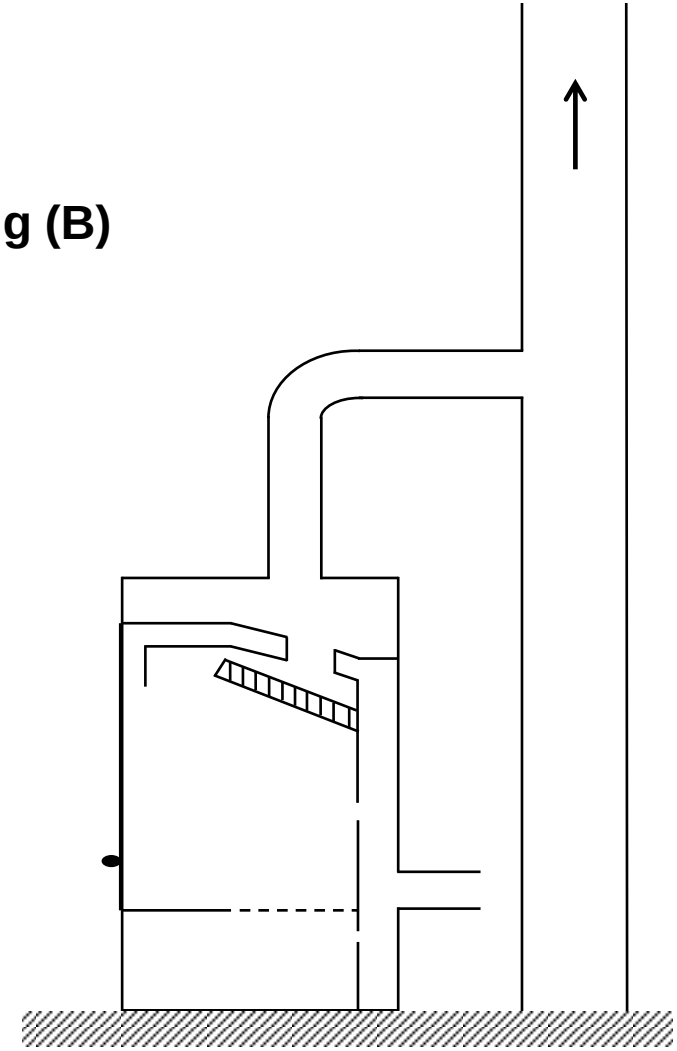


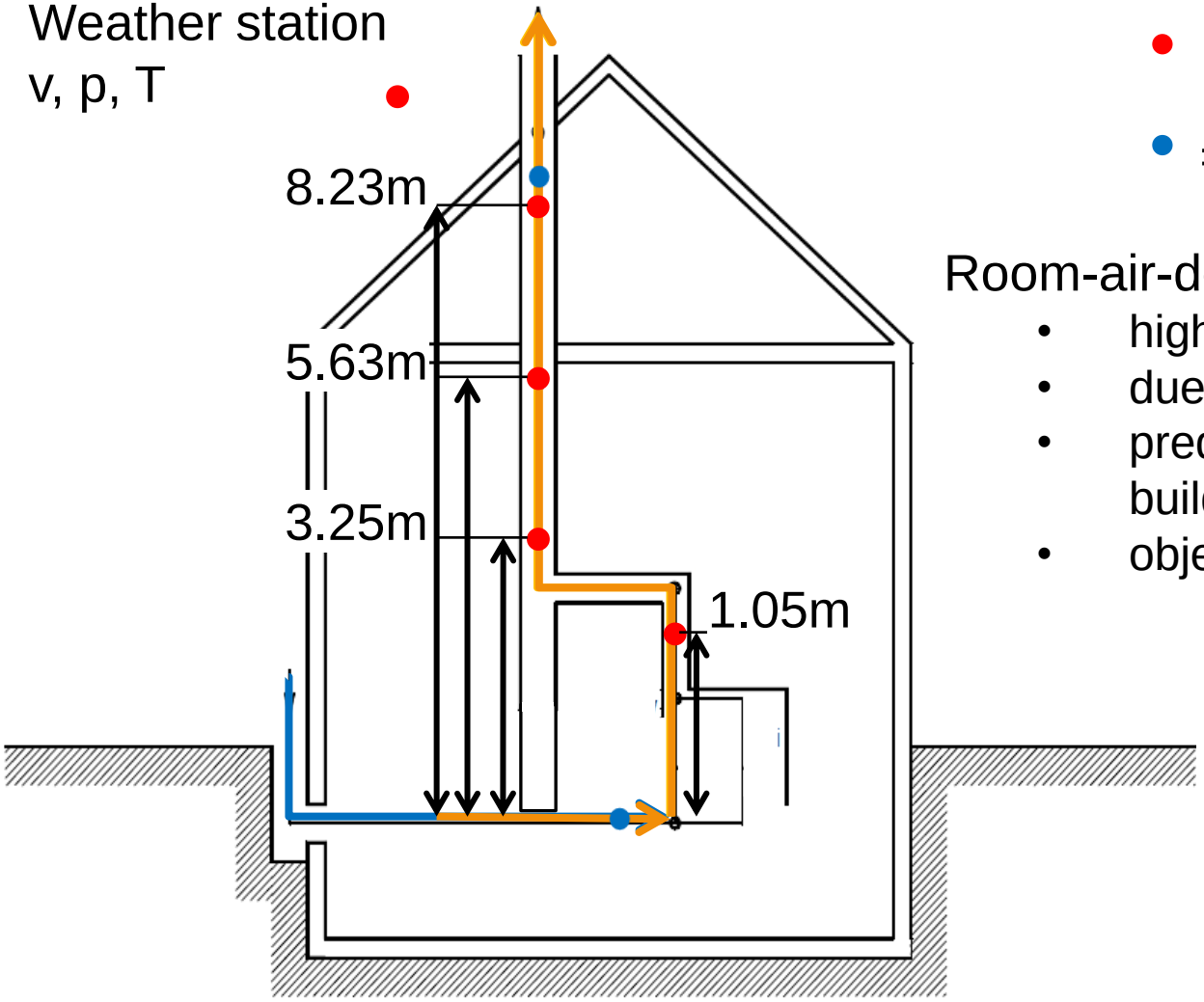
Methodology

- **Standing losses from cold stove and chimney (A):**
  - **Monitoring of 3 state of the art log wood stoves at cold natural draught chimney for several weeks and several flap positions.**
  - **Evaluation of the heat losses and calculation of average monthly standing losses.**

- **Standing losses after stove operation (B) (during chimney cooling):**
  - **Determination of the heat losses after each stove operation (5 full load and 3 partial load batches) until 50°C at the flue gas socked is reached**
  - **Investigation of different flap positions and air tight closure of the flue gas socket.**
  - **Evaluation of the heat losses after heat operation and calculation of average losses with respective flap positions.**


Stove A (8 kW)

System boundary's and overview of measurement points



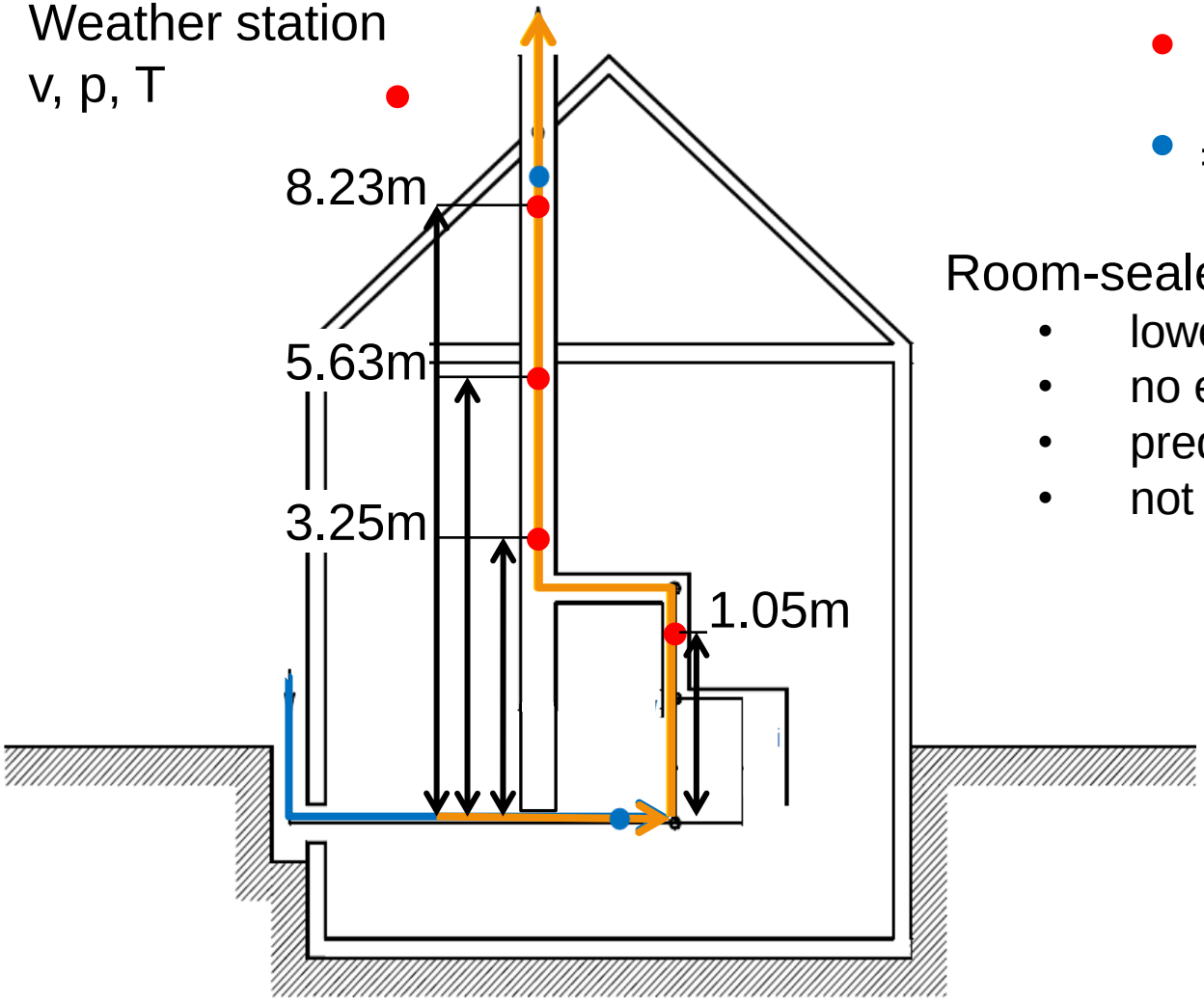
● = Temperature

● = Velocity

Room-air-dependent:

- higher heat losses
- due to exhaust of room heat
- predominantly in existing buildings
- object of this investigation

System boundary's and overview of measurement points



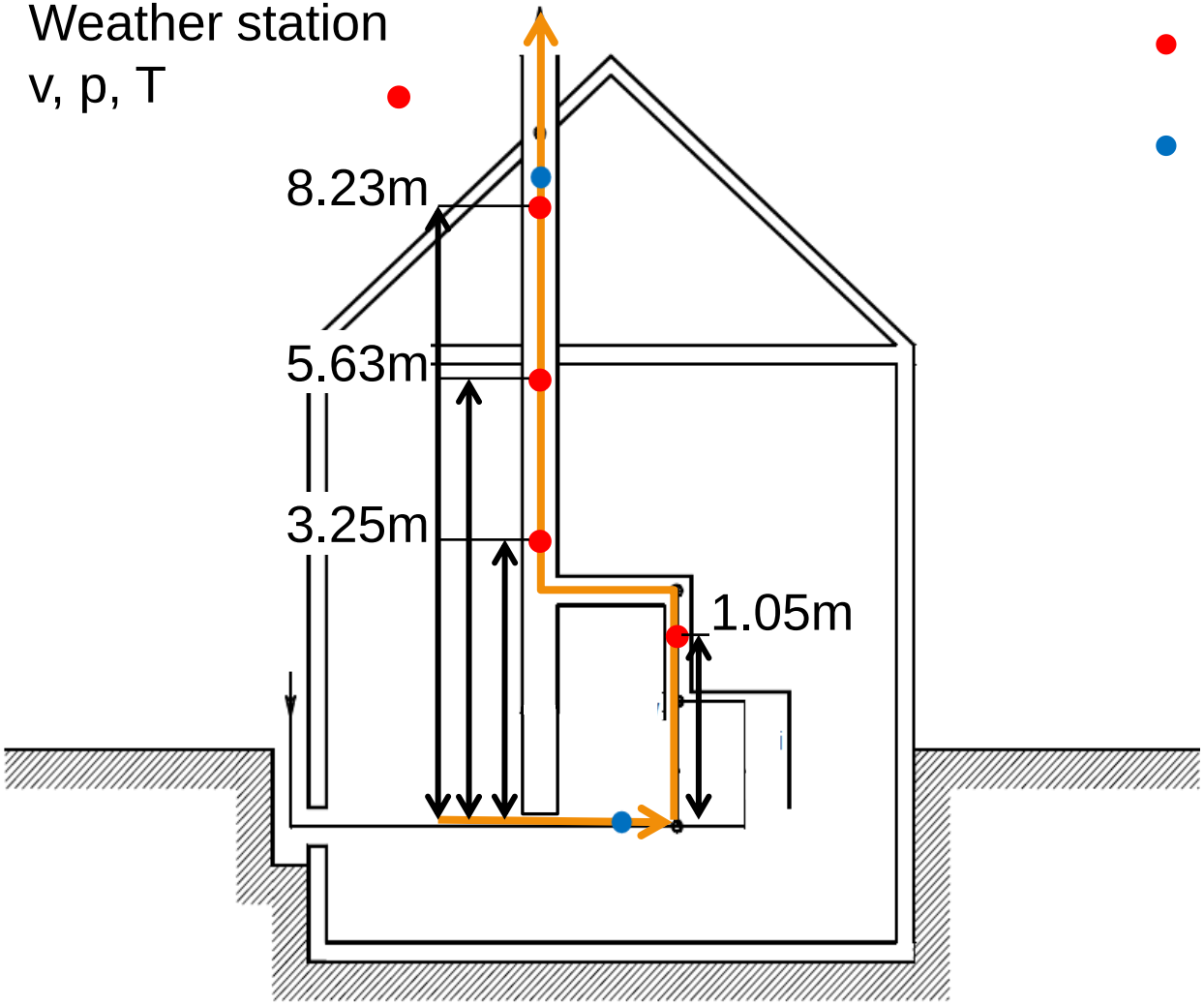
● = Temperature

● = Velocity

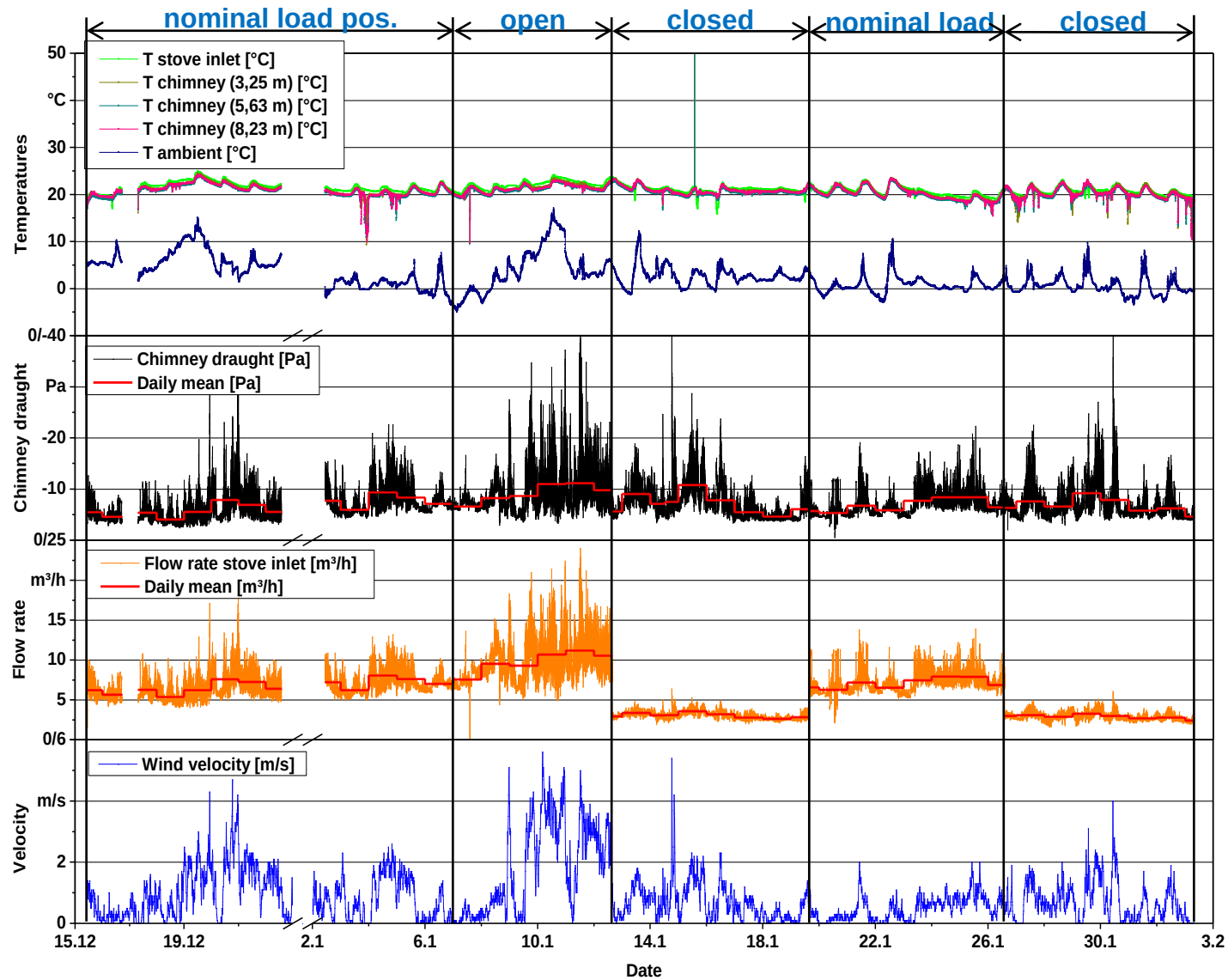
Room-sealed:

- lower heat losses
- no exhaust of room heat
- predominantly in new buildings
- not object of this investigation

System boundary's and overview of measurement points



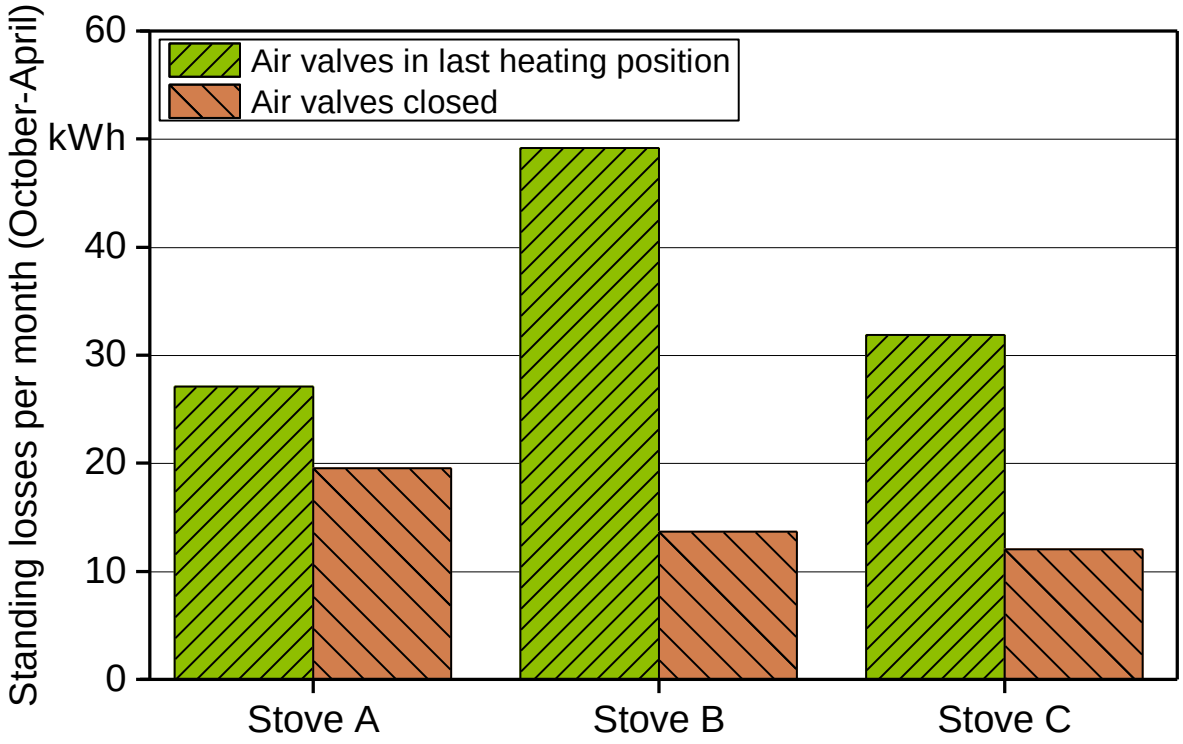
Monitoring on a cold natural draught chimney ($H_{chimney}$ = 11 m)



Stove A

Standing losses from cold chimney ($H_{chimney}$ = 11 m)

$$\dot{Q}_{chimney} = \dot{V}_{air} * \overline{\rho}_{air} * \overline{c_{p}}_{air} * (\overline{T}_{air} - T_{ambient})$$



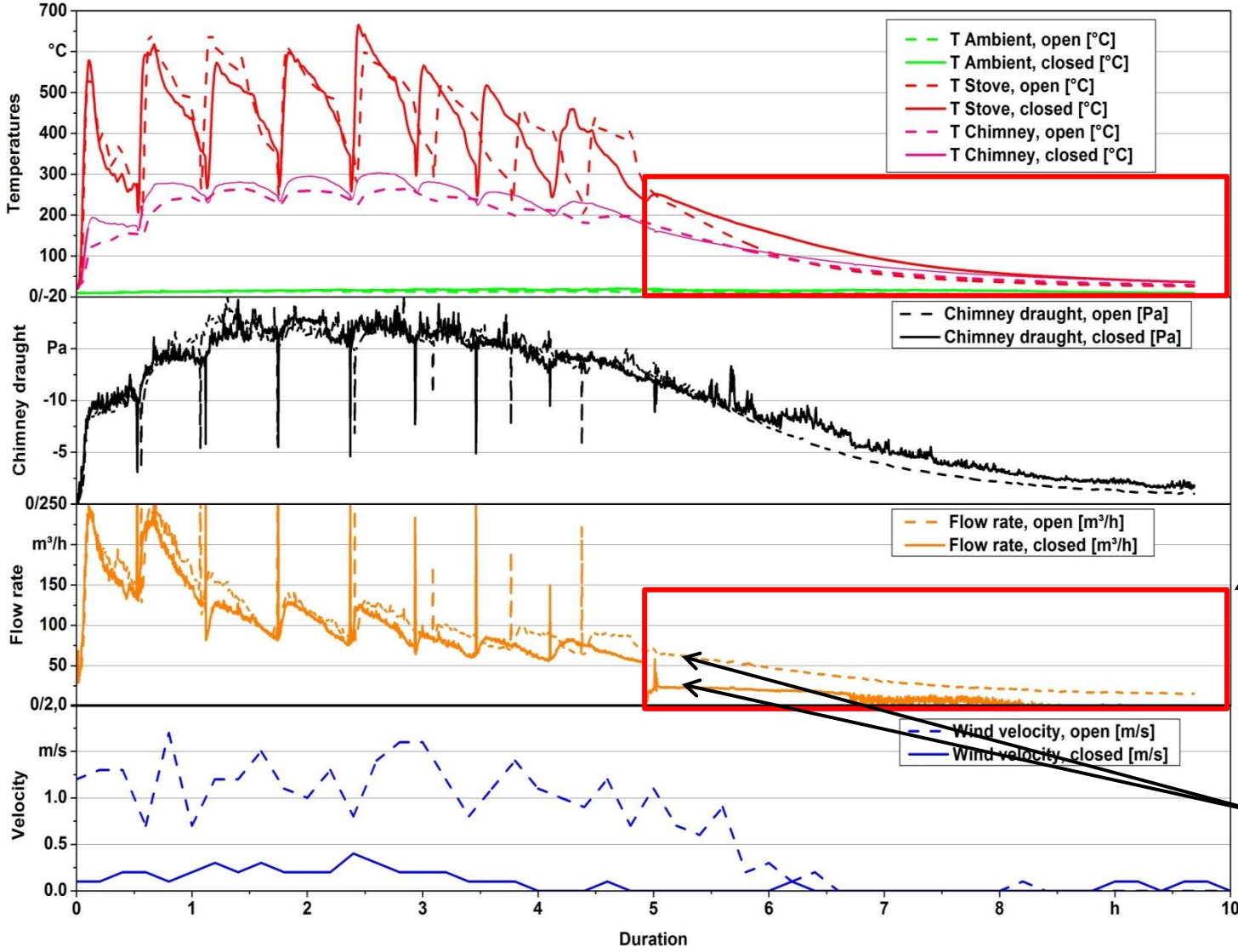
Max. monthly heat losses:

- 27-49 kWh with open flaps (in last heating position)
- 12-19 kWh with closed flaps

→ **approx. 3 kg to 12 kg of air dried beech wood per month**

Monitoring of 3 log wood stoves (8 kW) over the heating season at comparable climatic conditions.

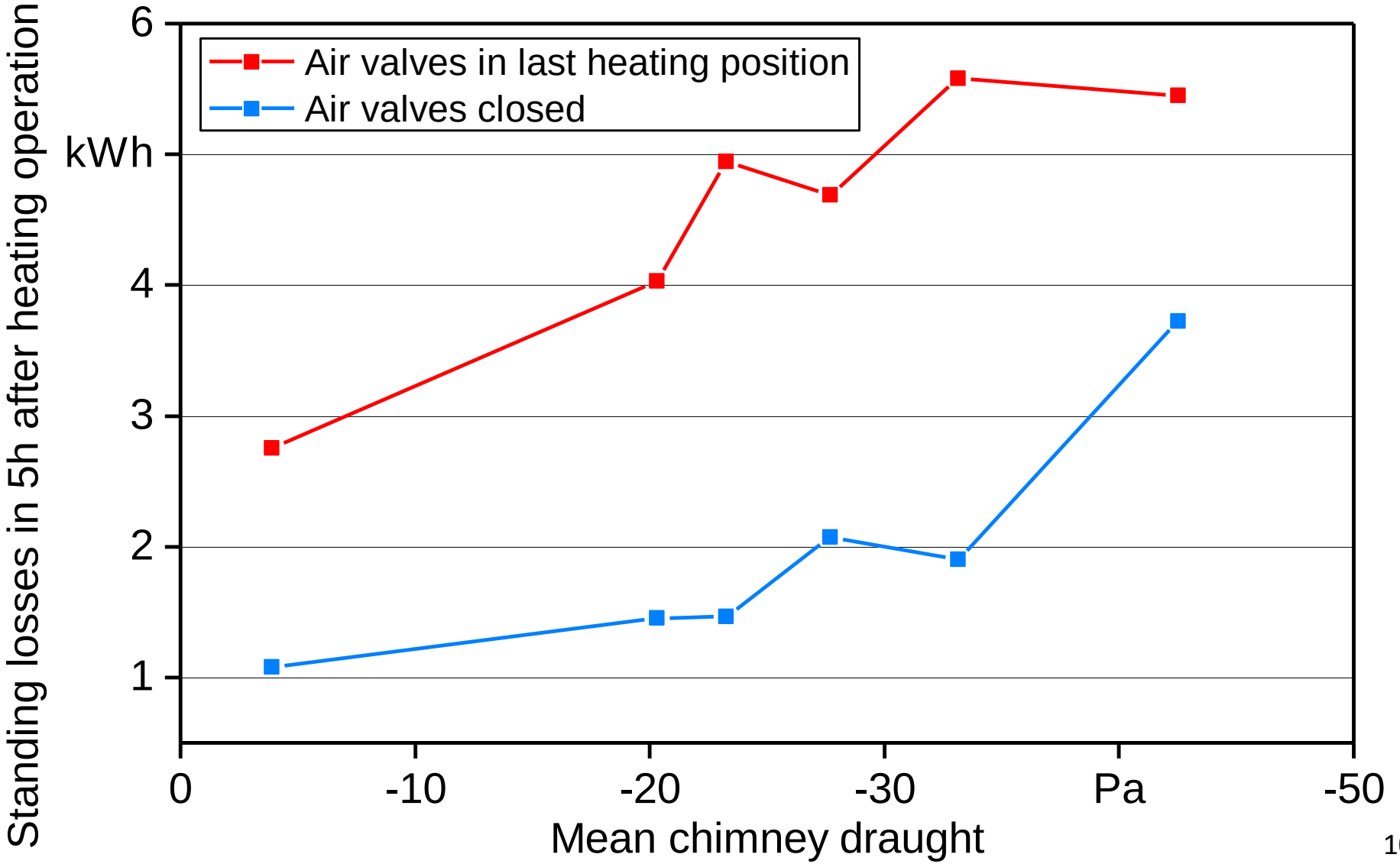
Standing losses after stove operation till 50°C flue gas temperature (Stove B)



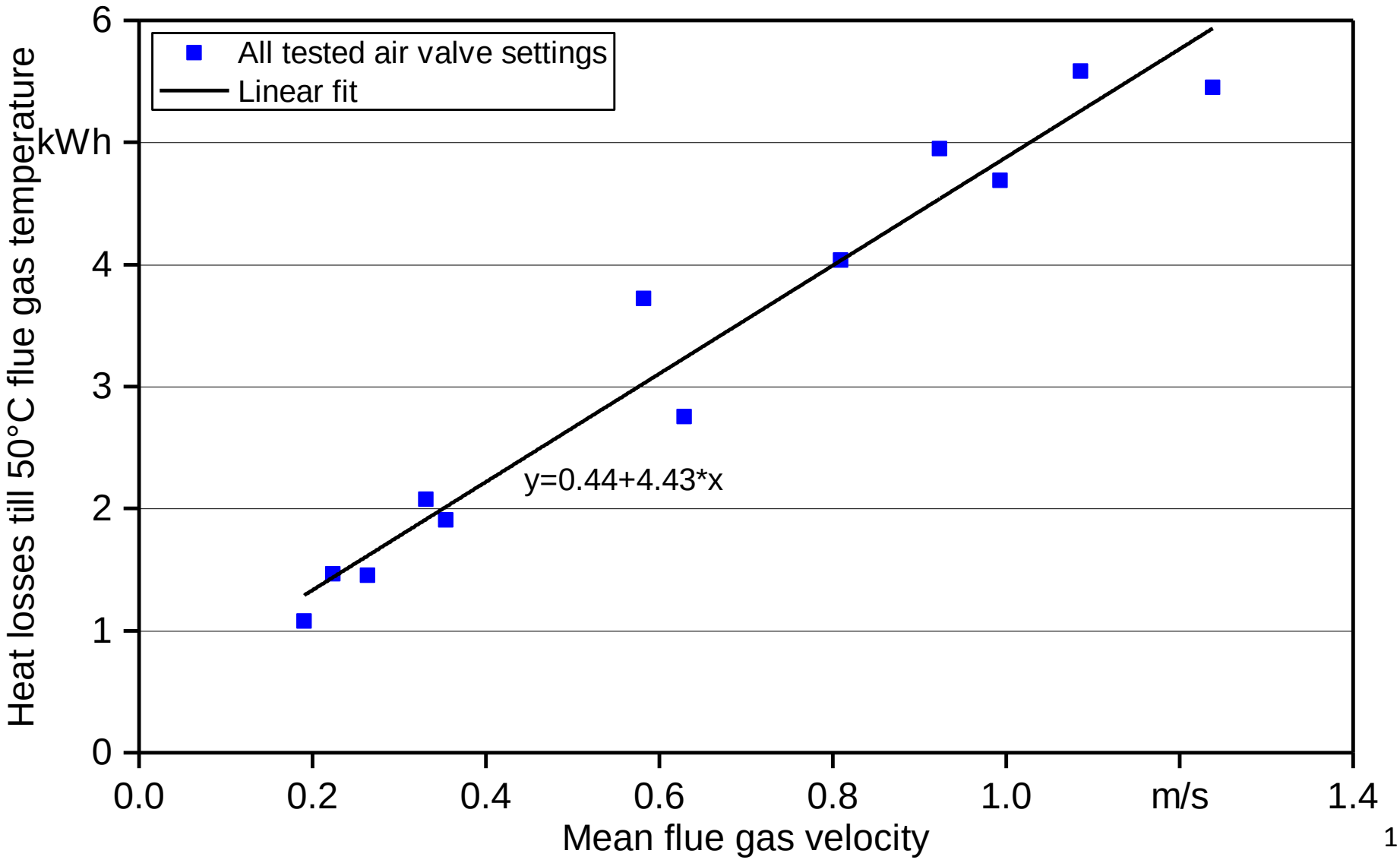
evaluation period

influence of air valve position

Standing losses after stove operation till 50°C flue gas temperature (Stove B) (1)



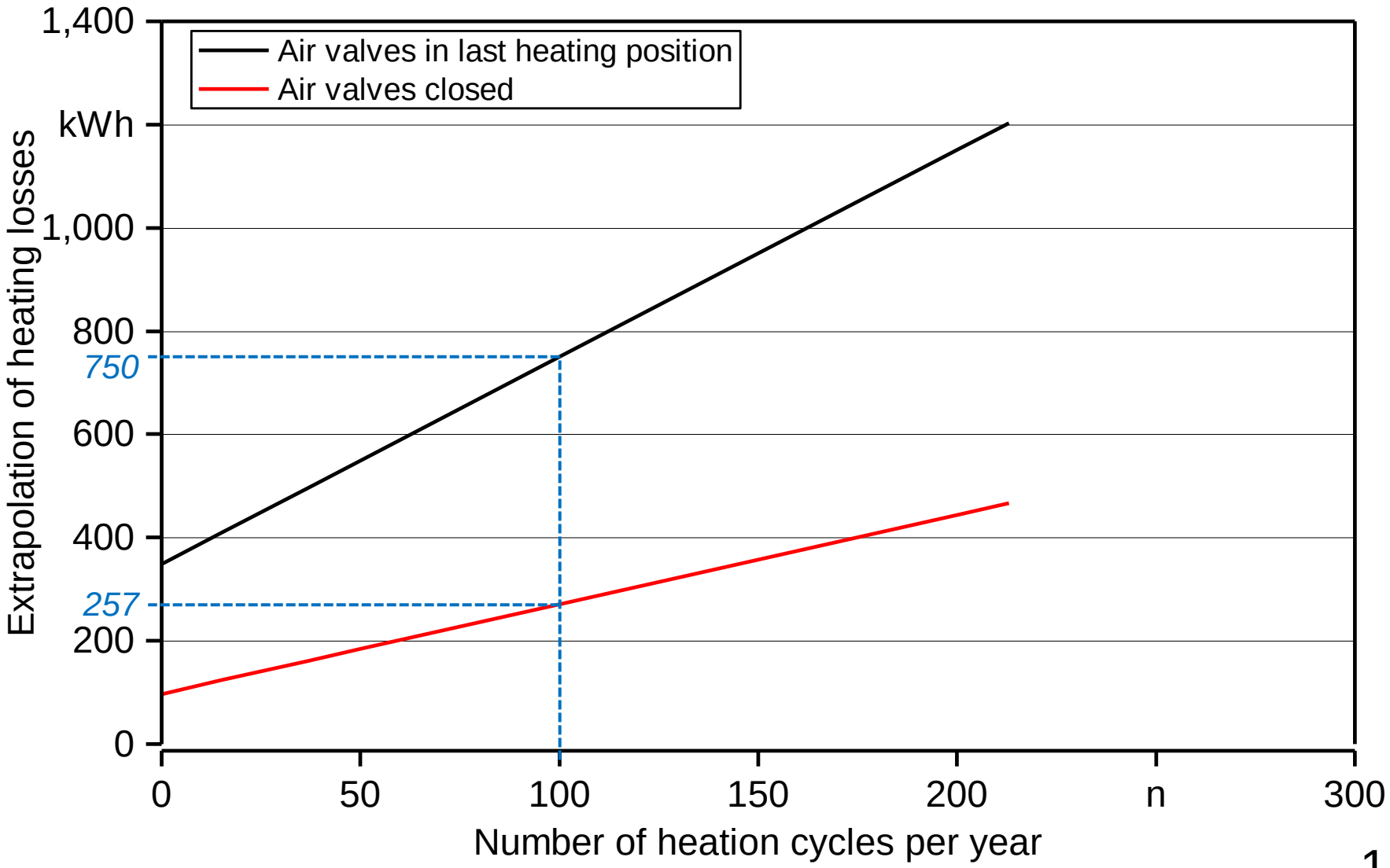
Standing losses after stove operation till 50°C flue gas temperature (Stove B) (2)



Summary for standing losses during chimney cooling (till 50°C flue gas temperature)

- 12 testing days with 8 batches (5 full load, 3 partial load)
- Heat losses with closed air flaps: 1.1 to 3.7 kWh per heating cycle
- Heat losses when air flaps remain in last position: 2.8 to 5.6 kWh per heating cycle
- This equals 0.3 kg up to 1.4 kg beech wood per heating cycle.
- Heat losses are depending on chimney draught resp. flue gas velocity after stove operation.
- This is mainly influenced by flap position and tightness of stove and air flaps.
- It can be assumed that with a tight stove the heat losses can be prevented easily by using an automatically closing air flap.

Extrapolation of standing losses from „cold“ chimney and after stove operation



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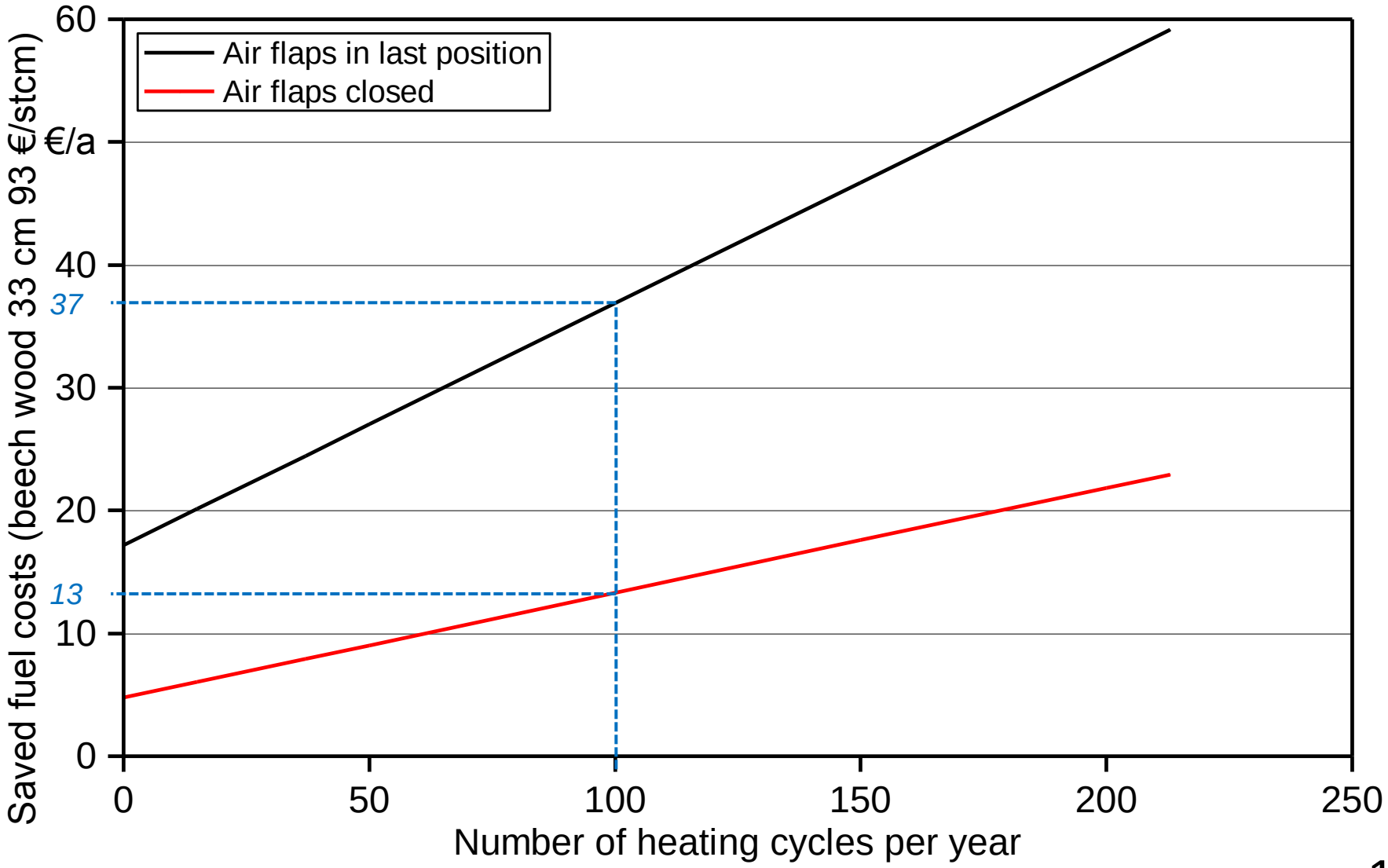

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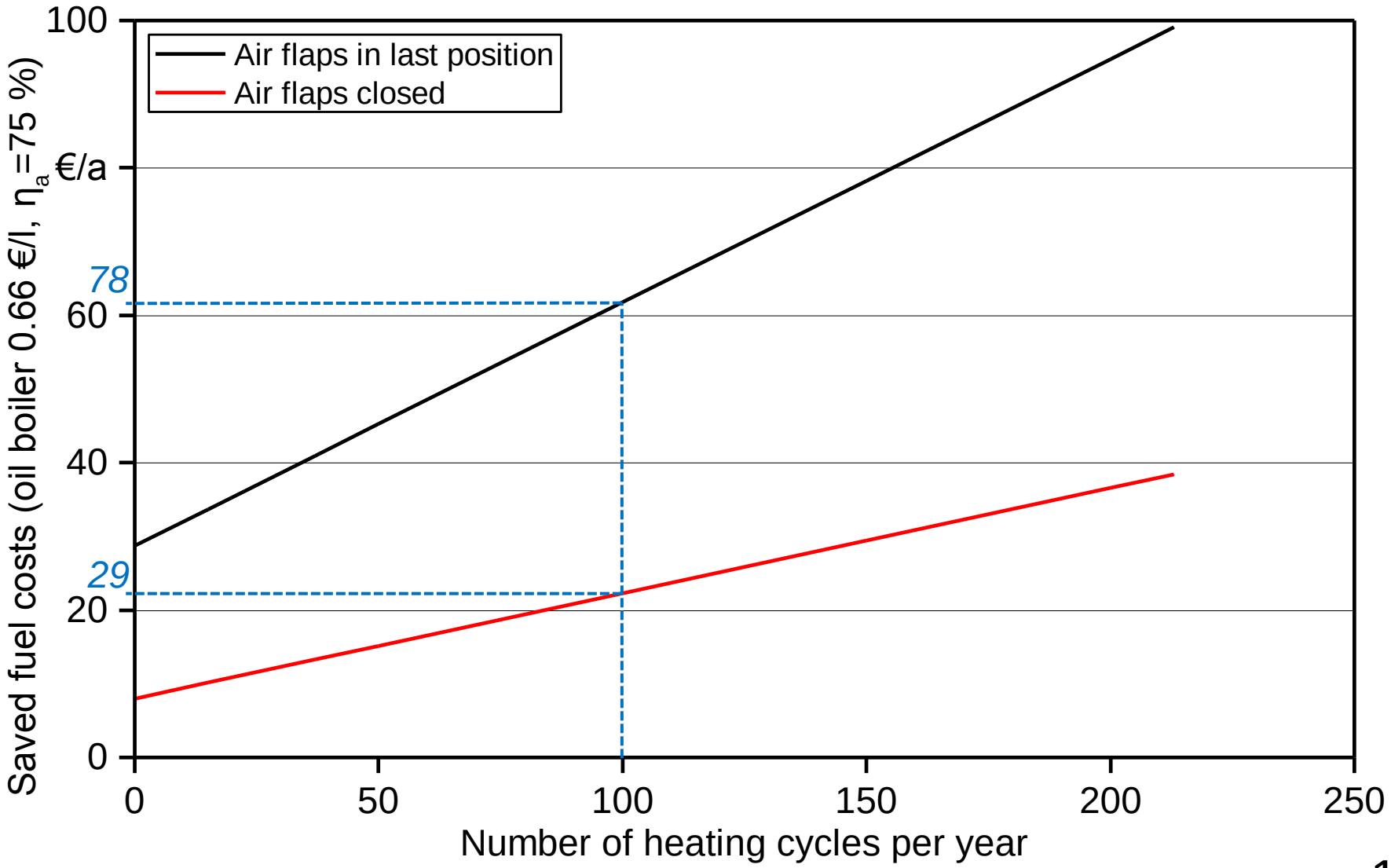
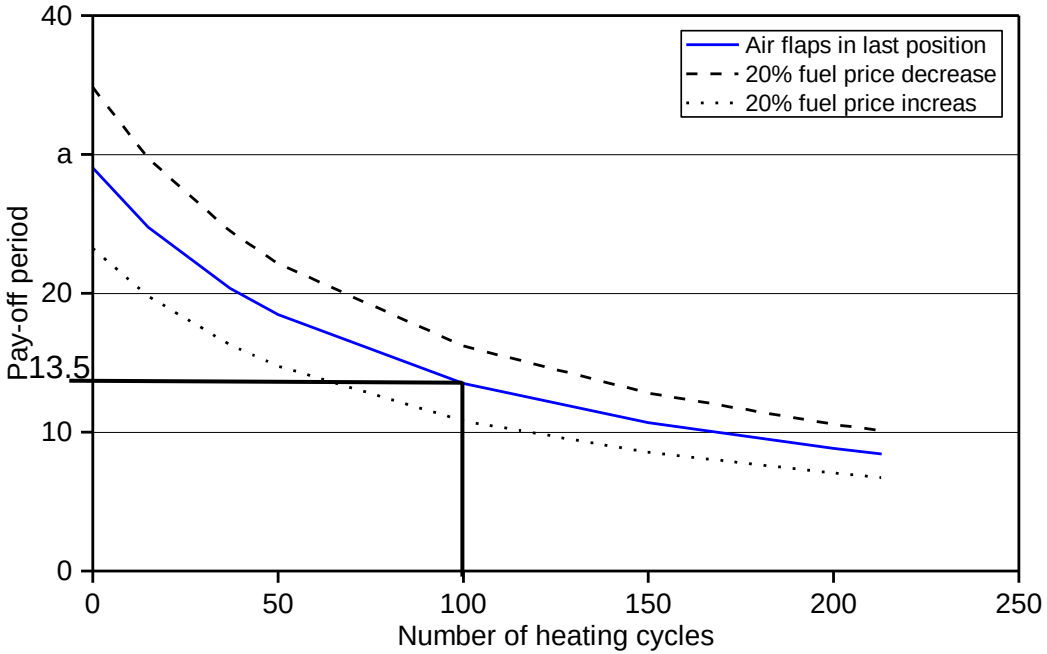
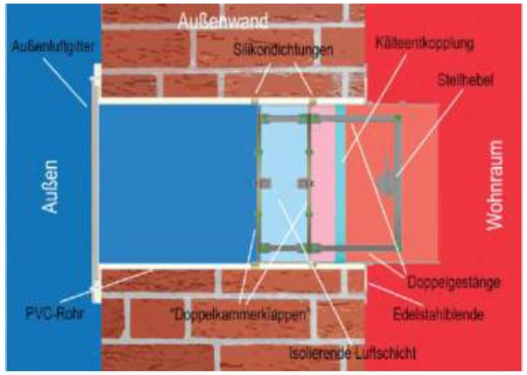


Conclusion: Motor driven air flap for prevention of standing losses

- An automatically air tight closing flap can reduce the standing losses nearly to zero.
- Currently no harmonized standard, there are high safety requirements → DIBT admission (Germany / Europe) → higher prices.





End consumer price approx. 835 €

Source: http://www.raab-gruppe.de

Assumptions for pay-off calculations:
Main heating with oil boiler, annual efficiency 75%;
oil price 0,66 €/l

Development of a cheap automatic air flap

- **Targets**
  - The flap should be mounted directly on the air socked of the stove
  - Use of simple electronics to reduce costs
  - Price target: below 250 €
- **Problems**
  - Safety requirements still have to be fulfilled (admission)
  - Electronics have to distinguish between intermediate batches and the last batch
  - → electronics similar to a retrofit controller
- **Recommendation**
  - Development of low cost retrofit controllers

Prototype from K+W

Thanks for listening!

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