User and Fuel Impact on Emissions of Wood Stoves

20th ETH-Conference on Combustion Generated Nanoparticles
June 14th, 2016

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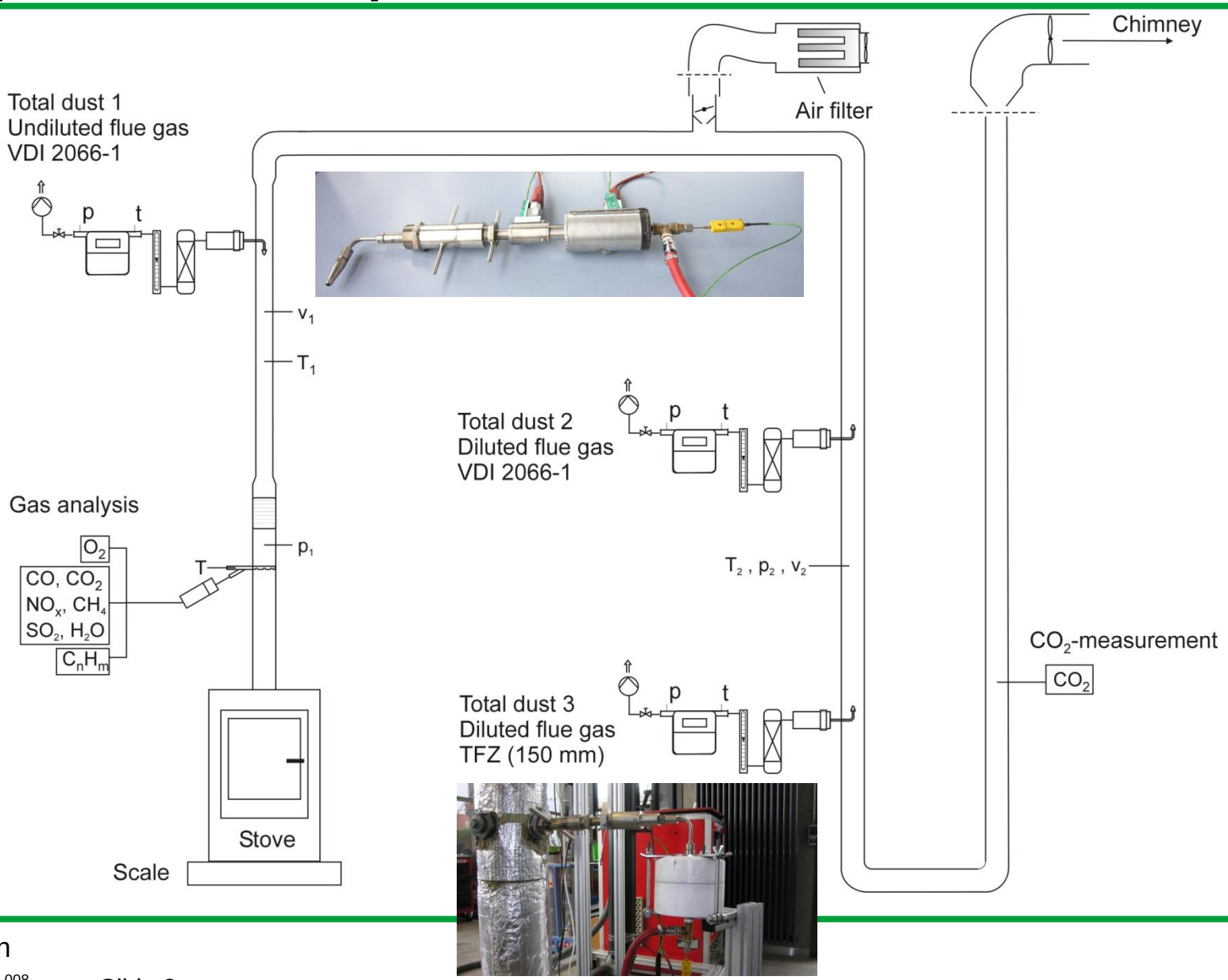
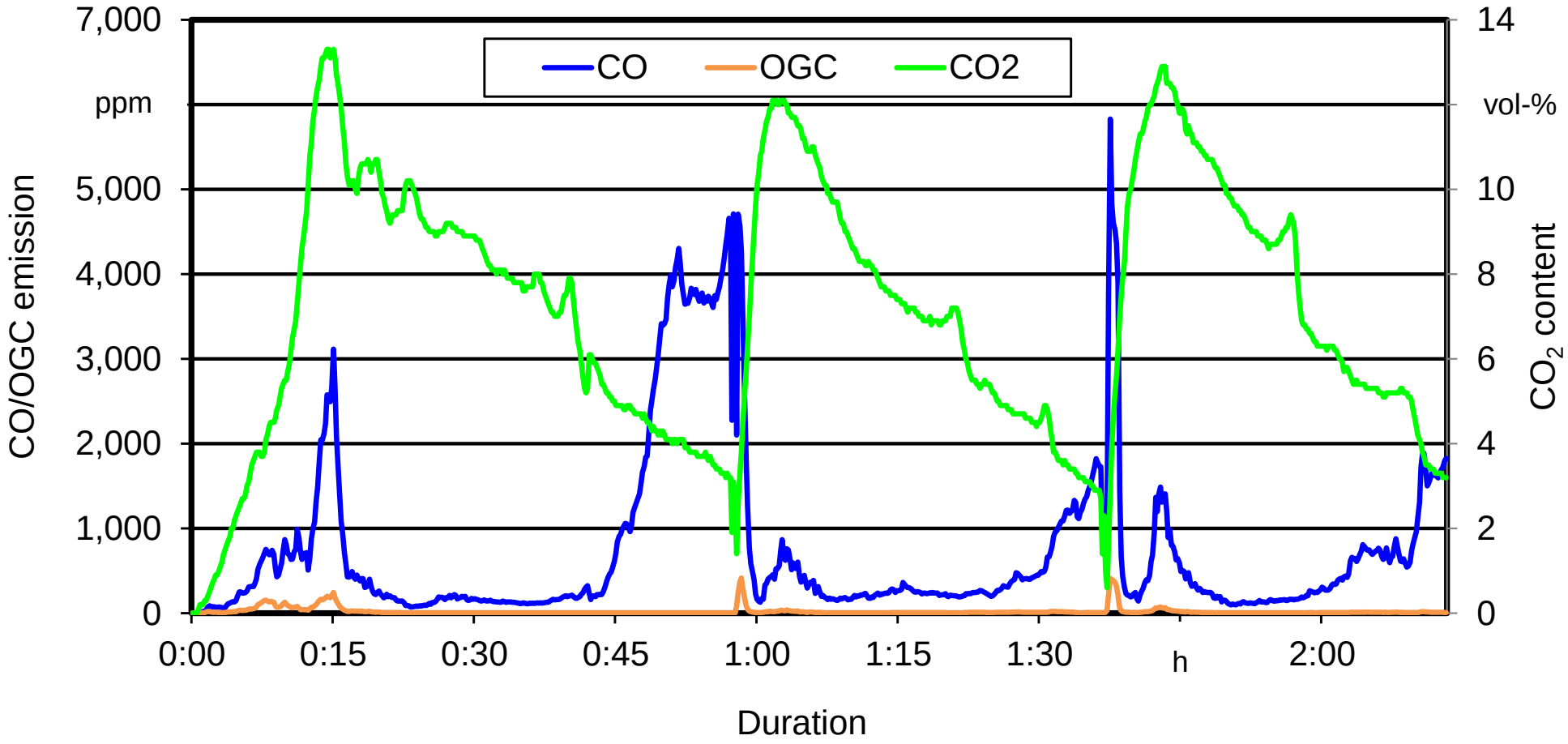
Content

Experimental setup

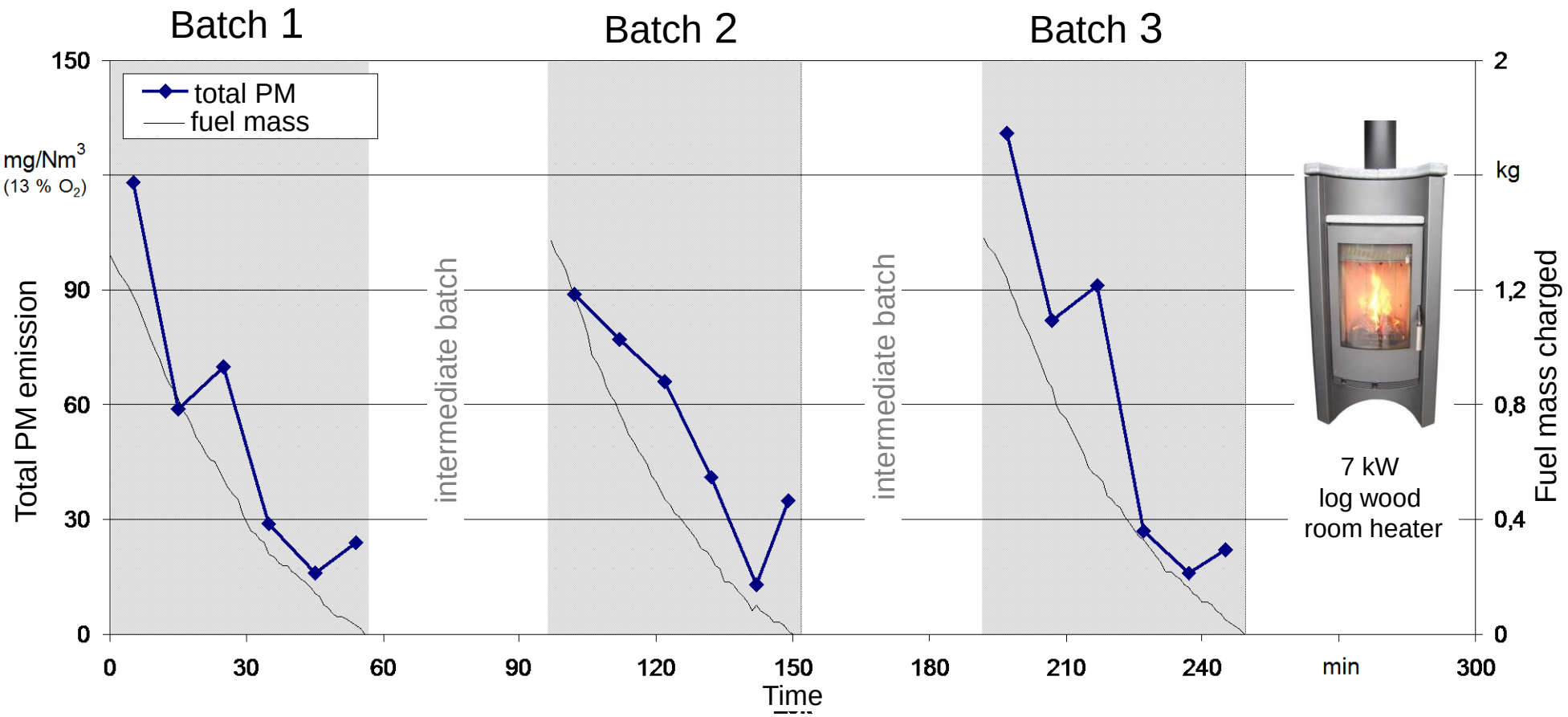


Typical profile of flue gas components from a 8 kW room heater



Source: TFZ

Total PM emissions from a log wood stove over complete batches

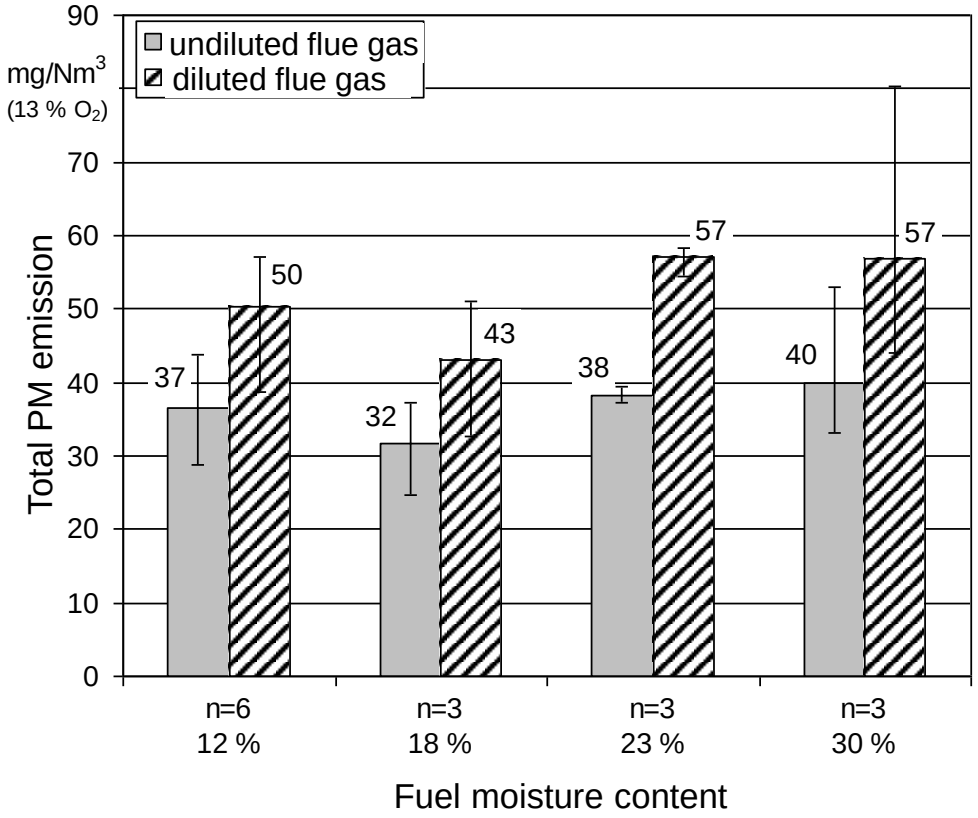


Fuel used: beech logs, 25 cm, 1.4 kg per batch,
PM measured in 10-min-increments in undiluted flue gas

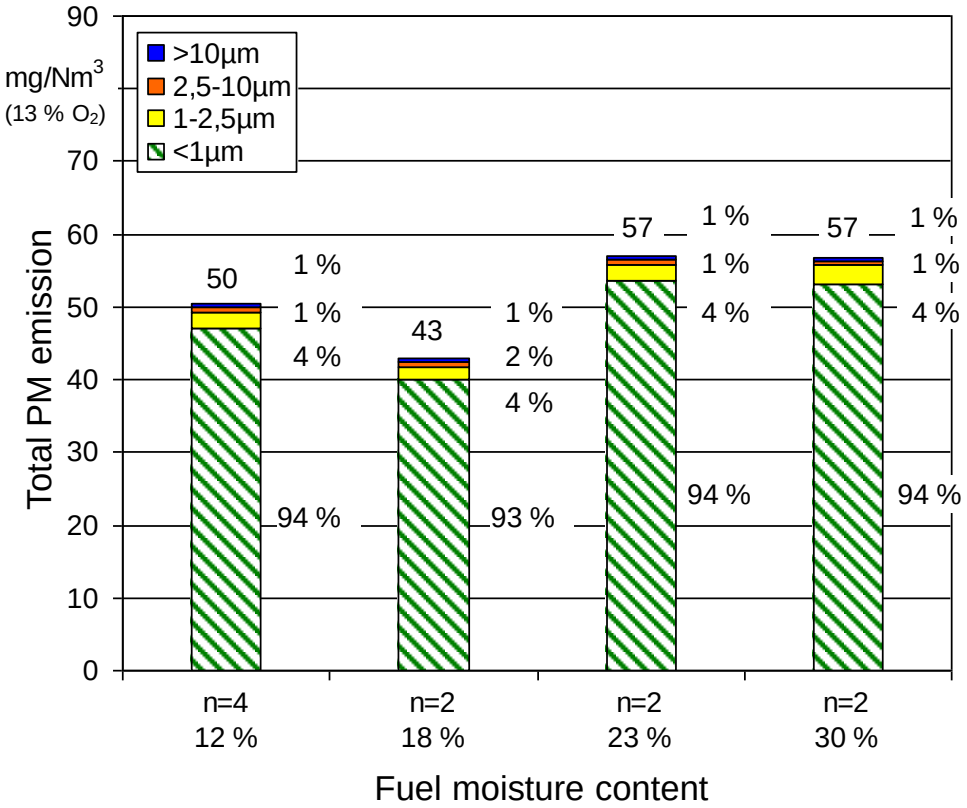
Source: TFZ-Report No. 22
download: www.tfz.bayern.de

PM emissions and particle size distribution from a tiled stove insert (7 kW)

Diluted vs. undiluted PM-sampling



Particle size distribution

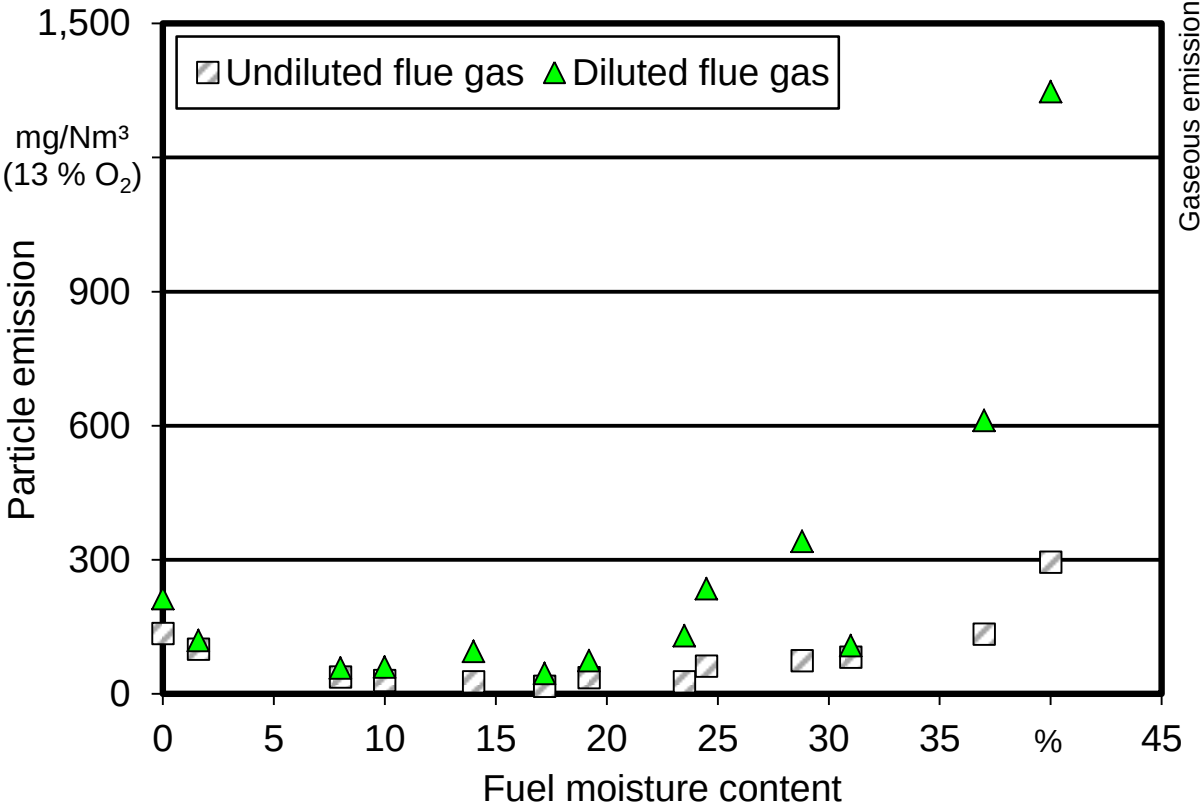


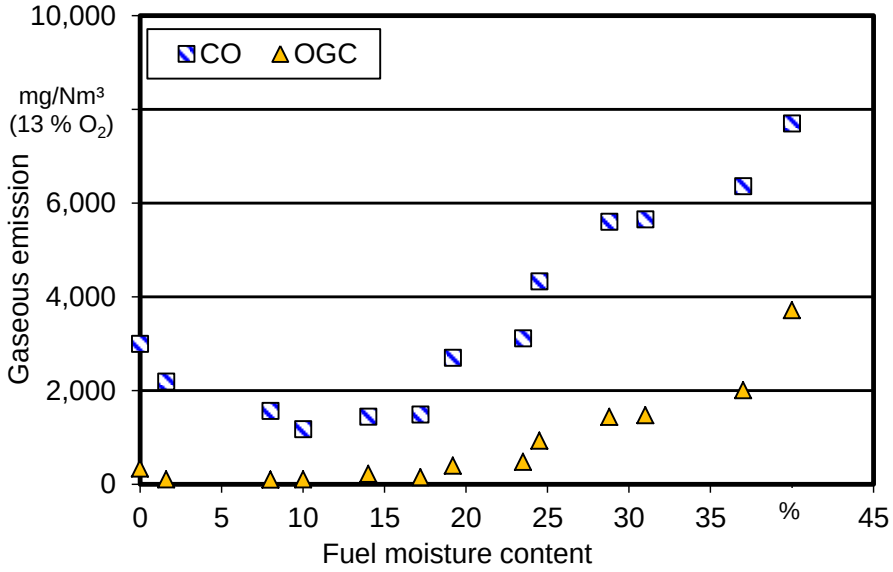
Source: TFZ-Report No. 22
download: www.tfz.bayern.de

Furnaces used in further tests

Stove 1 (log wood room heater): *Buderus blueline 12*	**Stove 2** (log wood room heater): *Fireplace Santa Fe*	**Stove 3** (tiled stove insert): *Brunner KKE 33*
		
8 kW, with grate 37 *L* reactive volume 25 cm logs max. 2.6 kg not suitable for coal	6 kW, with grate 25 *L* reactive volume 25 cm logs max. 1.6 kg suitable for coal	7 kW, without grate 35 *L* reactive volume 33 cm logs not suitable for coal

Fuel moisture impact of beech wood



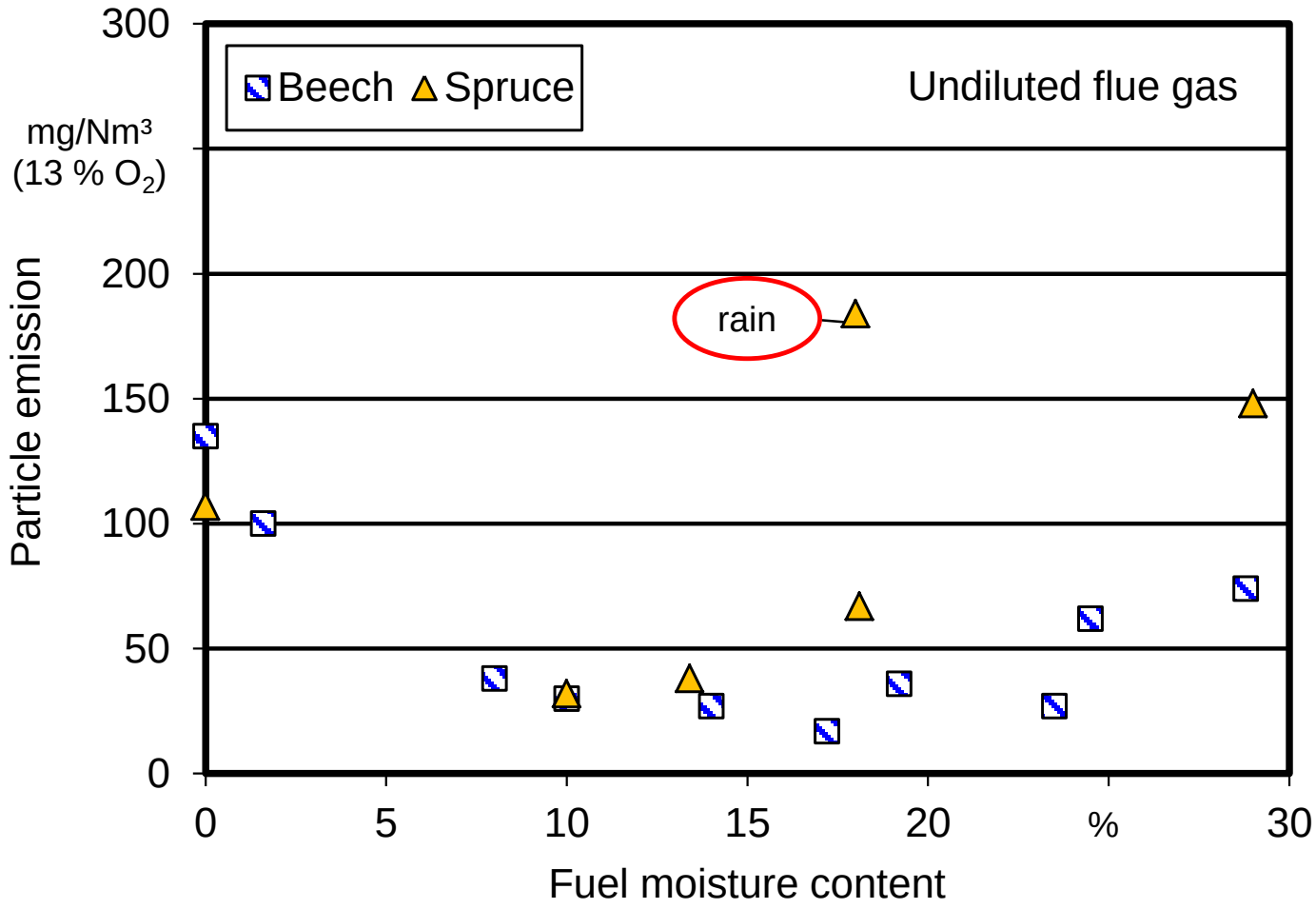


test fuel shape

8 kW stove (Stove 1)

Source: TFZ-Report No. 36
download: www.tfz.bayern.de

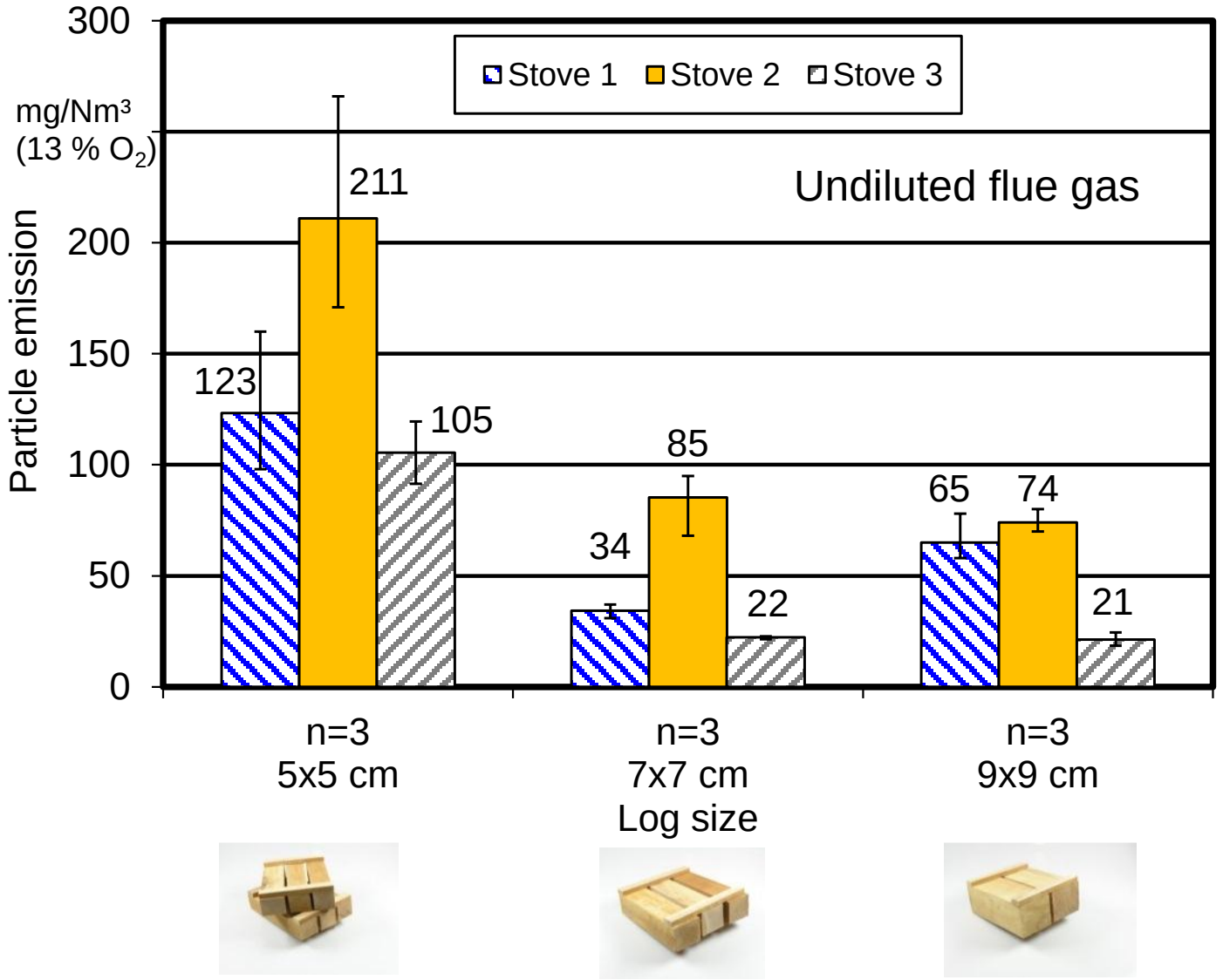
Fuel moisture impact of spruce and beech wood



8 kW stove (Stove 1)

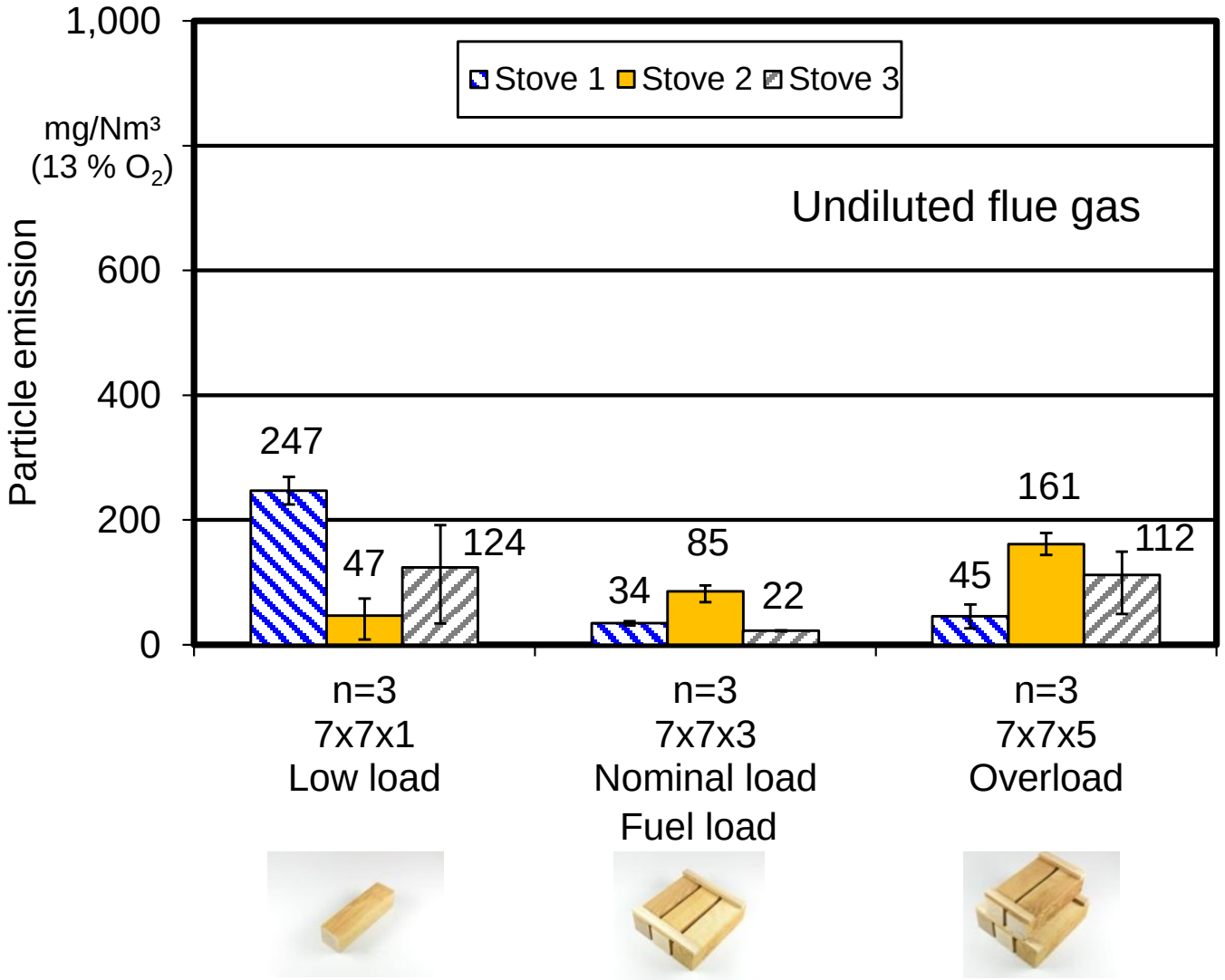
Source: TFZ-Report No. 36
download: www.tfz.bayern.de

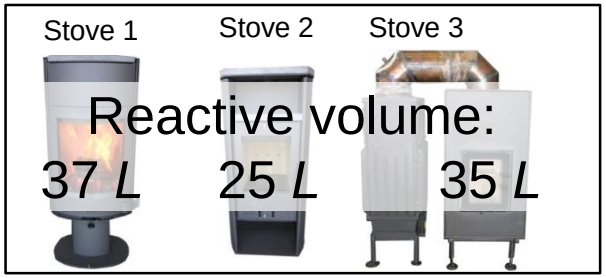
Log size impact on total PM emission



Source: TFZ-Report No. 36
download: www.tfz.bayern.de

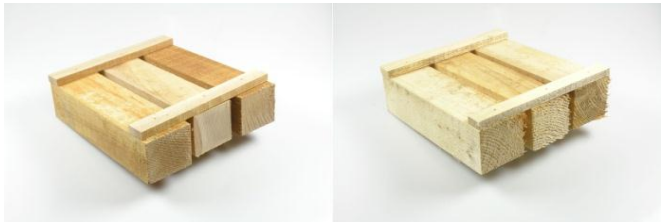
Fuel load impact on total PM emission



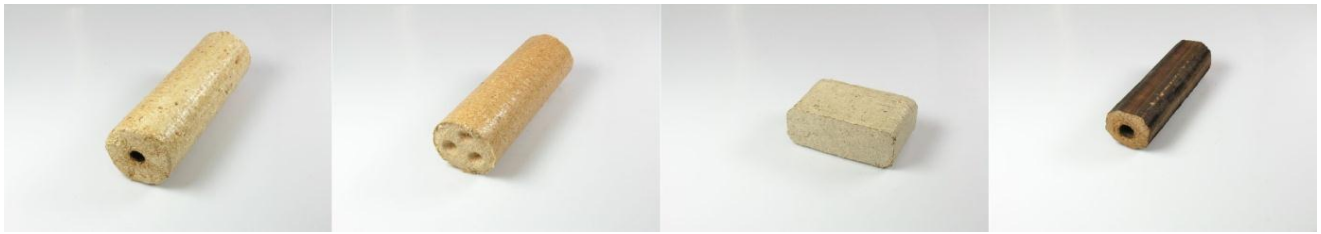


Source: TFZ-Report No. 36
download: www.tfz.bayern.de

Further fuels used



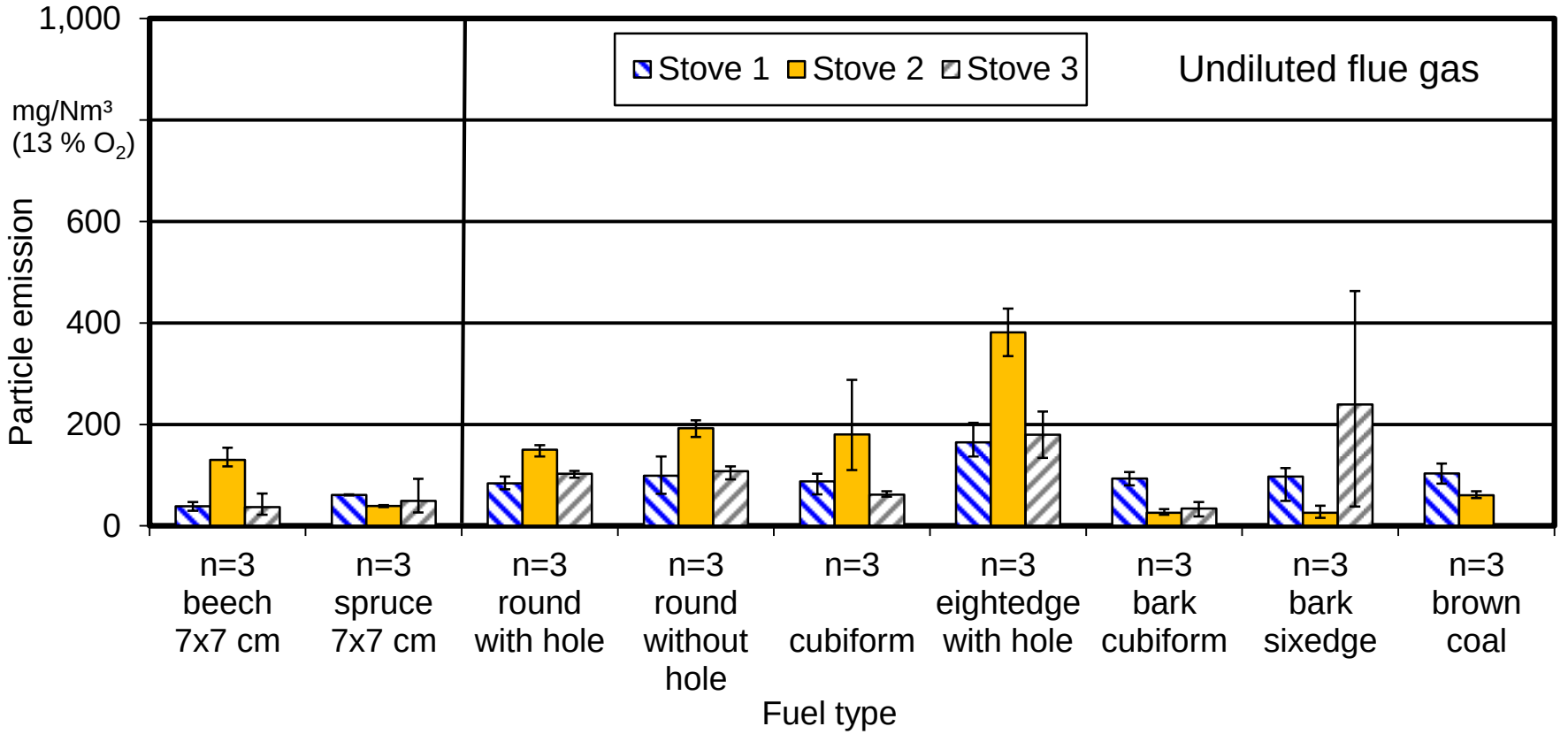
beech wood 7x7 cm	spruce wood 7x7 cm



round with hole	round without hole	cubiform	eight edged with hole

bark cubiform	bark six edged	bown coal (cubiform)

Log wood versus briquettes



Source: TFZ-Report No. 36
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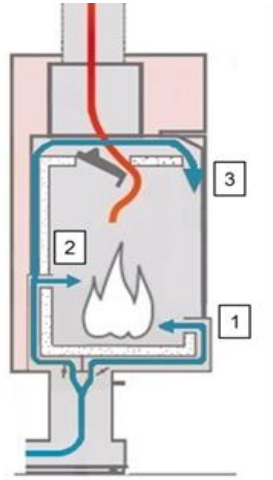
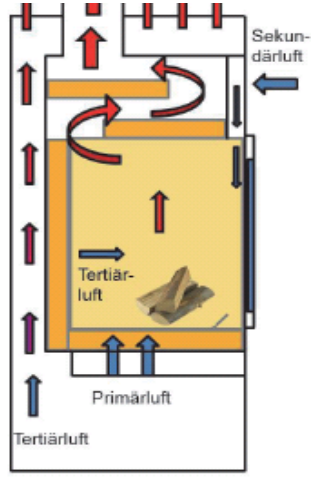
Ignition Tests – Materials & methods

- Two different roomheaters were used (different design of primary air supply)

BIOENERGY 2020+
Roomheater A



TFZ Straubing
Roomheater B



- Use of beech firewood, <u>BUT</u> two different kinds of kindling material: Spruce & Beech
- Two modes of ignition: Top down & Bottom up

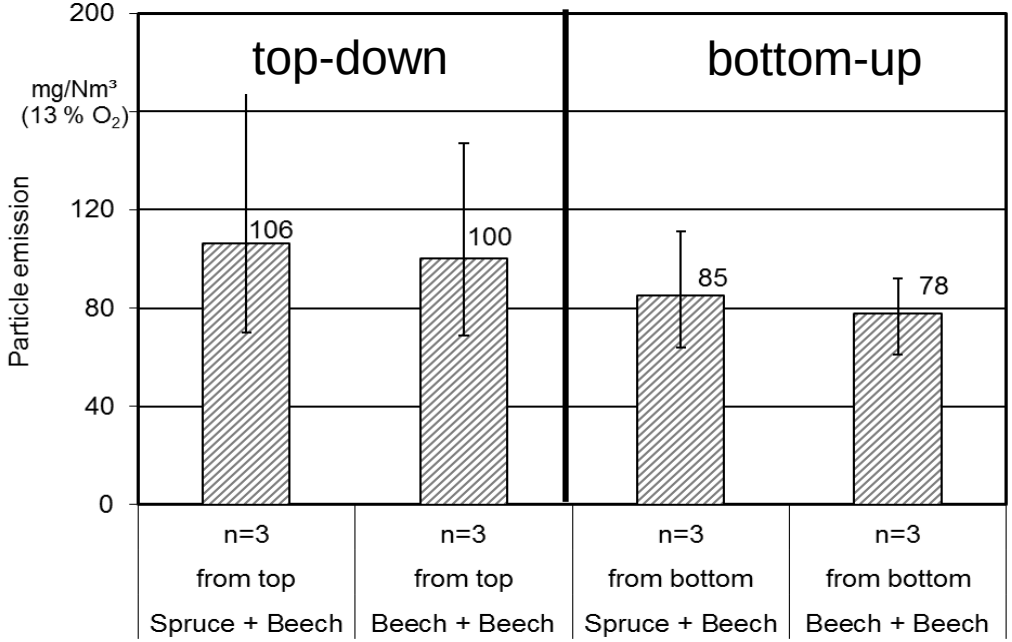
  → ∑ 4 Variations tested

Ignition Tests	
Ignition Mode: Top-down	**Ignition Mode: Bottom-up**
	
Spruce & Beech kindling	
2 layers with 4 firewood pieces a 600g (25cm) 500g kindling (3 layers) Mass of complete batch 2.9 kg Measuring of CO, OGC and PM emissions (PM sampling till flames are extinguished)	
Test facility acc. EN 13240	

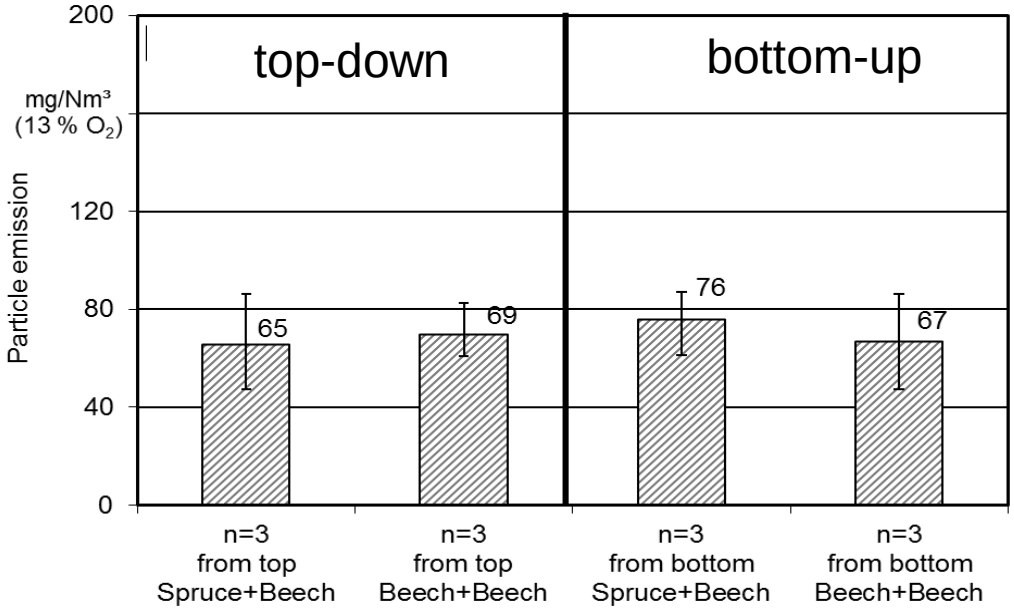
Source: Bioenergy 2020 & TFZ (from “beReal-Project“)

Total PM emissions with top-down and bottom-up ignition

Roomheater A

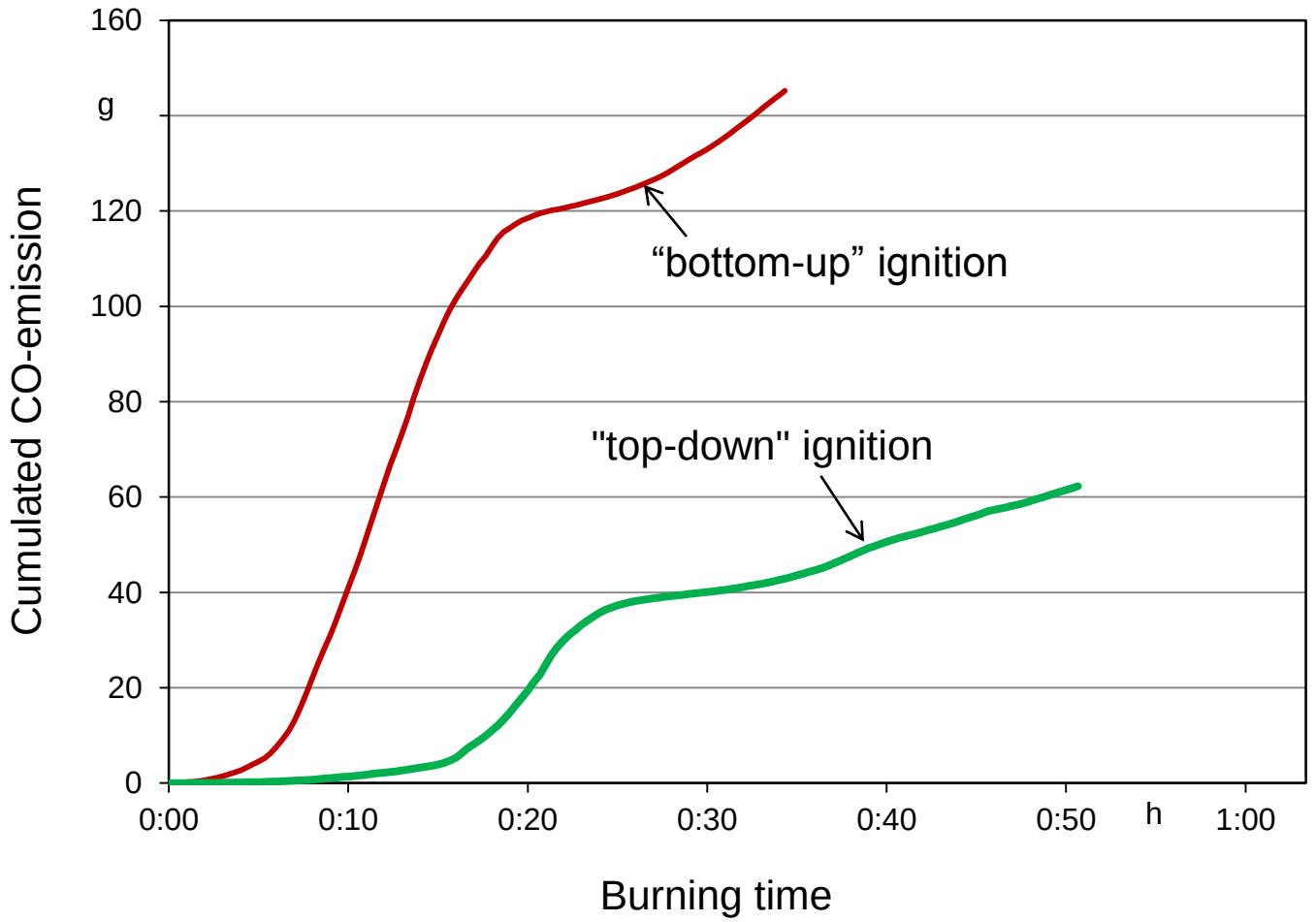


Roomheater B



Source: Bioenergy 2020 & TFZ (from “beReal-Project“)

CO emission during stove ignition: “top-down” versus “bottom-up”

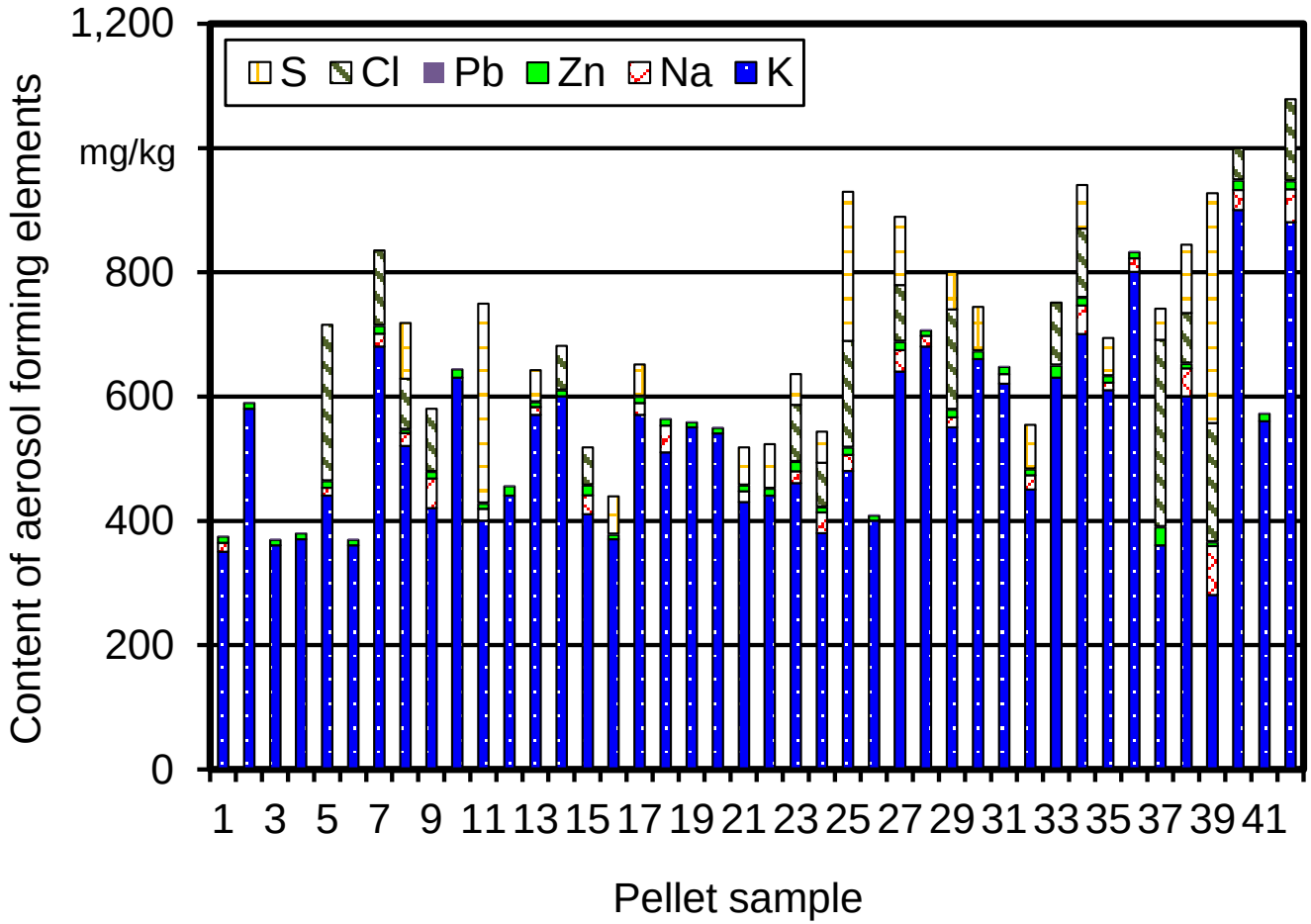


All trials were performed with 8 kW chimney stove with grate,
results are mean values of three replications, all were started from cold stage

Source: TFZ

Fuel impact on pellet stove emissions?

Pellet screening: Chemical composition in 42 pellet samples:
Aerosol forming elements



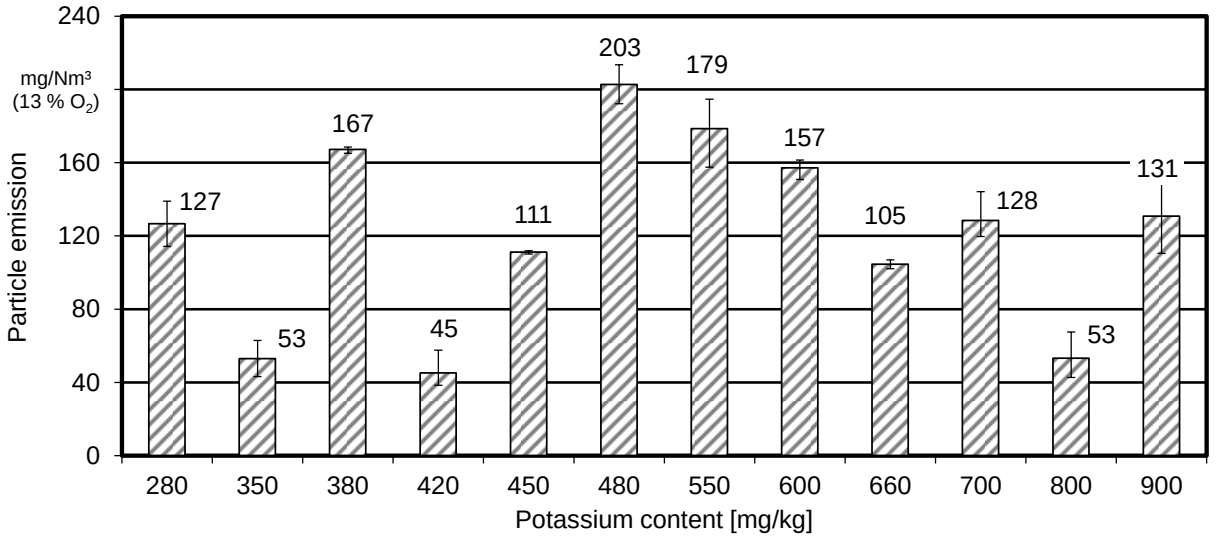
- Aerosol forming elements are dominated by K content which ranges between 280 and 900 mg/kg with an average value of 528 mg/kg → influence on PM emission

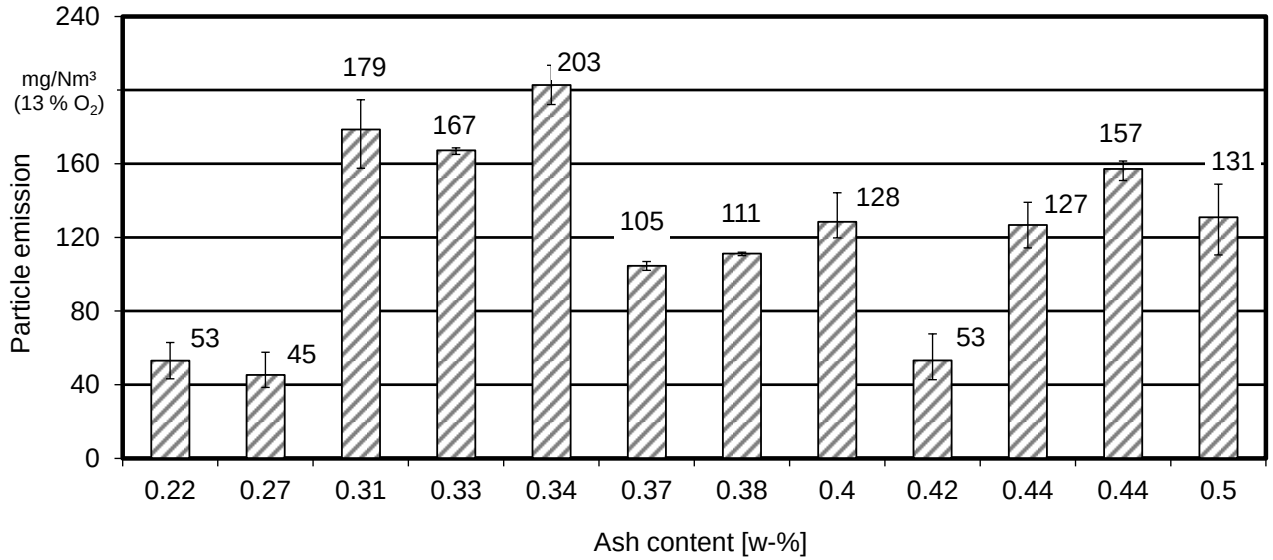
Performance tests: Combustion in pellet stove

- Sequential combustion of 12 selected pellet fuels from the pellet screening
- 3 PM samples, each over 15 minutes per fuel, using plane filters
- All 12 selected fuels are EN_{Plus}-certified wood pellets
- All test were performed in a conventional 8 kW pellet stove

Test results sorted by potassium content of the fuel

Potassium variation





Ash content variation

Some conclusions

1. Log wood fuel can also be too dry!
2. Avoid bark fuel briquettes in log wood room heaters
3. Fuel overloading problems depend on stove type & volume
4. Top-down ignition mode is (mostly) better than bottom-up mode
5. Yet unknown pellet fuel parameter(s) are decisive for PM emissions from pellet stoves

Thanks for listening !

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