User influence on emissions, and Technical Specification overload in CEN TC 295

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Overview

- Background
- User influence
  - Ignition
  - Different wood species
  - Wood log sizes and loads
- TS overload

Background

78 % of all electricity consumption in dwelling in Norway is used for heating

Contribution of wood heating was 17 % to room heating

40 % of all PM emission in Norway comes from wood heating[1]

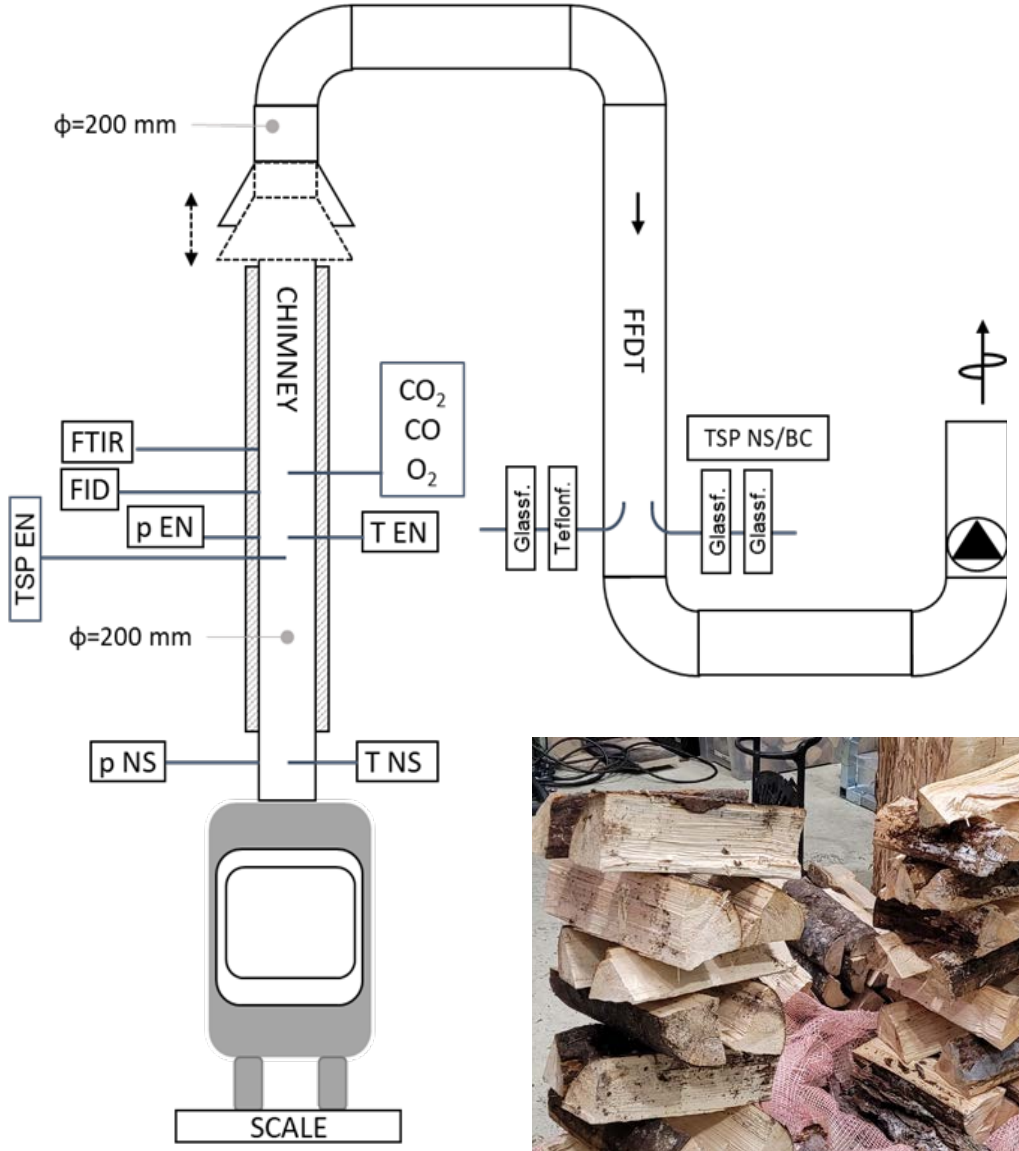
Emission Factor in Norway includes both condensed PM and poorer combustion conditions

[1] https://www.norskeutslipp.no/
https://www.ssb.no/natur-og-miljo/artikler-og-publikasjoner/vedforbruket-redusert-med-en-tredel-siden-2010

User influence on emission

- Impossible to include all possible user influences
- Examined influences
  - Ignition
    - Similar how people ignite at home
  - Comparison different wood specious: spruce, pine, birch
  - Different load 1,2 kg and 1,8 kg (moisture 15%)

- Test set up in accordance with NS3058
  - Natural draft
  - Wood logs with bark
- 1 or no air valves adjustment in the beginning
- Door 3 min open in the beginning



Seljeskog, M. et al.; Reducing Emissions from Current Clean-Burn Wood Stove Technology by Automating the Combustion Air Supply and Improving the End-User Interaction – Two Important Primary Measures; Chemical Engineering Transaction VOL. 99; 2023

Ignition

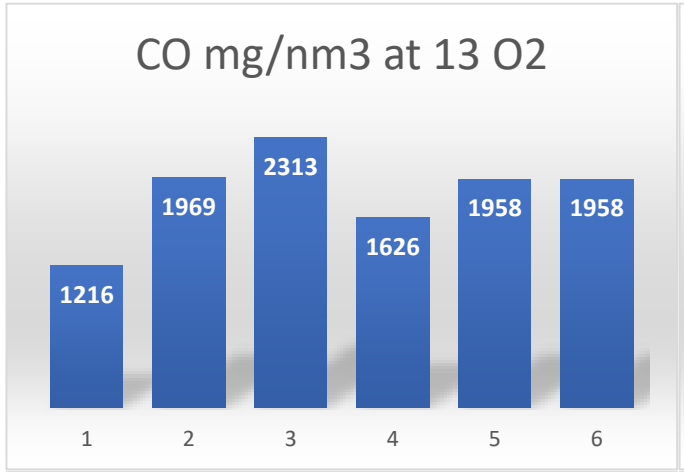
Modern wood stove with 3 air valves: ignition, glass door, combustion chamber back with 2,2 kg wood

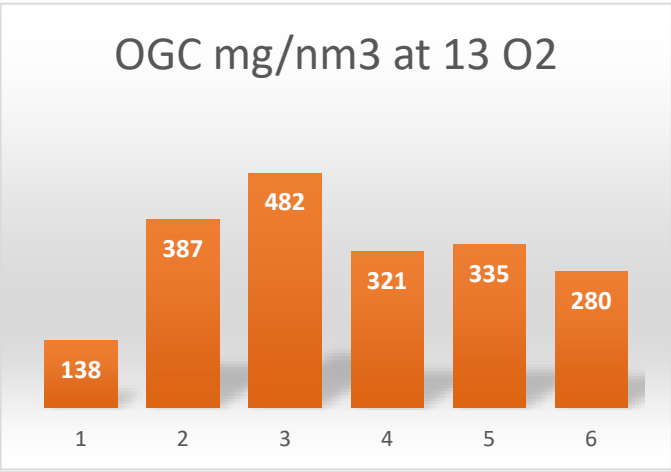
6 ignition resulted in 6 unlike combustion cycles

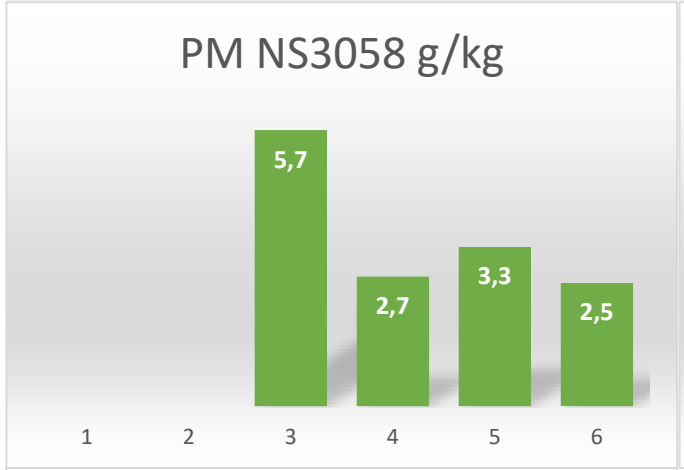
- 1) **best**: door 2 min, ign valve after 4 min 45% and closed after 12 min, prim open
- 2) over ignition, lack of O2
- 3) poor start
- 4) over ignition, lack of O2
- 5) stabled too dense
- 6) Recommended procedure
- 3-6) ignition valve open

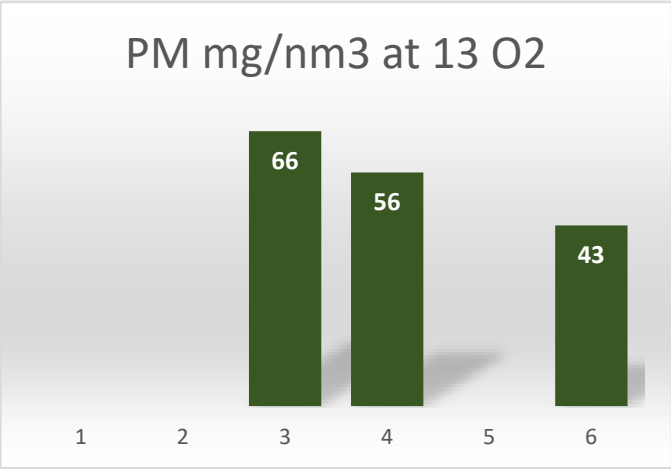
→ Difficult to get always a good ignition but possible

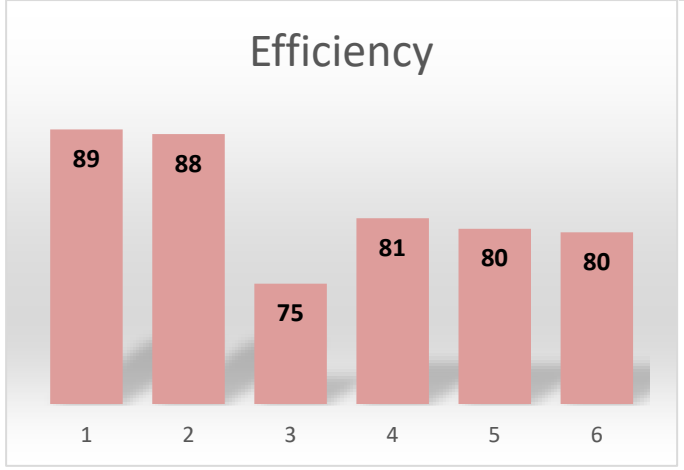
→ How to include ignition in a test procedure to achieve repeatable and comparable results?











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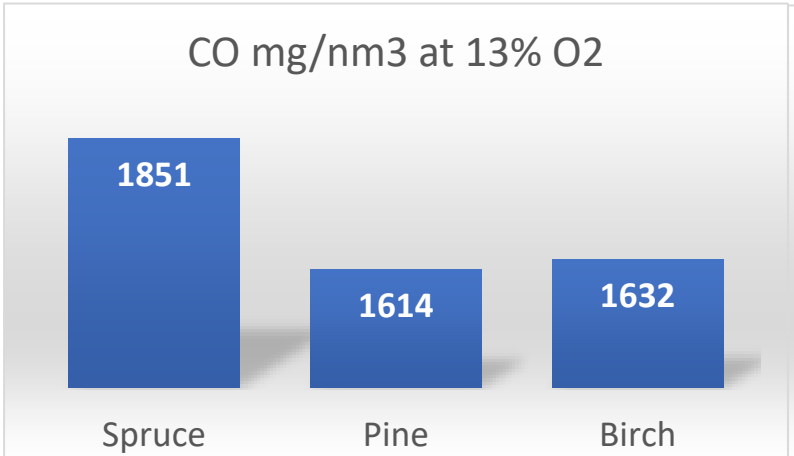
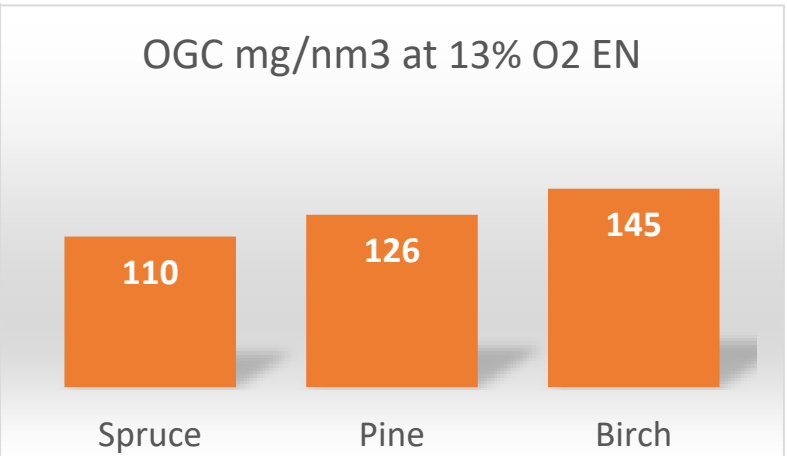
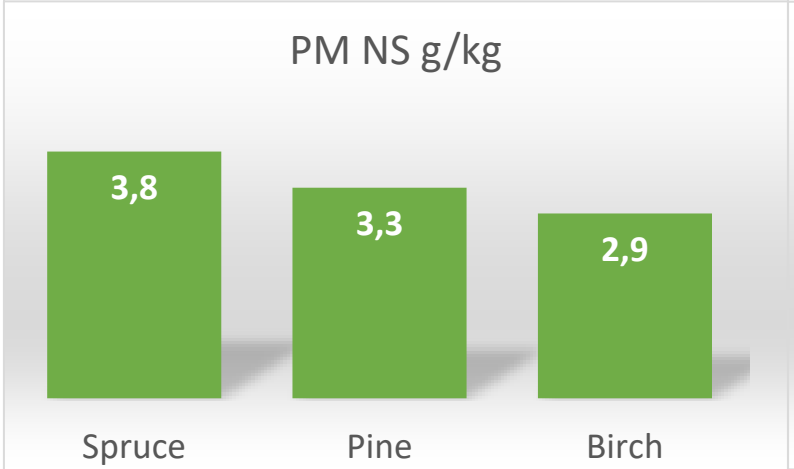
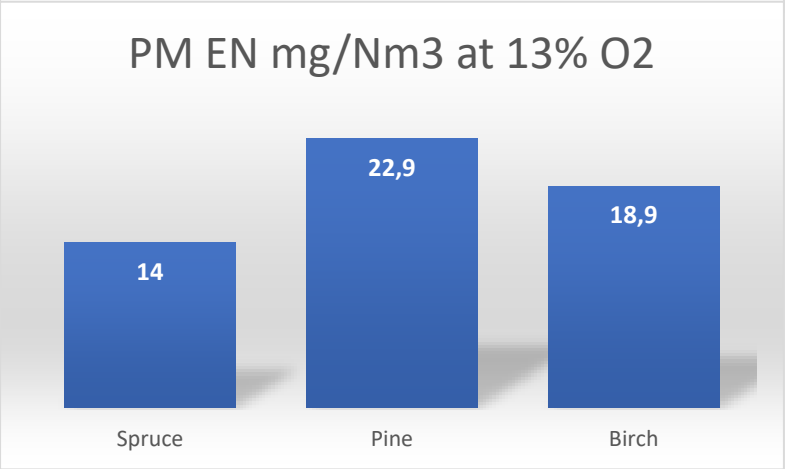
Birch, Spruce and Pine

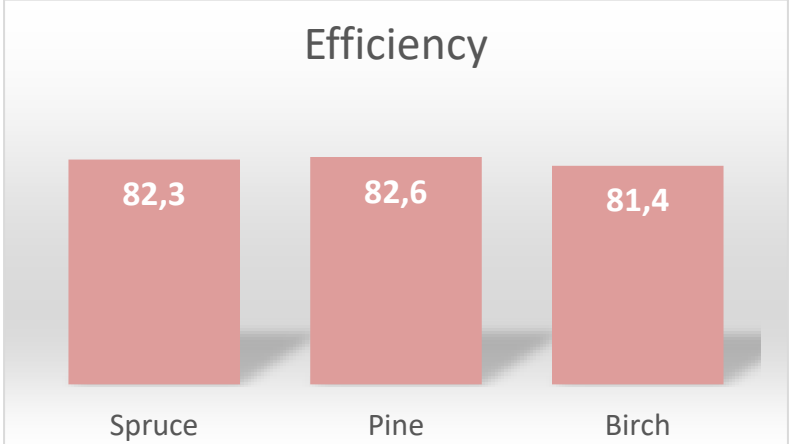
- In general, no large differences



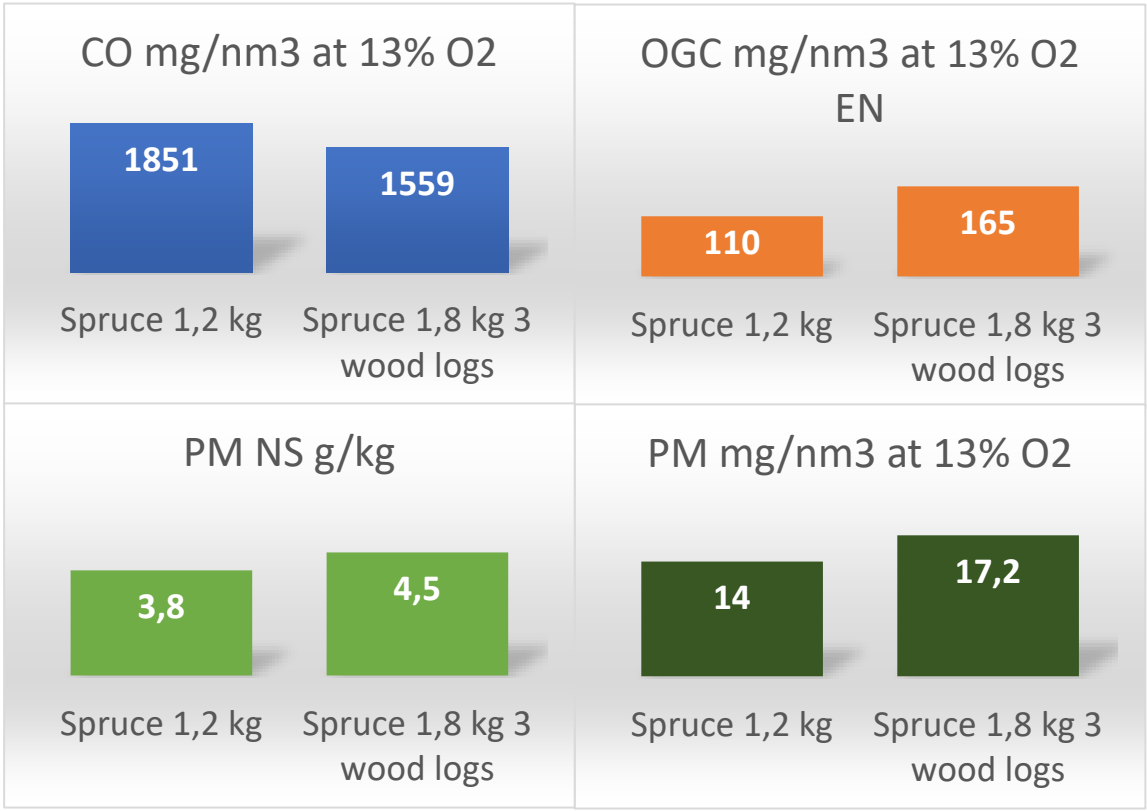


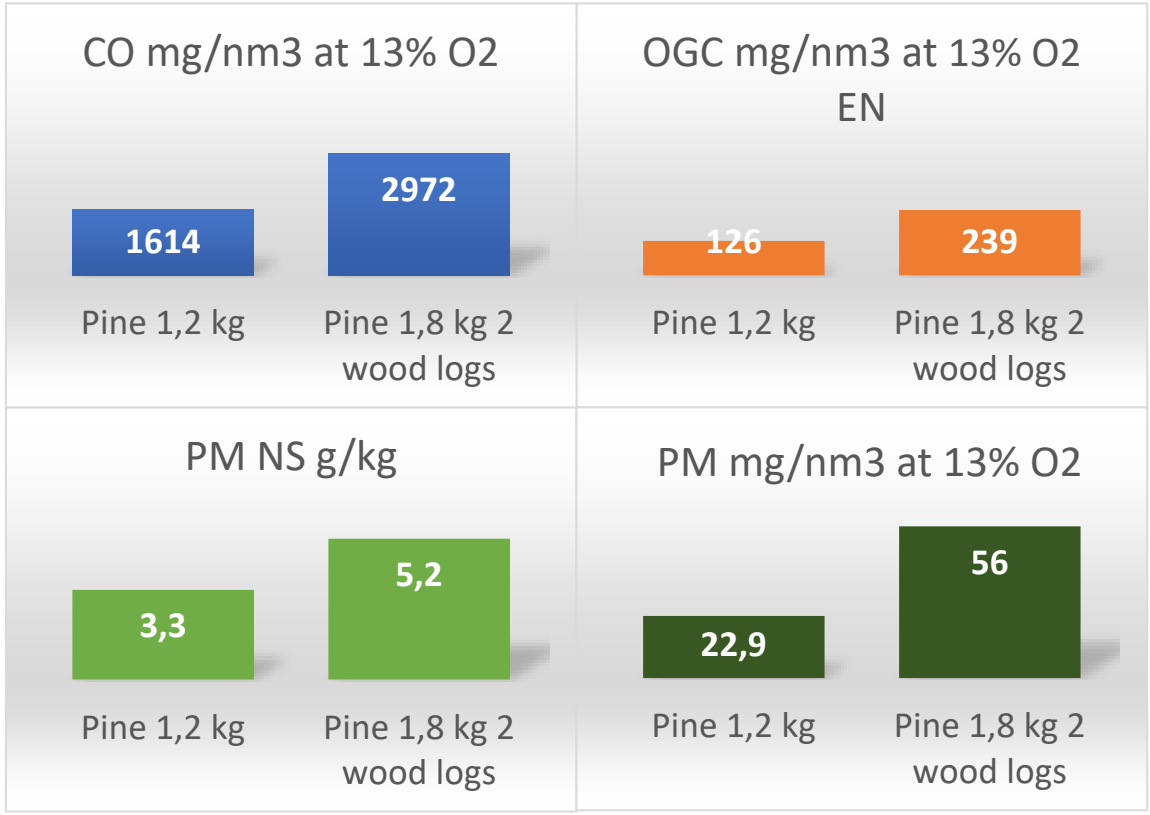






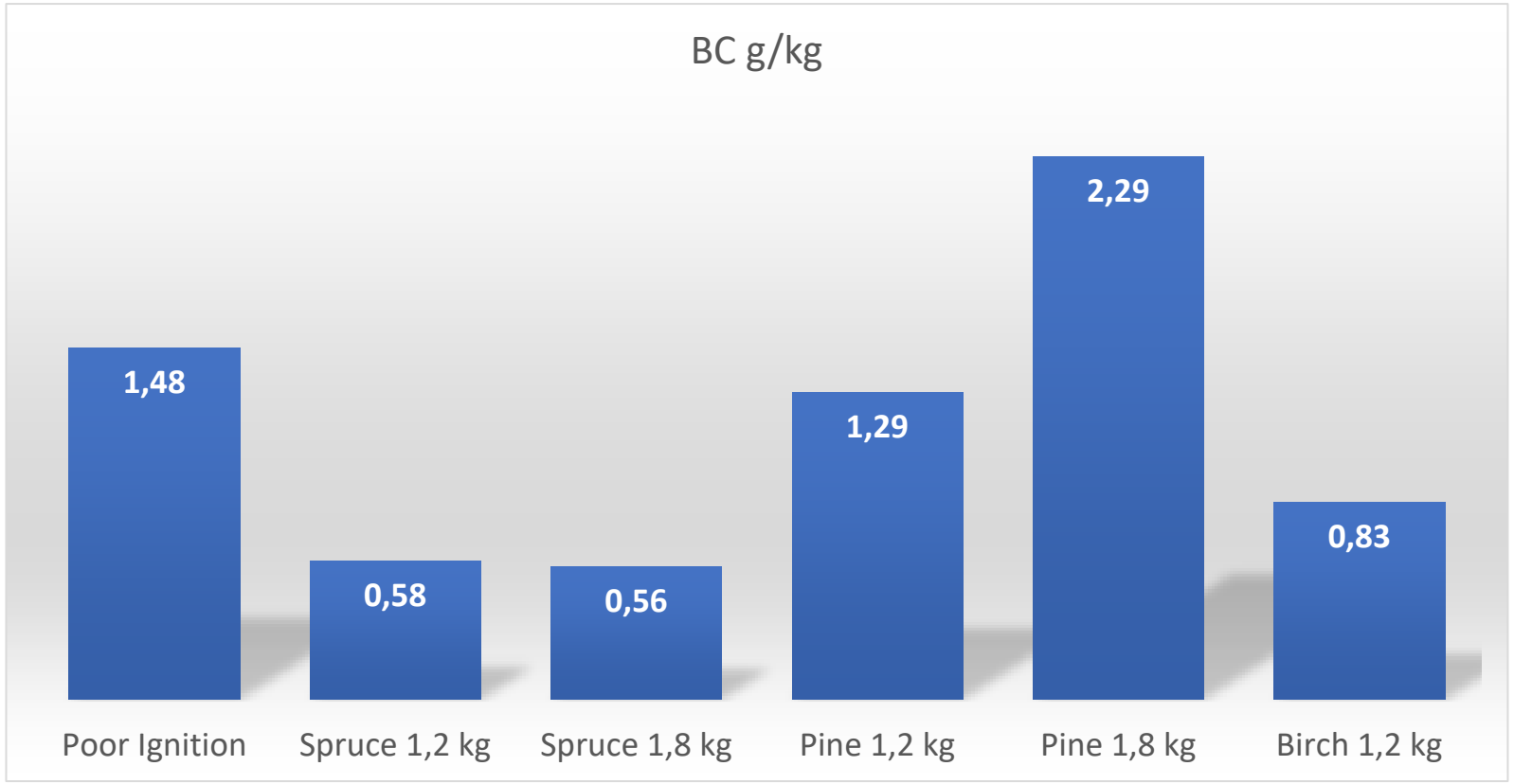
Wood load spruce (left) and pine (right) 1,2 vs 1,8 kg



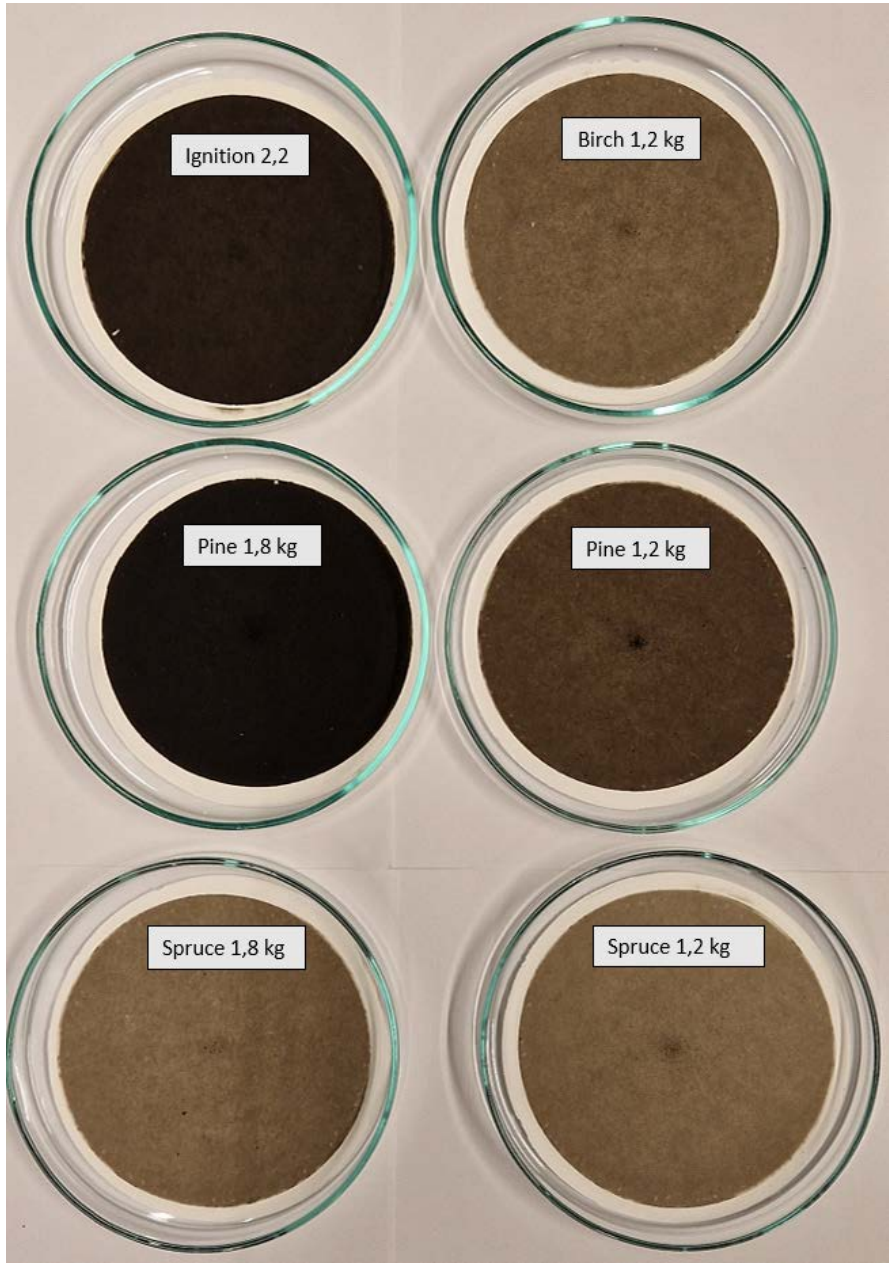


- Spruce: 2 vs 3 wood logs → 18% - 50% increased emissions
- Pine: 2 large logs → 58% - 144% increased emissions

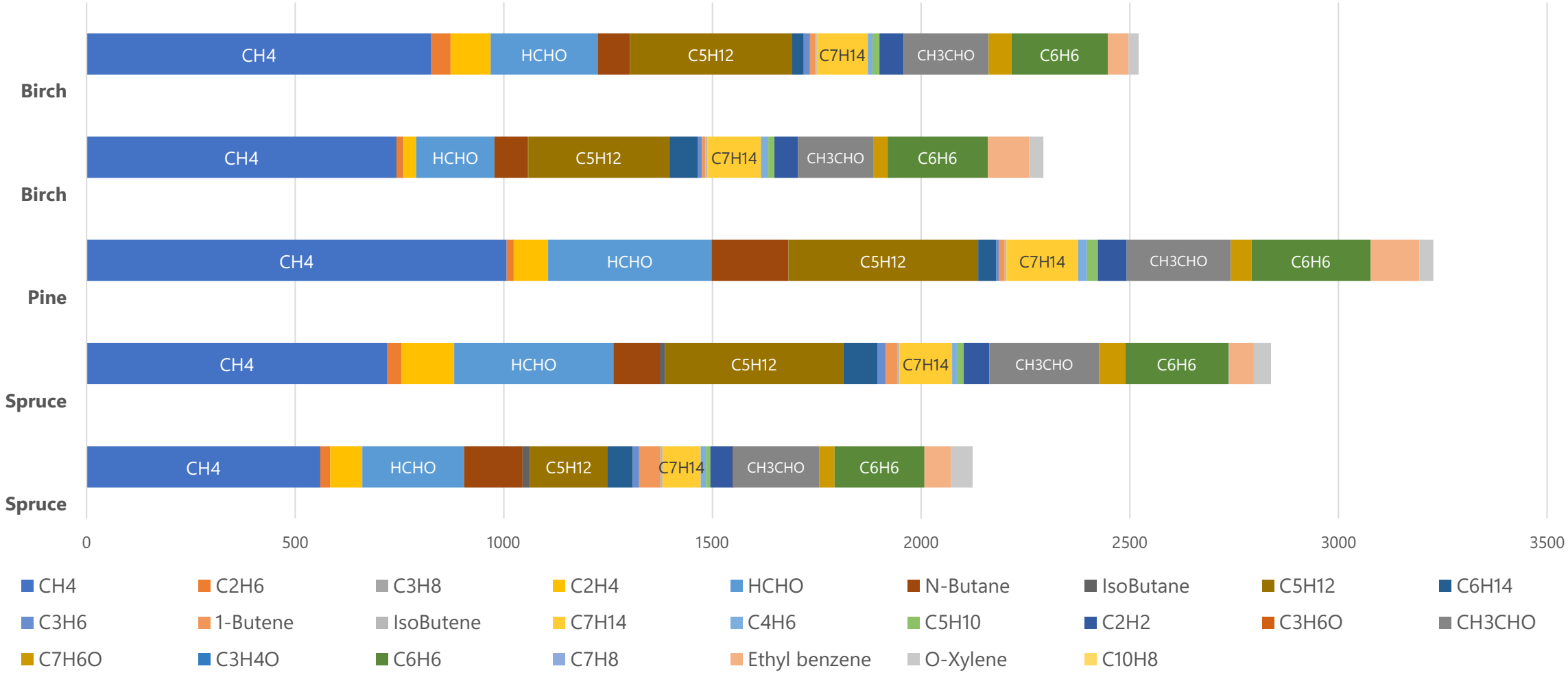
Black Carbon (BC) emissions



- Pine produces significant more BC



VOC, birch/spruce/pine, Fuel load=1.2 kg [mg/kg]



- CH4 accounts for 20-30% of the total hydrocarbons

Conclusion

- Good ignition possible but difficult to repeat, automatization will improve the operation of the air valve
- Use medium size wood logs and avoid large logs and loading

→ Good information to the user is important: Quick user guide

- No significant differences between wood types except for BC emissions

Technical Specification "Overload" CEN TC 295

- Background
  - Norwegian standard requires testing at different burn rates (heat outputs)
  - Users need different amounts of heat depending on a climate (winter, spring/autumn) but also within a frying cycle
  - Quick more heat in the beginning when the room is cold, less heat when the stove is warm
  - A wood stove is used within an operation range
  - Test procedure in EN16510 requires relative low wood loads (6 kW stove = 1,1 kg)
- In the working group 1 of technical committee CEN TC 295 "residential solid fuel appliances" a new WI-working item was created to write a Technical specification "Overload" (deadline for a draft is 31. Oktober 2023)
- This document will be circulated to the national mirror committee

Overload test

Overload: Heat output test with higher fuel load than the nominal fuel load

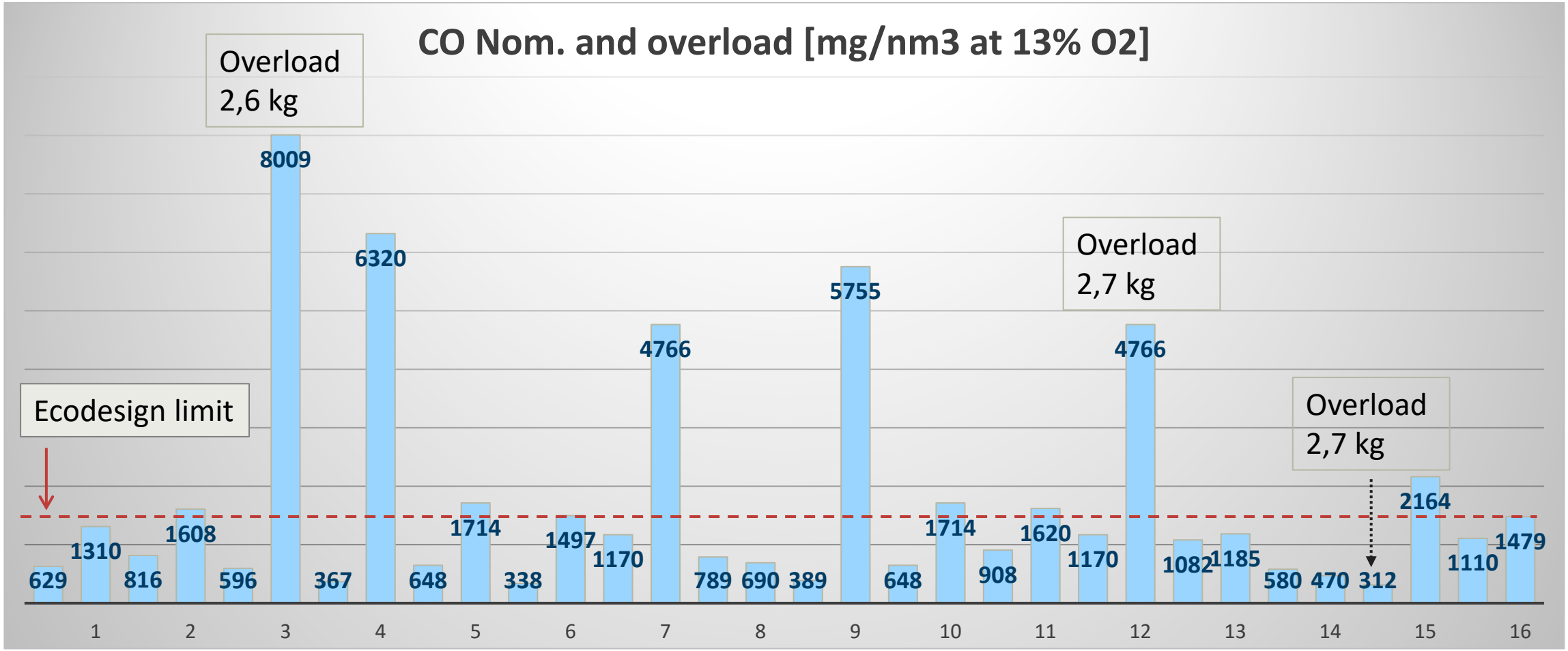
- Opposite to the safety test, that test a worse case operation, it is an expected use of the appliances
- The fuel mass for overload test is used as specified with a minimum of 150% of the nominal test fuel load.
- The flue draught is set to p_{over} or the value for the overload test as specified with a minimum of 14 Pa (or at least 2 Pa over the draft in the nominal test)
- One batch following either the nominal heat output test or the part load test

This option shall make testing practical and effective.

12 stoves and 4 insets were tested with overload fuel load:

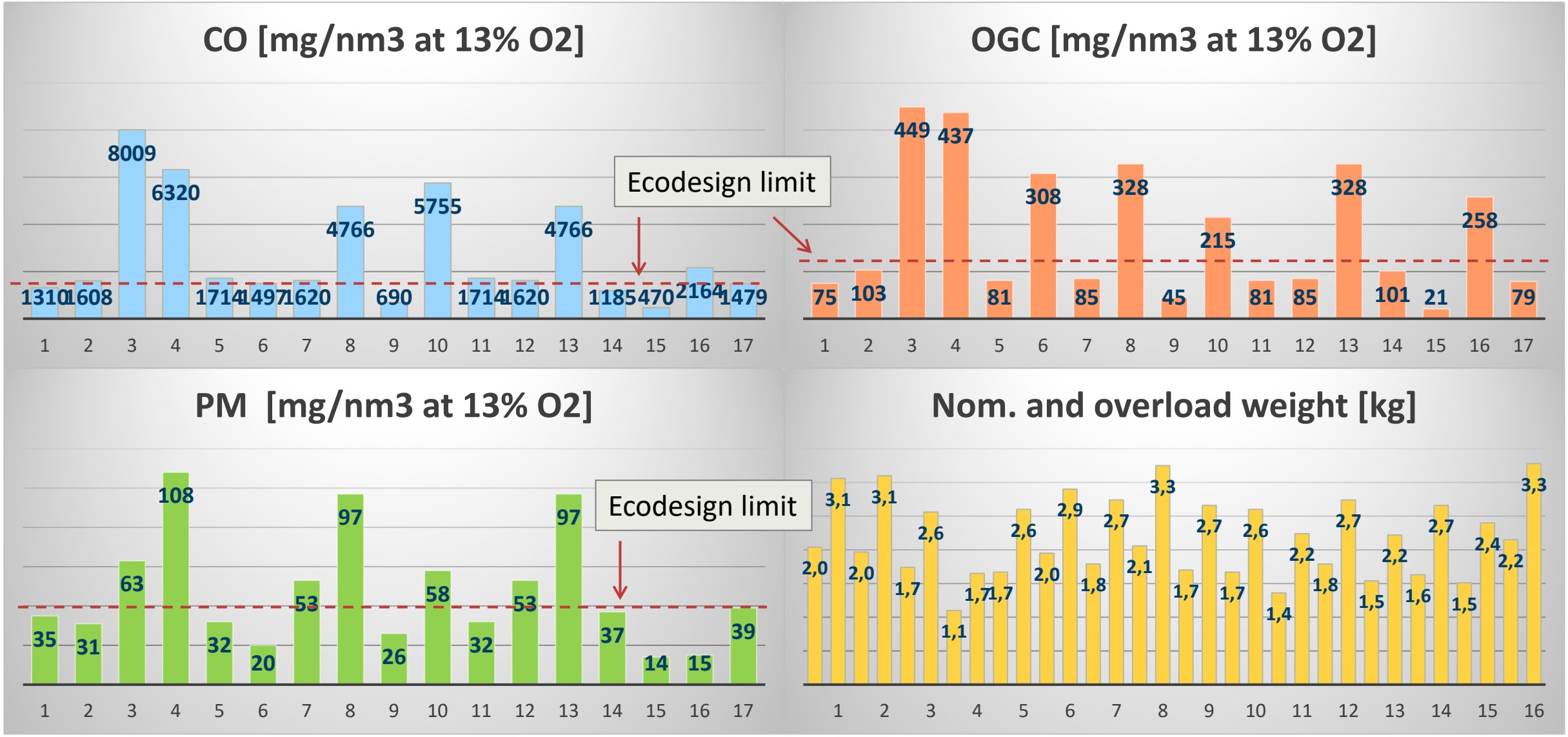
- 2 x 6 kW; 2 x 8 kW, 7 x 9 kW, 1 x 10 kW, 3 x 11 kW, 1 x 12 kW

CO emission from Nominal and Overload test for 16 appliances (12 wood stoves and 4 insets)



- Very different results for appliances with similar sizes

Emissions from 16 appliances test with Overload fuel (12 wood stoves and 4 insets)



Overload tests results

12 stoves and 4 inserts:

- 2 x 6 kW; 2 x 8 kW, 7 x 9 kW, 1 x 10 kW, 3 x 11 kW, 1 x 12 kW
  - PM: **10 below** Ecodesign emission limits
  - OGC: **9 below**
  - CO: **6 below,** 5 slightly above
- 5 stoves produced up to 400% higher emissions than the emission limits → these appliances perform well under 1 single operation (as tested in the standard) but do not burn well within an operation range

Conclusions of test results

- Test procedure for type testing
  - Identify the most important test conditions for wood appliances
  - Should reflect to some degree the use phase by testing an operation range to ensure products able to handle the varying conditions

  → nominal (average) load, part load, high load (overload)

- Emission from wood heating in the field
  - Very different from testing in the lab
  - Many influences: user, draft, fuel, weather

  → Testing in the field needs a different or extended method than for type testing

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