

The 20TH Conference on Combustion Generated Nanoparticles, Session 2: Biomass Combustion,
Tuesday 13.00 – 14.40, IEA Bioenergy Task 32 Session on Biomass

Variables Affecting Particulate Emissions from Residential Wood Combustion – Simultaneous Sampling on **Hot** and **Ambient** Filter



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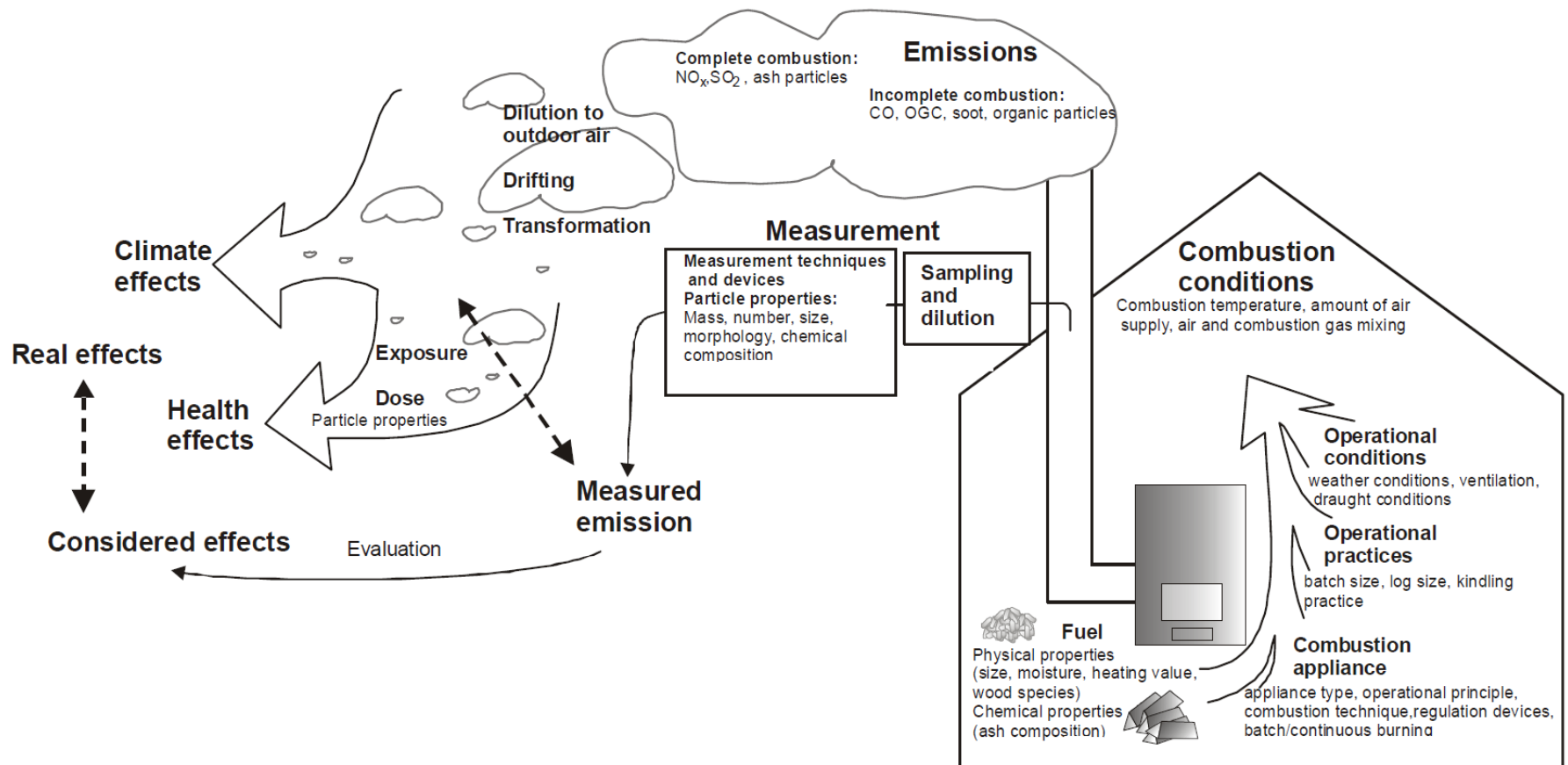
- Results from particulate measurements performed by SP Fire Research Norway in cooperation with SINTEF Energy AS, as part of a project funded by the Norwegian Environment Agency
- Purpose is to highlight the influence of some of the important variables, inherent to EN13240 DIN+ HF (heated filter) method and the NS3058-59 FFDT (Full Flow Dilution Tunnel) method, regarding the amount of measured particulate matter PMt collected gravimetrically
- Previous work has been criticized for not to have performed simultaneous measurements to ensure the exact same flue gas conditions

Main differences between NS 3058/Method 28 (US) and EN13240 DIN+

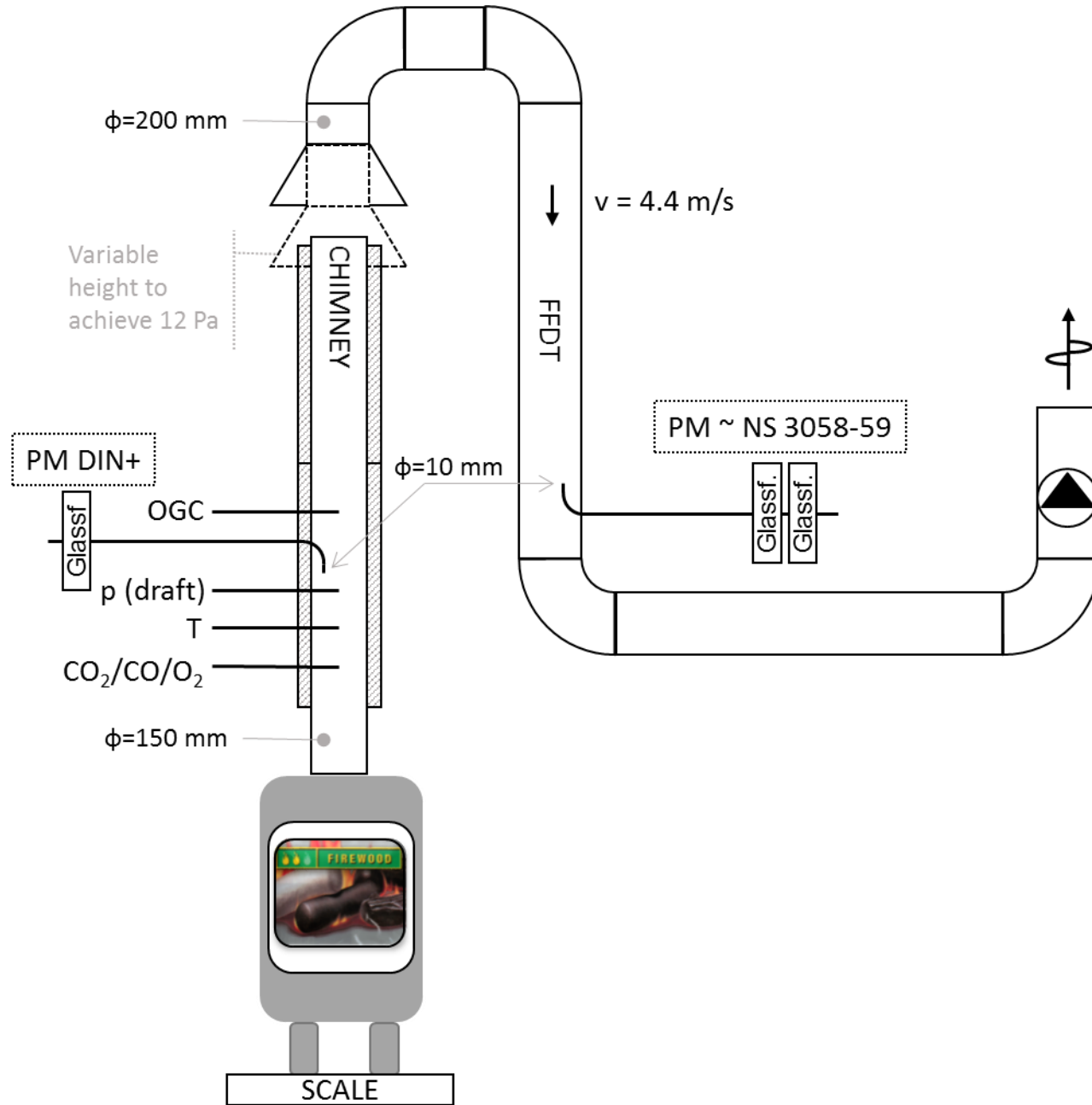
- The most significant differences in how particulate emissions are measured according to NS 3058/Method 28 (US) and EN13240 DIN+ are:

	13240 DIN+	NS 3058-59
Unit	mg/Nm ³	g/kg dry wood
Period	30 min. after 3 min.	The whole test batch period
Fuel	Hardwood (beech, birch)	Softwood (spruce)
Measured	Chimney	In dilution tunnel
Chimney	Usually 150 mm	200 mm, 4.5 m ± 0.3 m
Particles	Solid	Solid + condensables
Draft	12 Pa forced	Natural draft
Moisture	16 ± 4 % (dry basis)	16-20 % (dry basis)
Fuel load	Acc. to manufacture	112 ± 11 kg/m ³ of the firebox volume
Filter temp.	≥ 70°C	≤ 35°C
Filter size	90 mm	100-103 mm
Tested heat output	Nominal heat output (specified by manufacturer)	4 burn rate categories, low -> max

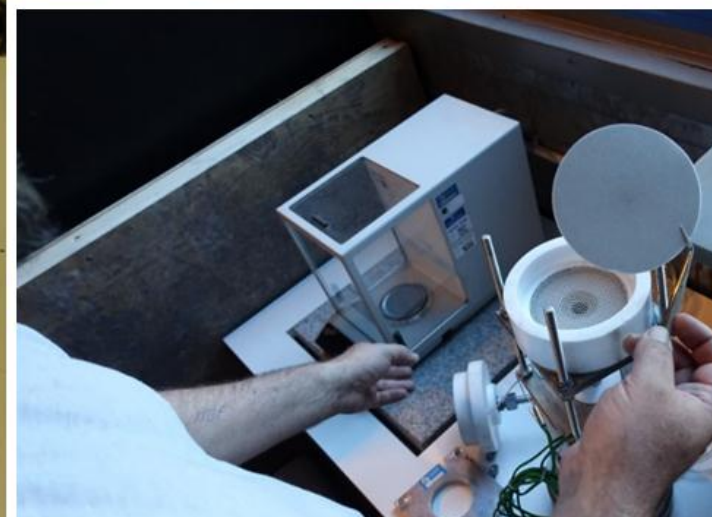
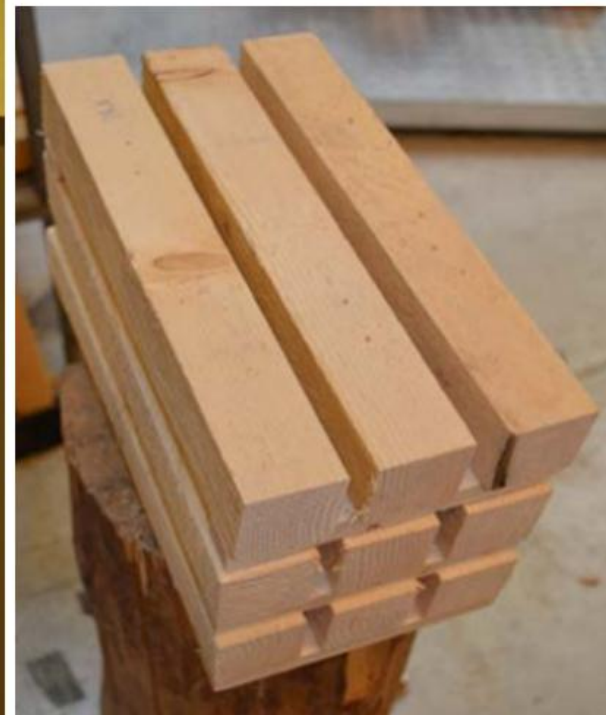
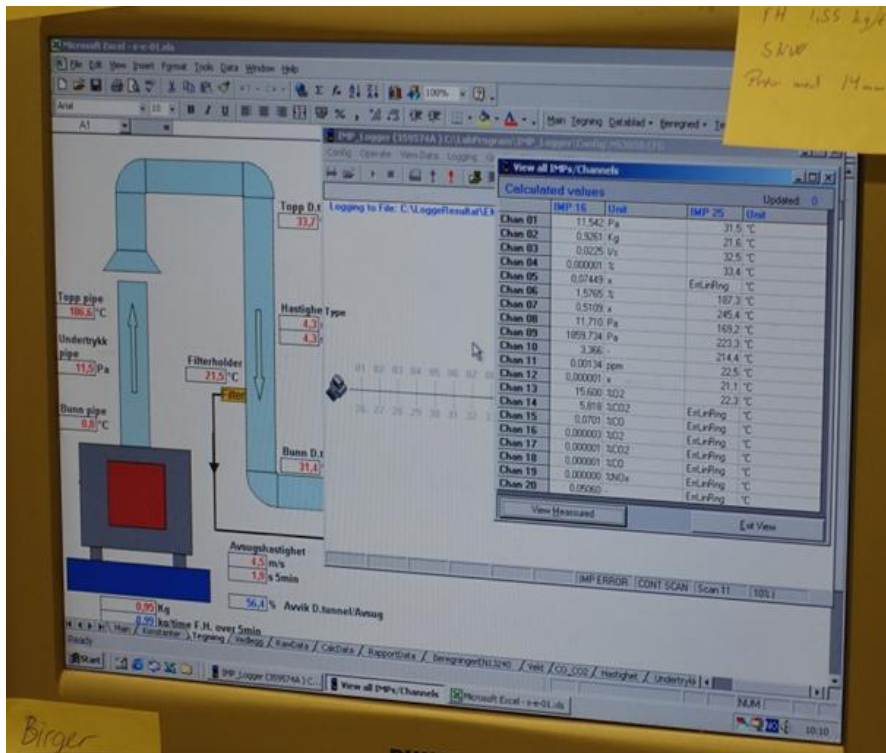
Factors affecting emissions from residential wood combustion



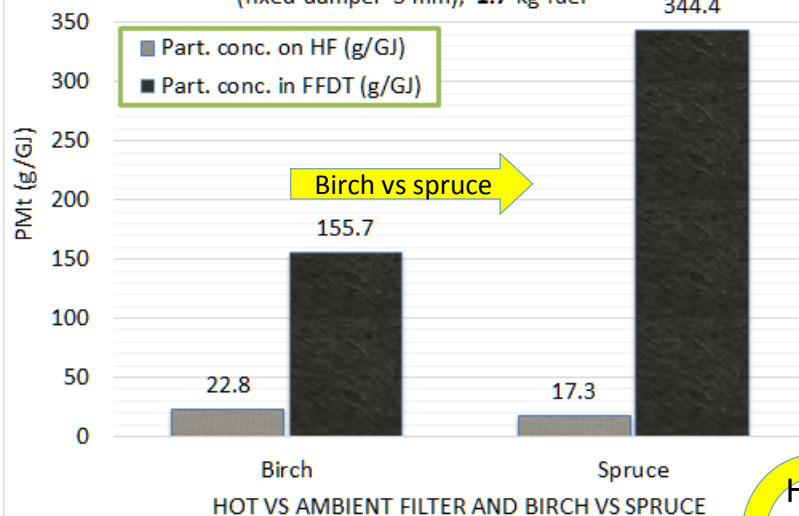
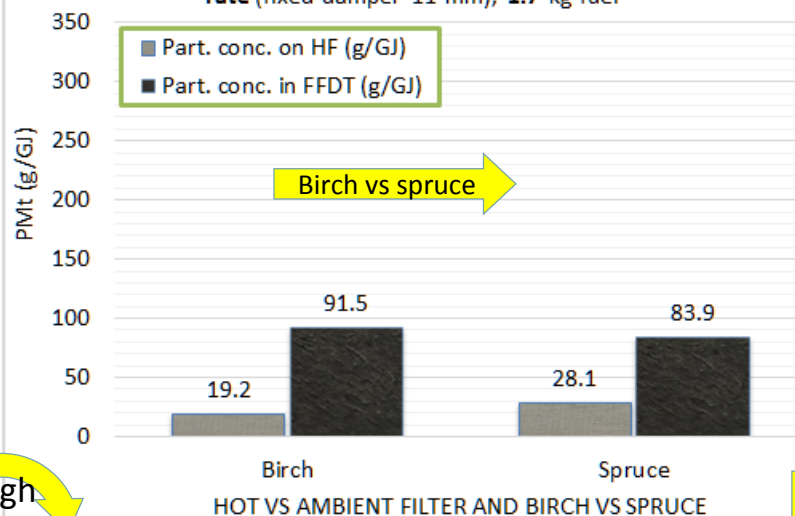
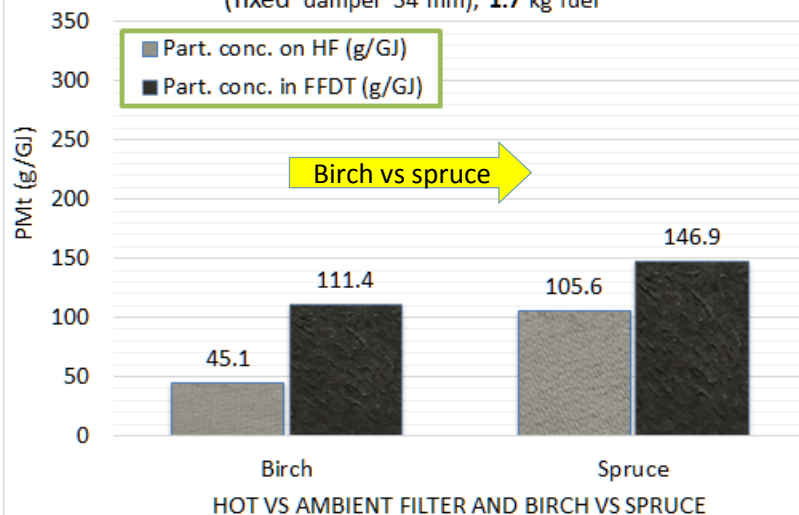
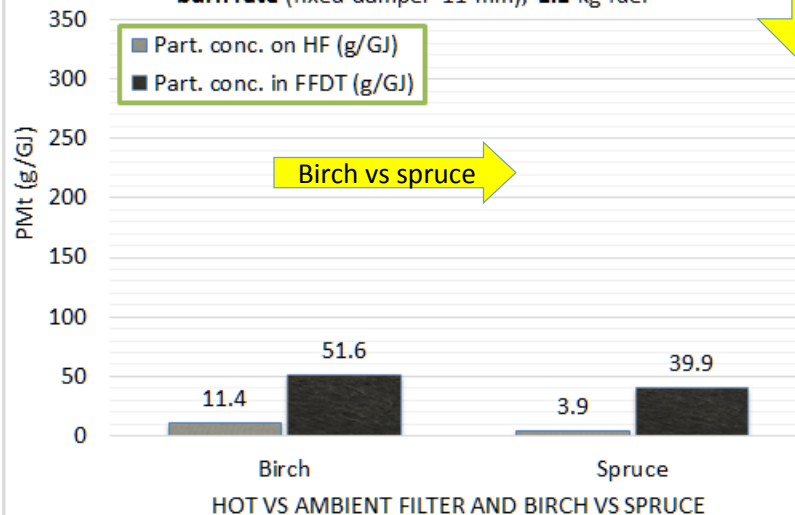
Ref.: JARKKO TISSARI Fine Particle Emissions from Residential Wood Combustion JOKA KUOPIO 2008

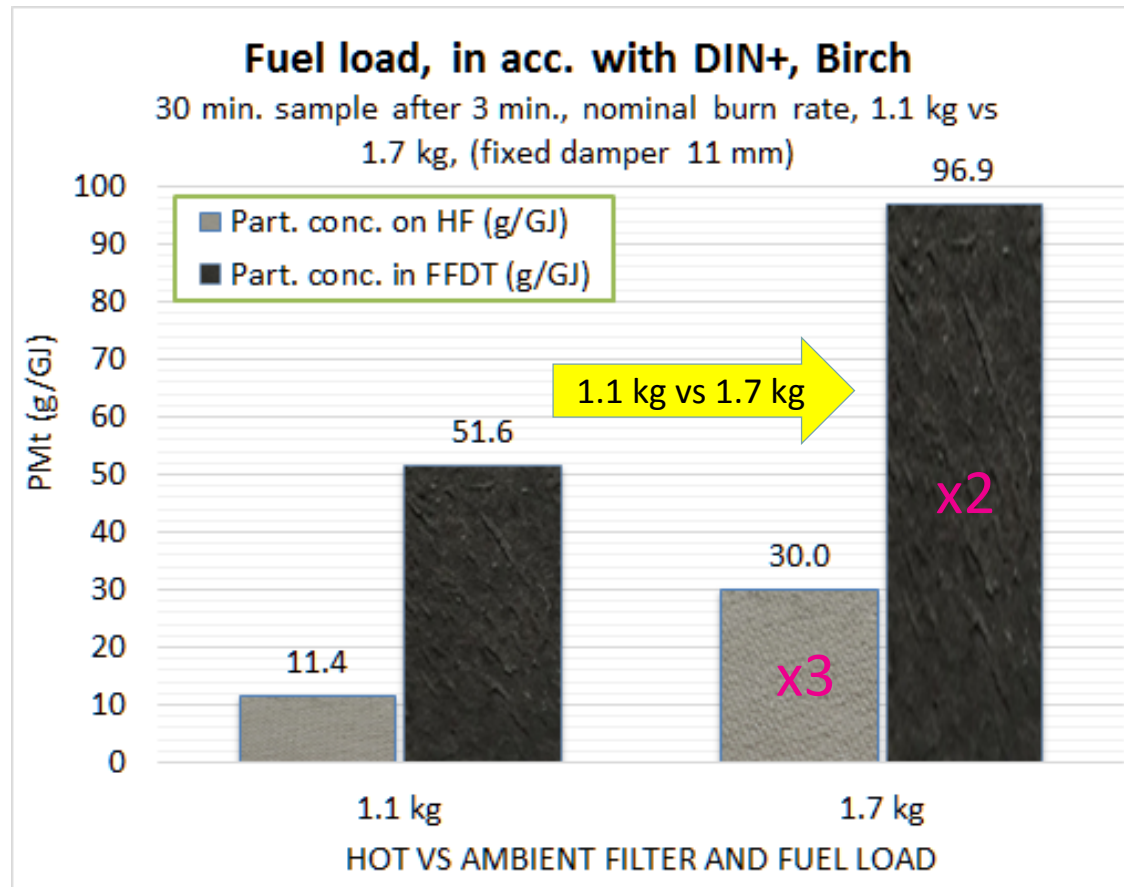






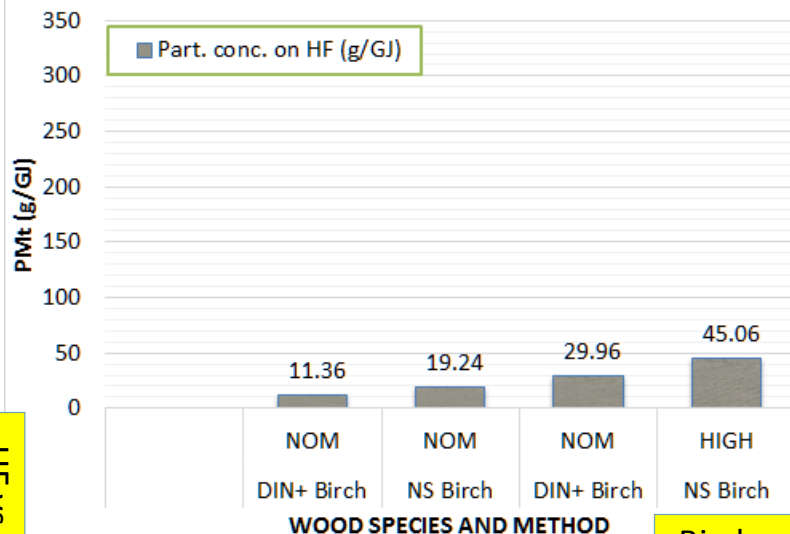
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Birch vs Spruce, in acc. with NS3058-59Average of 2 samples, complete periode, **low burn rate**
(fixed damper 3 mm), **1.7 kg fuel****Birch vs Spruce, in acc. with NS3058-59**Average of 3 samples, complete periode, **nominal burn rate**
(fixed damper 11 mm), **1.7 kg fuel**High
to
low**Birch vs Spruce, in acc. with NS3058-59**Average of 3 samples, complete periode, **high burn rate**
(fixed damper 34 mm), **1.7 kg fuel****Birch vs Spruce, in acc. with DIN+**Average of 3 samples, 30 min. sample after 3 min., **nominal burn rate**
(fixed damper 11 mm), **1.1 kg fuel**Method at
similar load

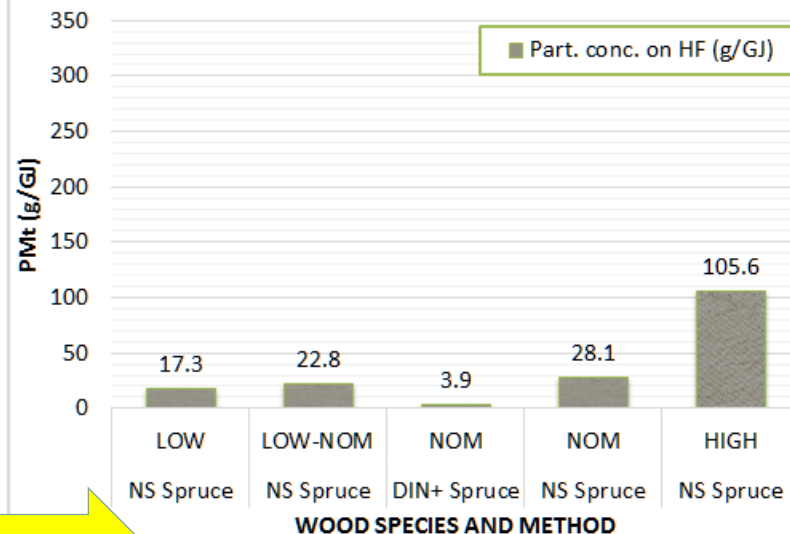


Birch: Part. on HF vs burnrate

DIN+ fuel load (1.1 kg) as DIN+ vs NS fuel load (1.7) as NS

**Spruce: Part. on HF vs burnrate**

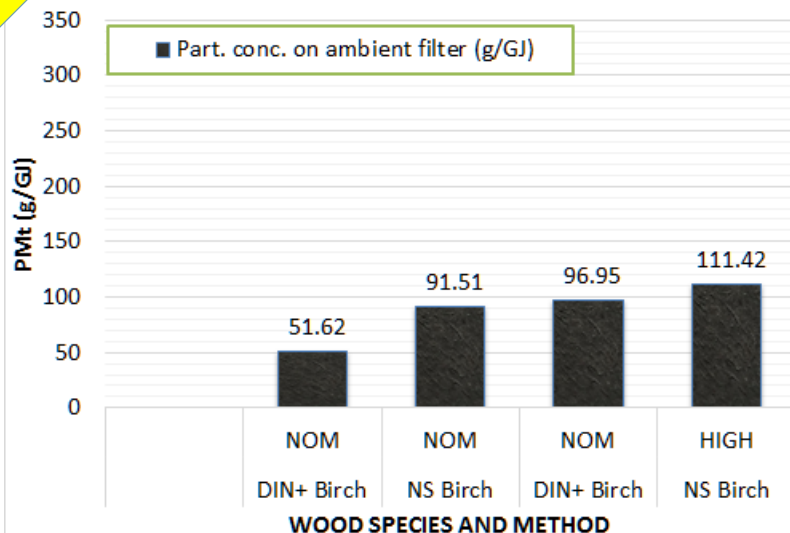
DIN+ fuel load (1.1 kg) as DIN+ vs NS fuel load (1.7) as NS



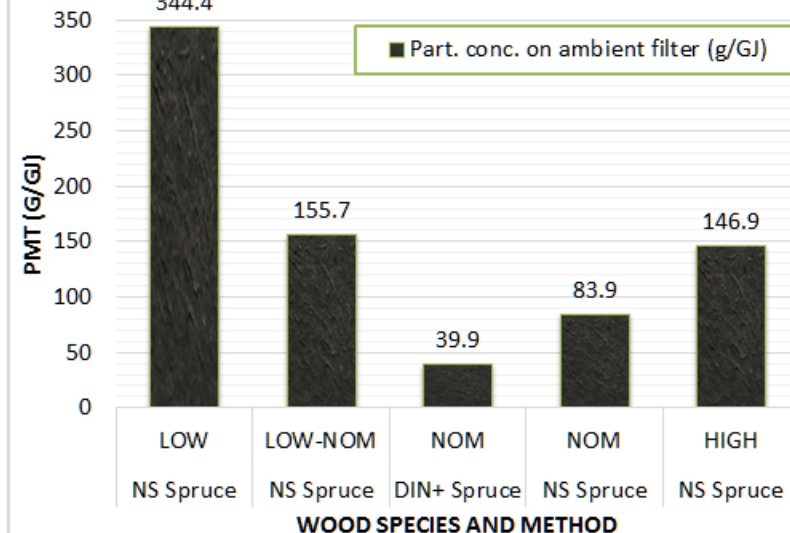
Birch vs spruce

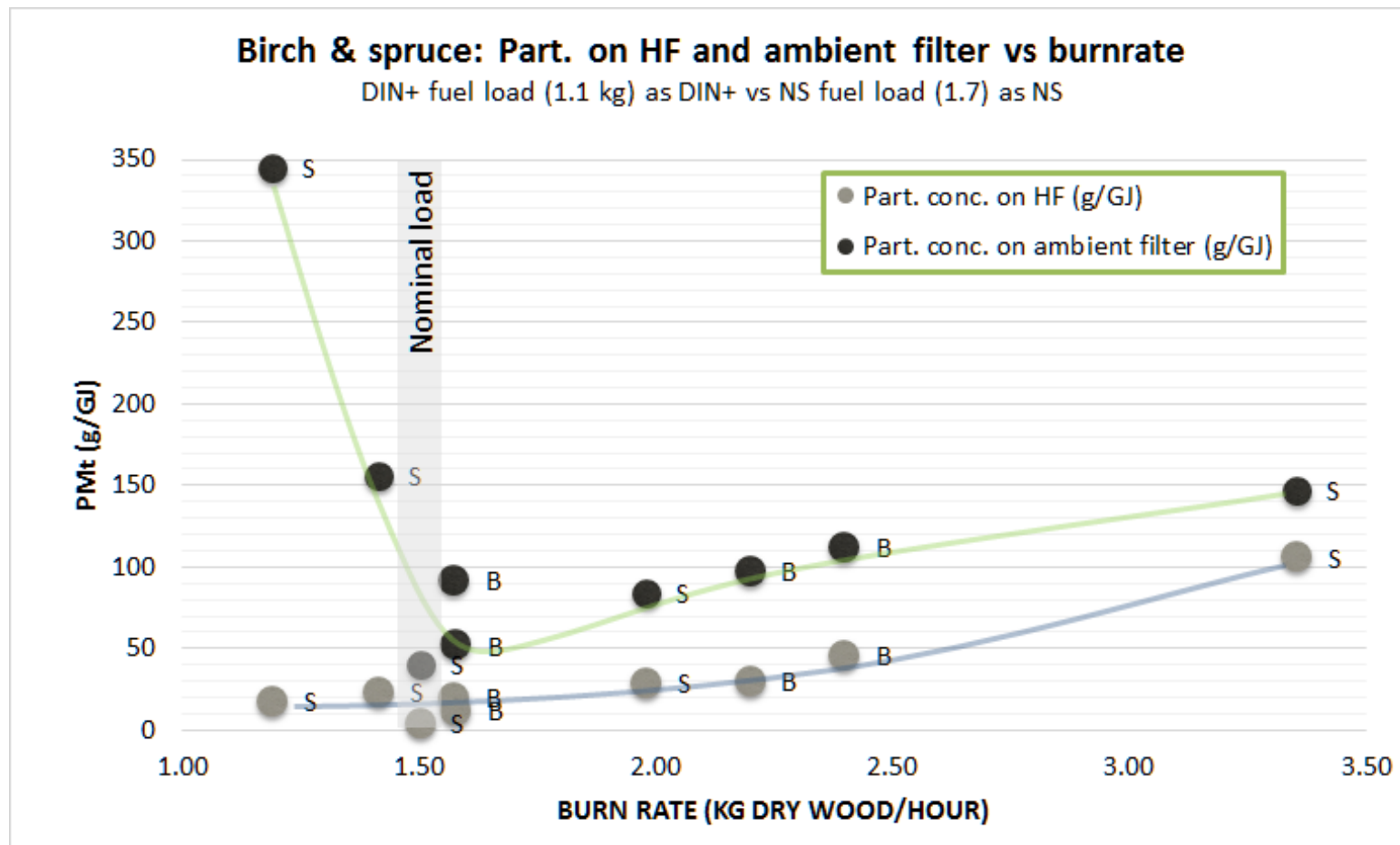
Birch: Part. in FFDT vs burnrate

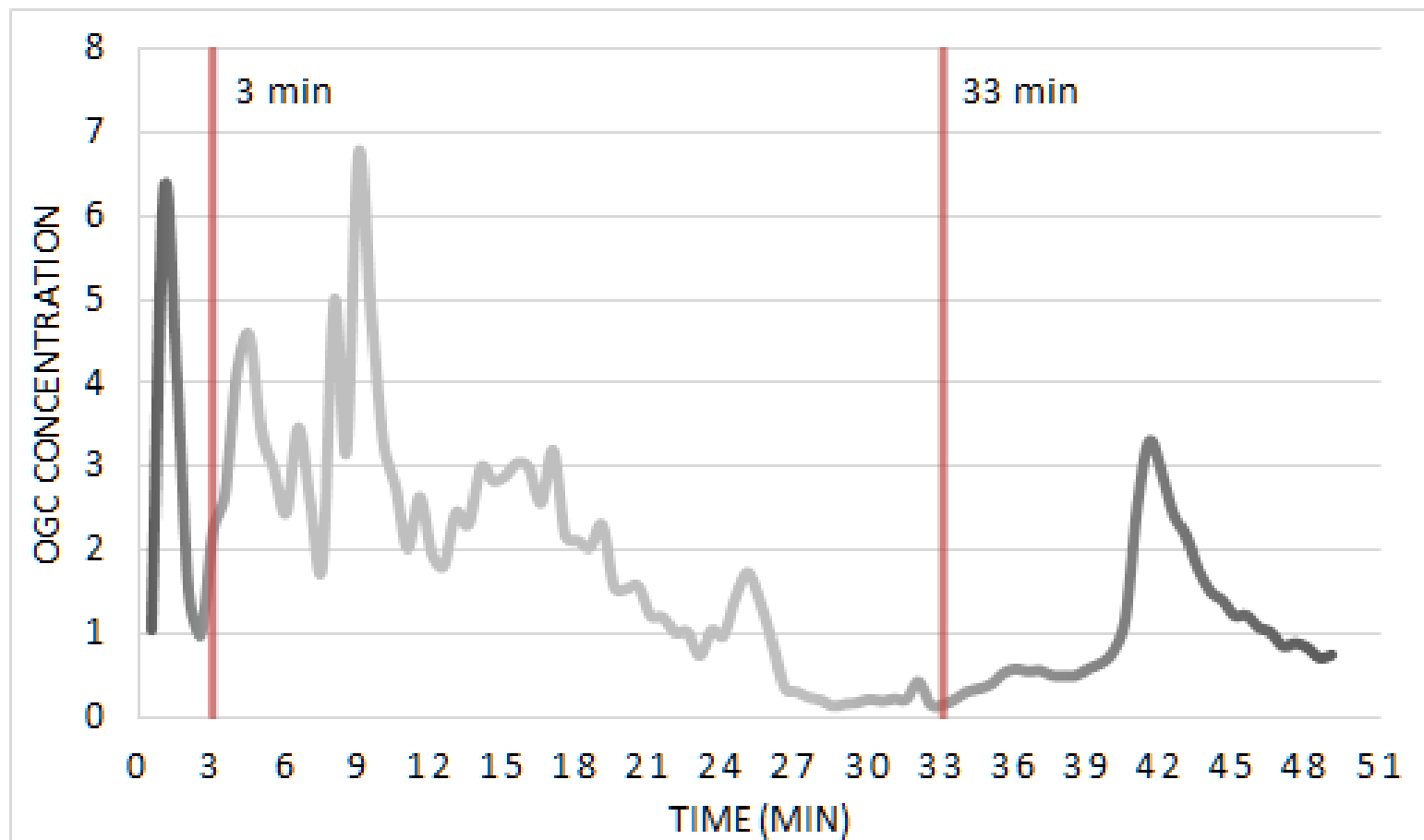
DIN+ fuel load (1.1 kg) as DIN+ vs NS fuel load (1.7) as NS

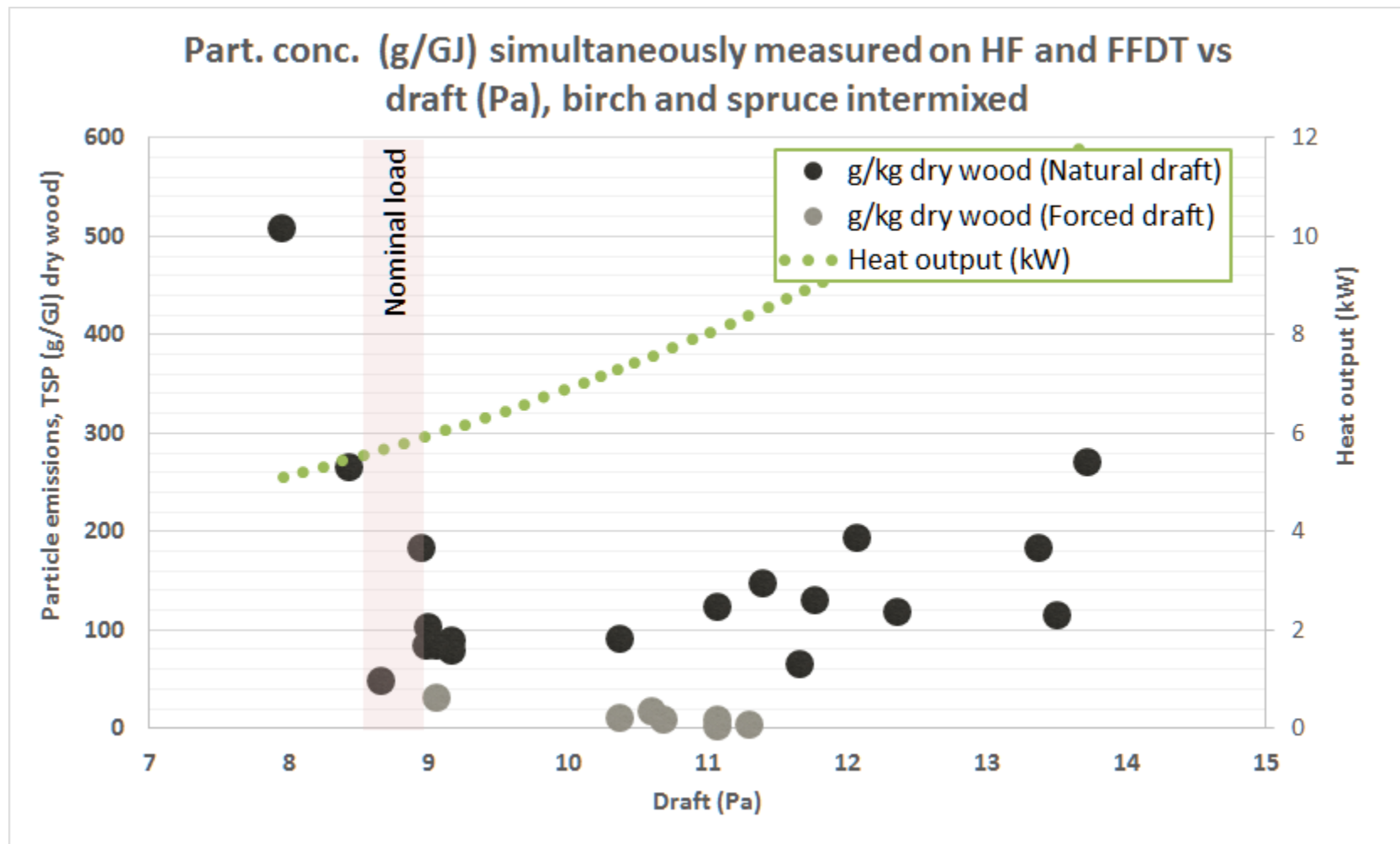
**Spruce: Part. in FFDT vs burnrate**

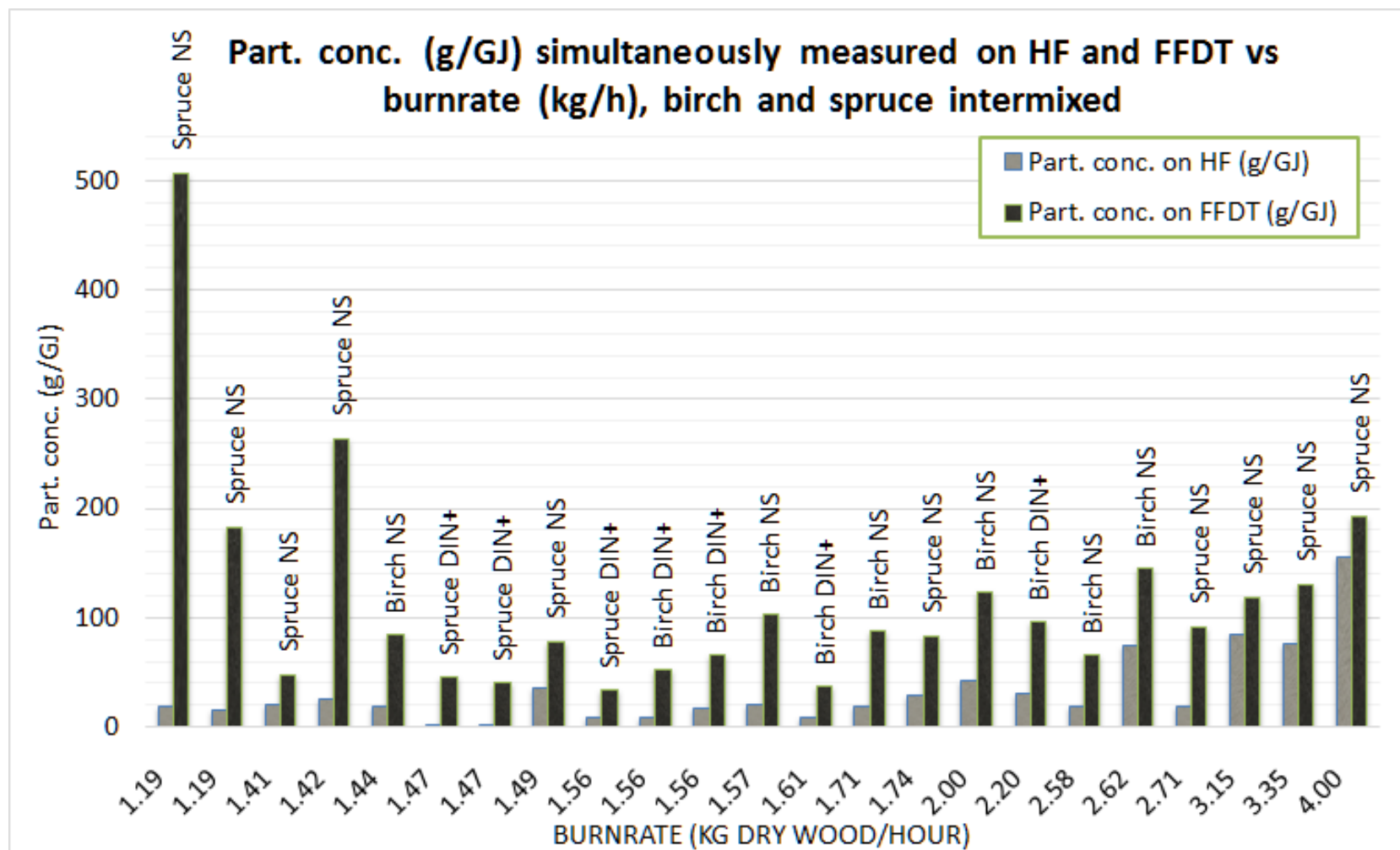
DIN+ fuel load (1.1 kg) as DIN+ vs NS fuel load (1.7) as NS

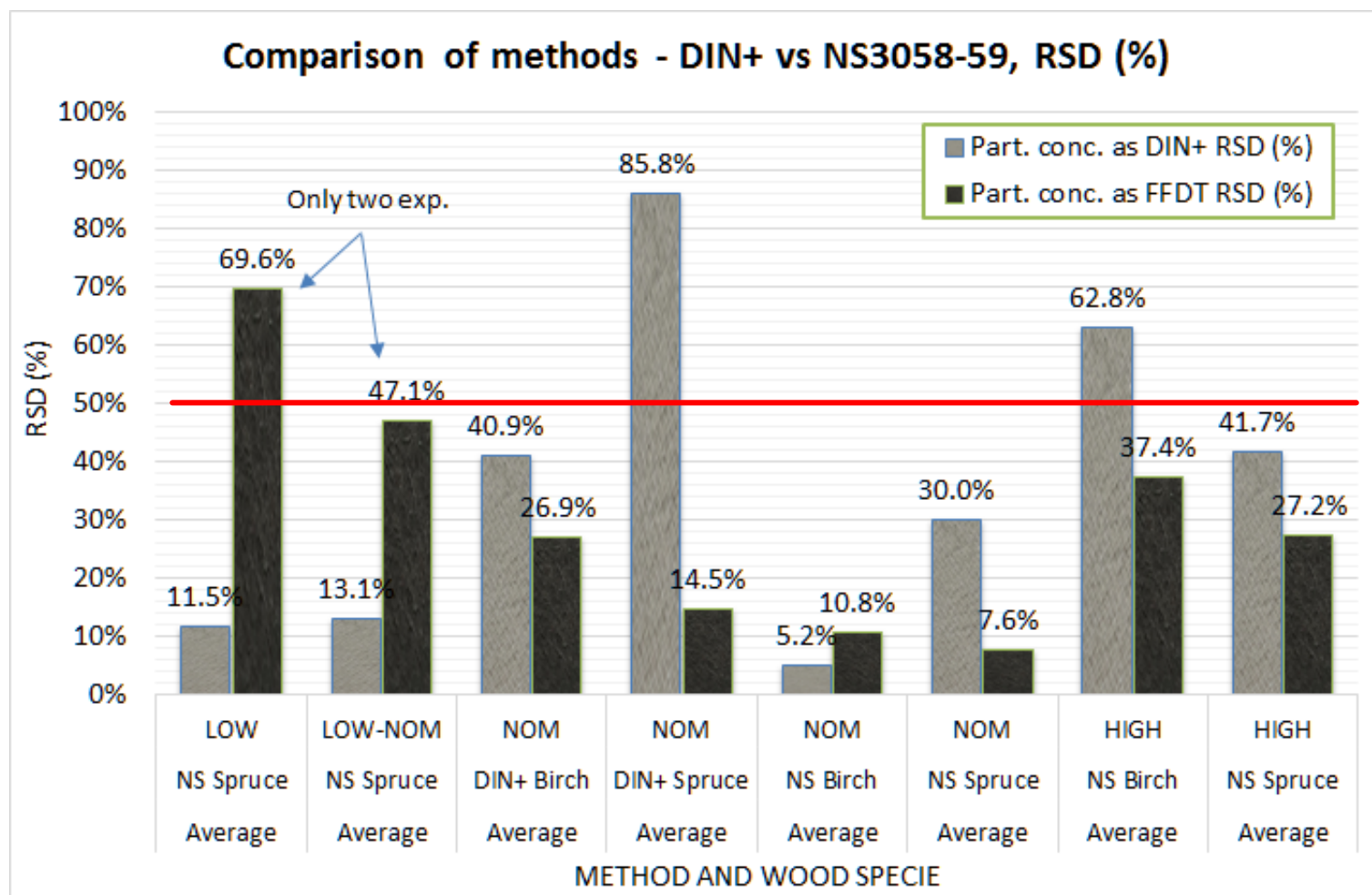




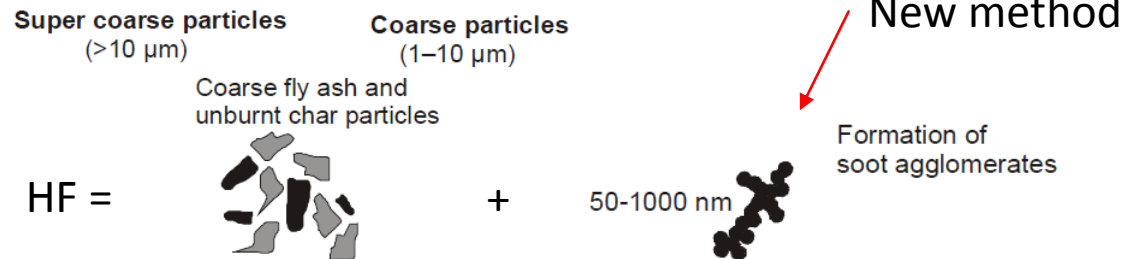




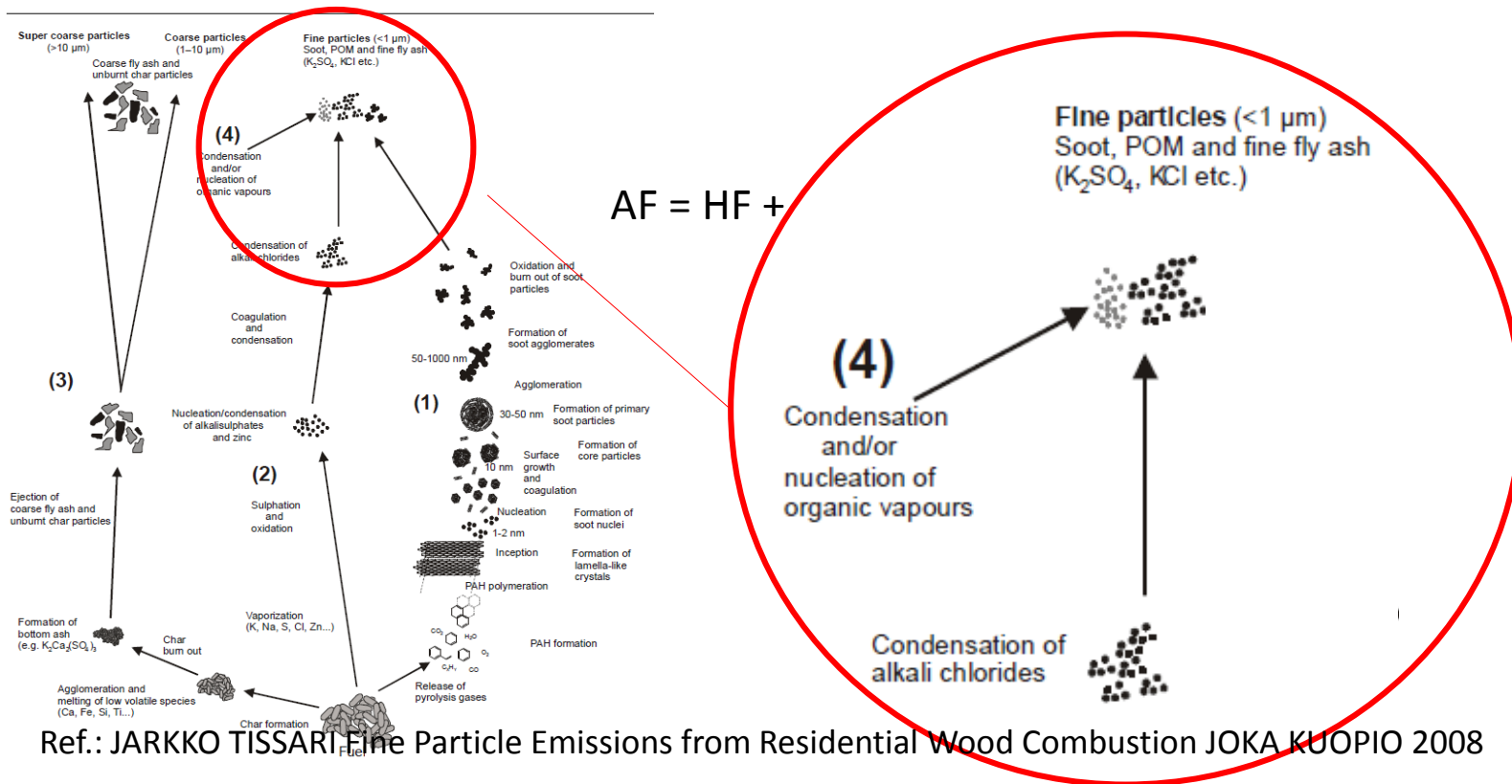




Summary



Jarkko Tissari: Fine particle emissions from residential wood combustion



Ref.: JARKKO TISSARI Fine Particle Emissions from Residential Wood Combustion JOKA KUOPIO 2008

Summary

- Consider to define fuel load according to combustion chamber dimensions rather than following the manufacturers recommendation
- Consider where to sample -> FFDT produces a well mixed flue gas while chimney sampling close to the stove outlet might decrease the repeatability
- Measure solids + condensables -> emission factors
- Perform filter sampling over the complete batch period(s), cold and hot stove
- Assure that sufficient mass of particulate matter is collected on the filter to improve the relative standard deviation -> repeatability
- Measure at varying burn rates, min nom max, if the stove allows for this
- Perform a sufficient number (3-5?) of repeated tests to assure statistically sound values?
- Always apply same type of filters with given pore size
- Make use of a filter discharge routine

The wood log combustion/Universe analogy



Your ordinary stove

Carina Nebula seen through the Hubble telescope

ANYONE SEE THE RESEMBLENCE?

THANK YOU FOR YOUR ATTENTION!