Technologie- und Förderzentrum
im Kompetenzzentrum
für Nachwachsende Rohstoffe

Real LIFE emission test protocol for stoves – Suggestions and preliminary results

26th October 2023 in Straubing/online
2nd International Workshop

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Real-LIFE Emissions

Content

- Motivation and background
- Real LIFE test protocol – Procedure
- Experimental setup at TFZ
- Data evaluation
- First experiences with 3 different stoves
- Suggestions for further development of protocol
- Summary and outlook

Motivation and background

- Different test protocols for log wood stoves were previously defined such as:
  - Type tests
  - beReal
  - Blauer Engel (Blue Angel) in Germany – DE-UZ 212 (2020)
- What is real life?
  - Cold startup at natural draught
  - Batches with nominal load → if manual was read by users
  - Batches with partial load → lower heat output
  - Batches with overload → intensive combustion wanted by users
- All phases should be covered within the test protocol BUT it should be possible to perform measurement within **one** testing day!

Real LIFE test protocol – Procedure

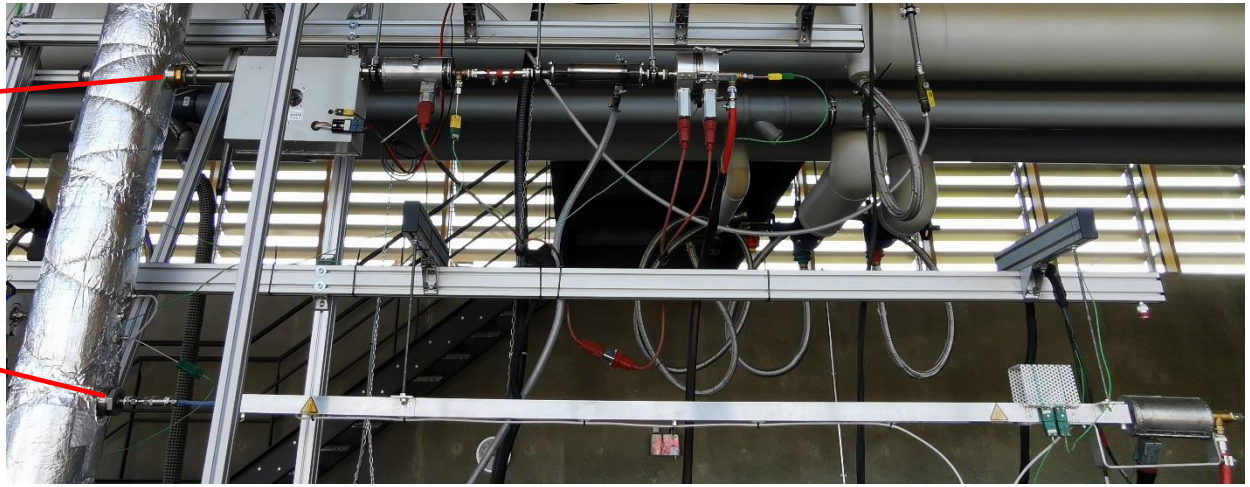
- 1st batch at natural draught
  - Fuel mass: nominal load + 25 % kindling material + 1-2 igniter blocks
  - Ignition from top or bottom depending on users manual suggestion
  - TPM probe must be already preheated, **ENPME** method is used (EN16510:2023)
- 2nd batch at natural draught
  - Fuel mass: nominal load
- 3rd to 5th batch at **nominal** load and forced draught at about -12 Pa
- 6th and 7th batch at **65% partial** load and forced draught at about -6 Pa, also if only one heat output is given by the manufacturer
- 8th batch at **150% overload** and forced draught at about -14 Pa
- Reloading at (4.0 ± 0.5) vol-% CO_2 or according to stove signal

→ Follow the instructions on reloading method and log orientation as in manual!

Experimental setup at TFZ using a 4 m flue gas tunnel

Hood is open during 1st and 2nd batch (natural draught)

Novel method: combined ENPME + Porous Tube at DR 1:8 (only during 2nd, 4th, 6th and 8th batch)

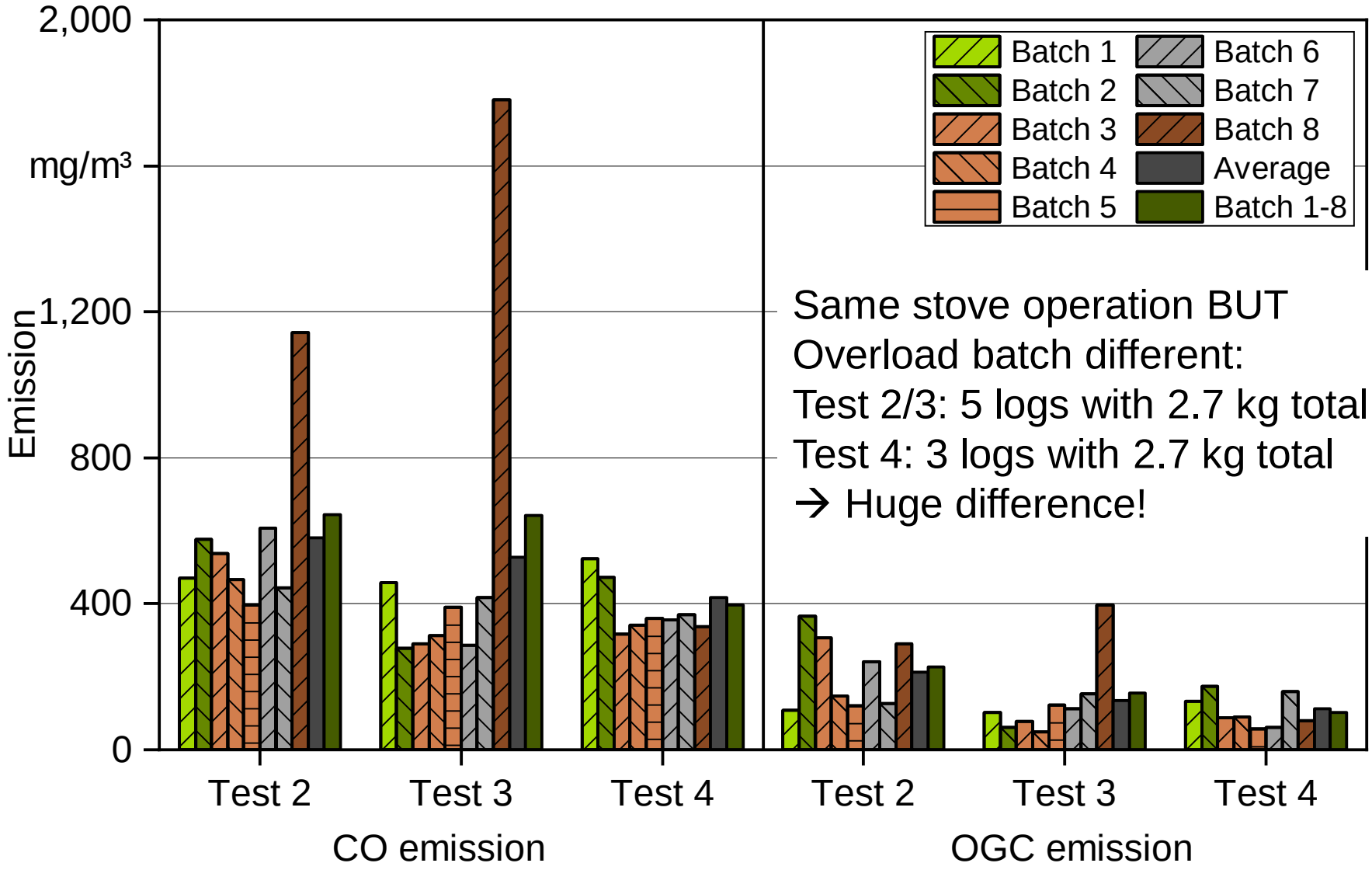


ENPME – straight probe (prototype instrument) used for every batch, only about 3 minutes for filter change necessary between batches

Data evaluation

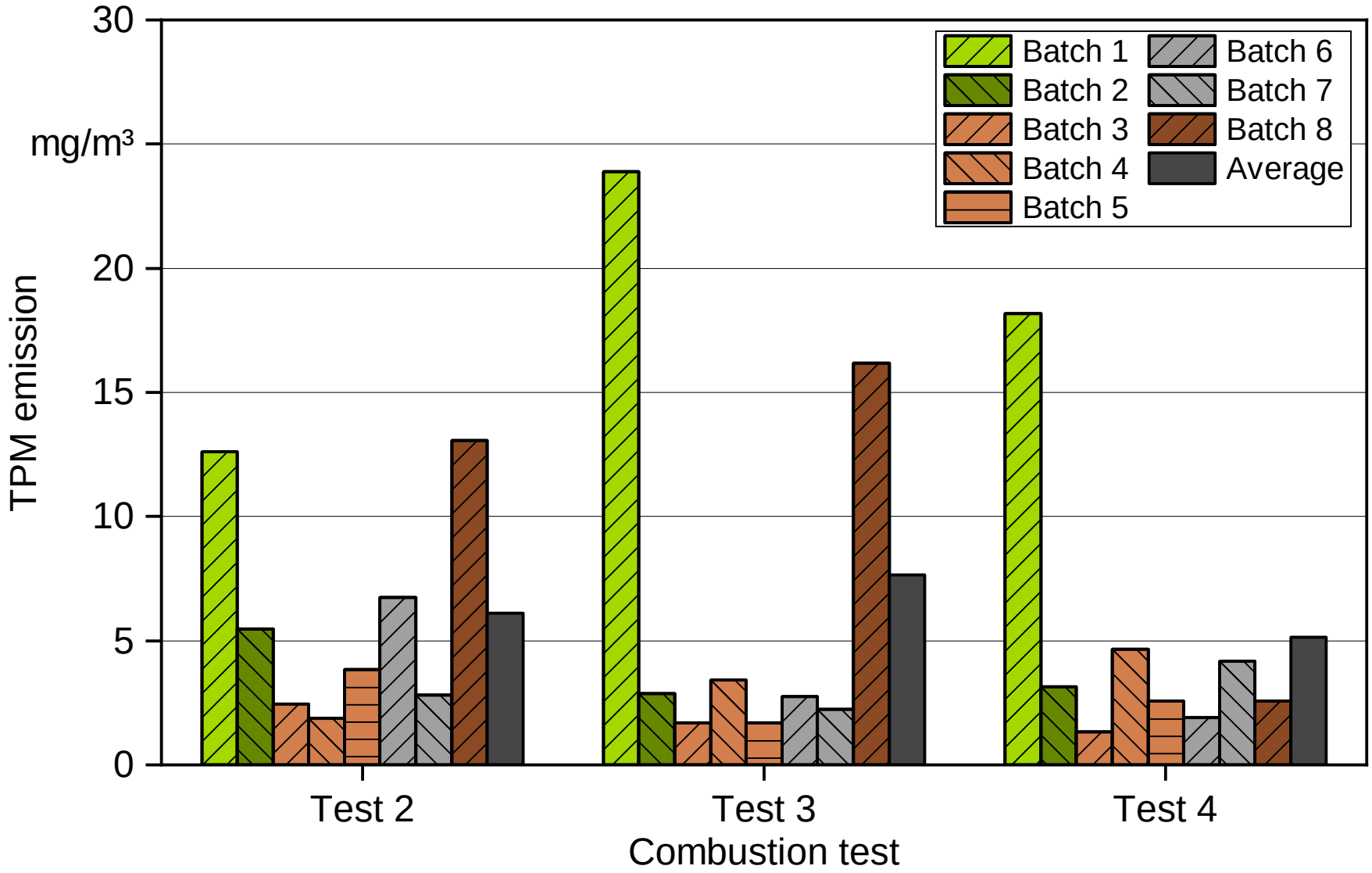
- **TPM** emissions are weighted according to duration of each batch → Short duration without measurement, time for filter change was limited to 3 minutes
  - TPM measurement terminated at recharging criteria/stove signal
  - Change of filter media in filter holder
  - Recharging the stove and starting TPM measurement immediatly
  - No intermediate batches, each batch is measured!
- **Gaseous** components evaluation starts right after ignition of 1st batch and is terminated when the last TPM measurement (8th batch) is finished → no interruptions between batches
  - Also time during filter changes are considered with higher CO and OGC emissions due to mostly flameless combustion
  - Moreover, each batch was evaluated for further analysis

First results using new test protocol – Example – Stove 1

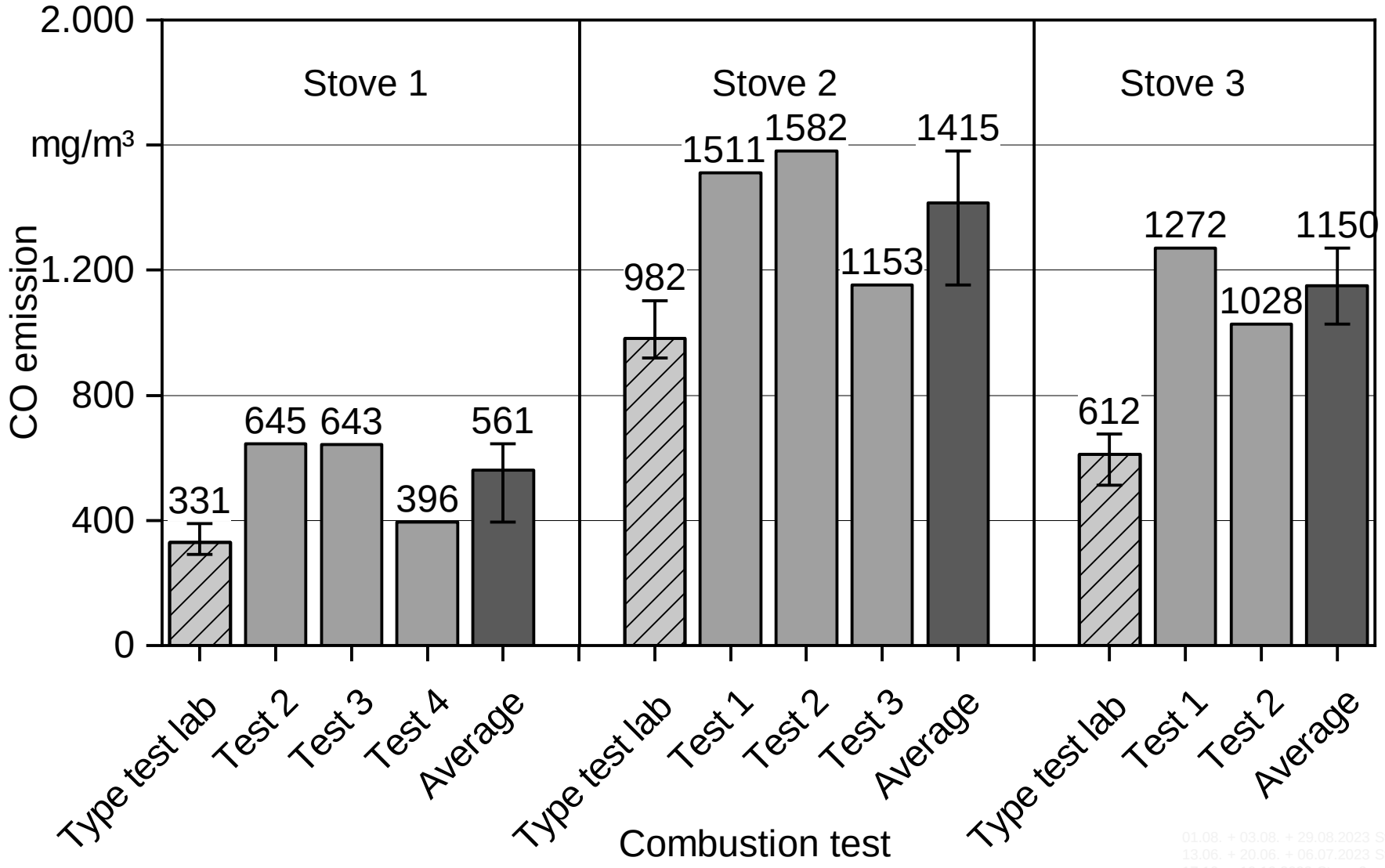


Same stove operation BUT
Overload batch different:
Test 2/3: 5 logs with 2.7 kg total
Test 4: 3 logs with 2.7 kg total
→ Huge difference!

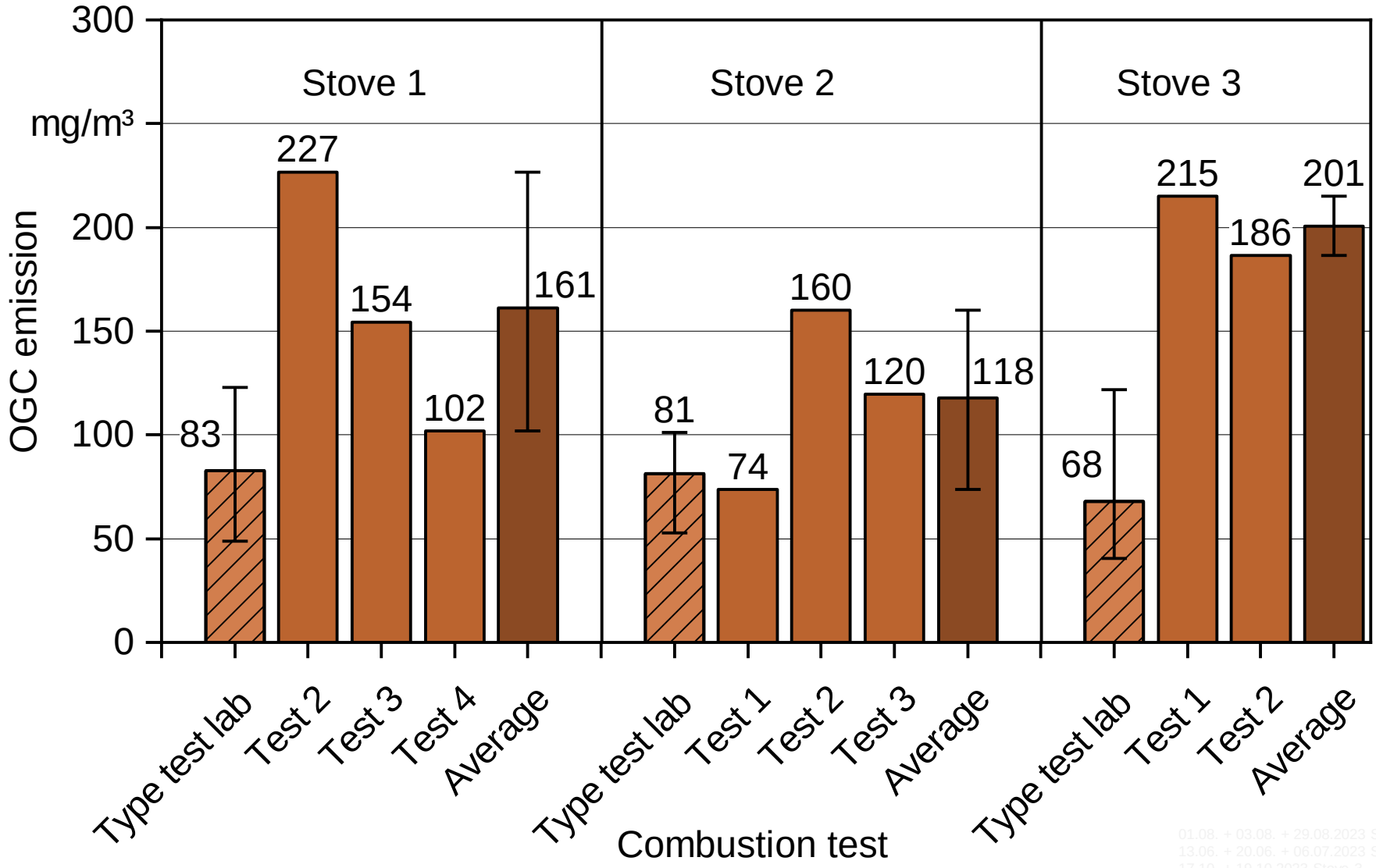
First results using new test protocol – Example – Stove 1



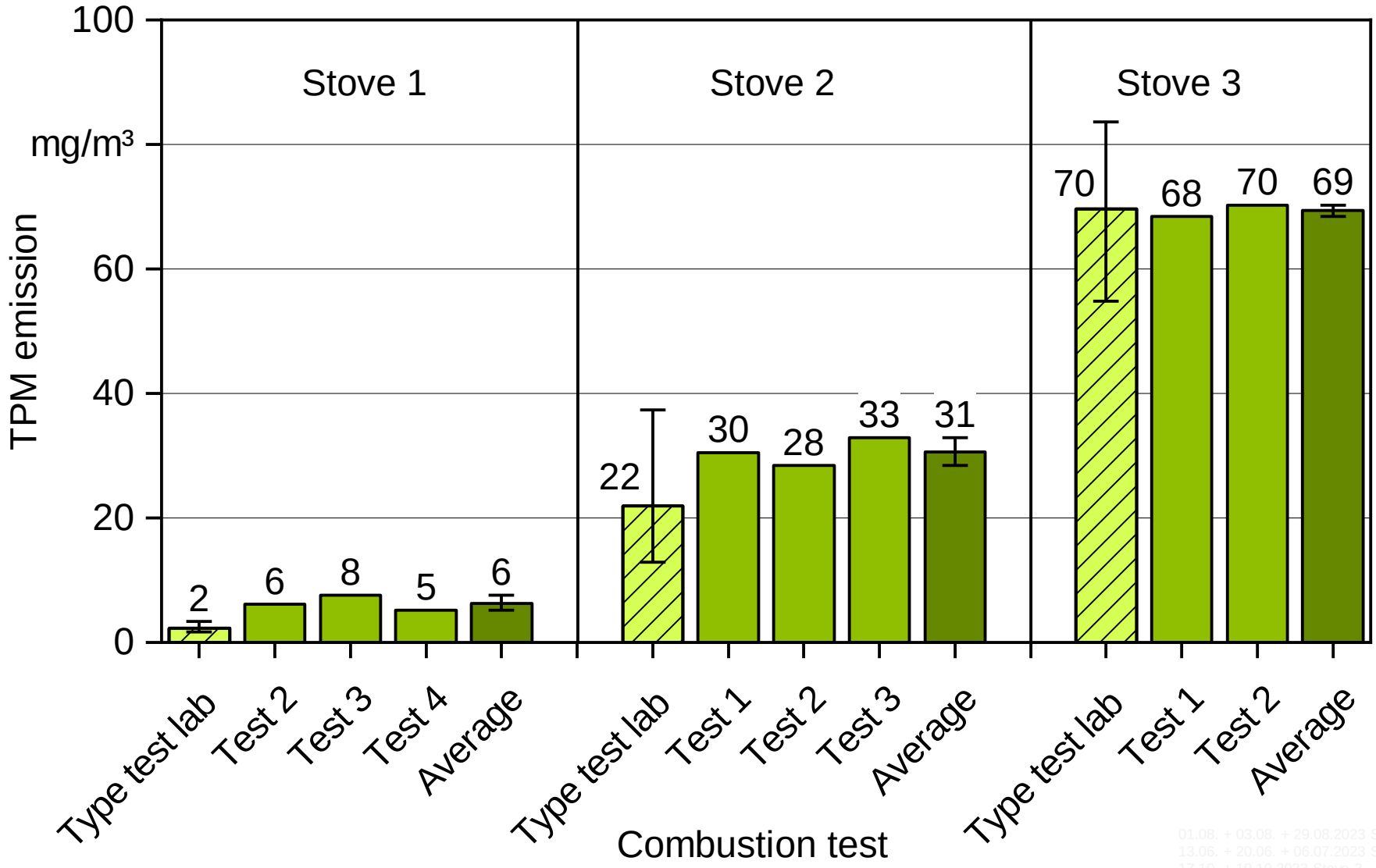
Results for 3 stoves – CO emission



Results for 3 stoves – OGC emission



Results for 3 stoves – TPM emission



Further suggestions/improvements for RealLIFE test protocol

- Ignition batch → fuel mass according to manual or to test protocol (mass as for nominal load + 25% mass)
- Natural draught during all batches without adjustments of draught by valve or flaps
- Perform „partial load“ also if stove has only one heat output
- Overload batch → 150% of mass:
  - Increase mass of fuel by increasing the number of logs and keeping the size of logs the same as for „nominal load“ → more reactive surface → most likely more intensive combustion → higher emission → prefered since we want real life
- Recharge the stove at flame extinction or according to stove signal (if that is the signal for recharging according to manufacturer)

Summary and outlook

- Several stoves have been tested using the RealLIFE test protocol
- Validation of RealLIFE test protocol within round robin
  - 2 log wood stoves are tested at 4 laboratories (INERIS, VSB, UEF and TFZ)
  - Fuel logs for all combustion tests in the correct mass were provided by TFZ using beech wood
  - Current status:
    - INERIS and UEF have tested both stoves
    - TFZ and VSB have tested one stove
    - tests will be completed in November/December 2023
    - Final evaluation until February/March 2024

- Generation of a database of 10-15 appliances → combustion tests will be completed in April/May 2024 and evaluated until 3rd workshop
- Final definition of RealLIFE test protocol in summer 2024

Thank you for your attention!

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