NO and SO_2 emissions from combustion of raw and torrefied biomasses and their blends with lignite

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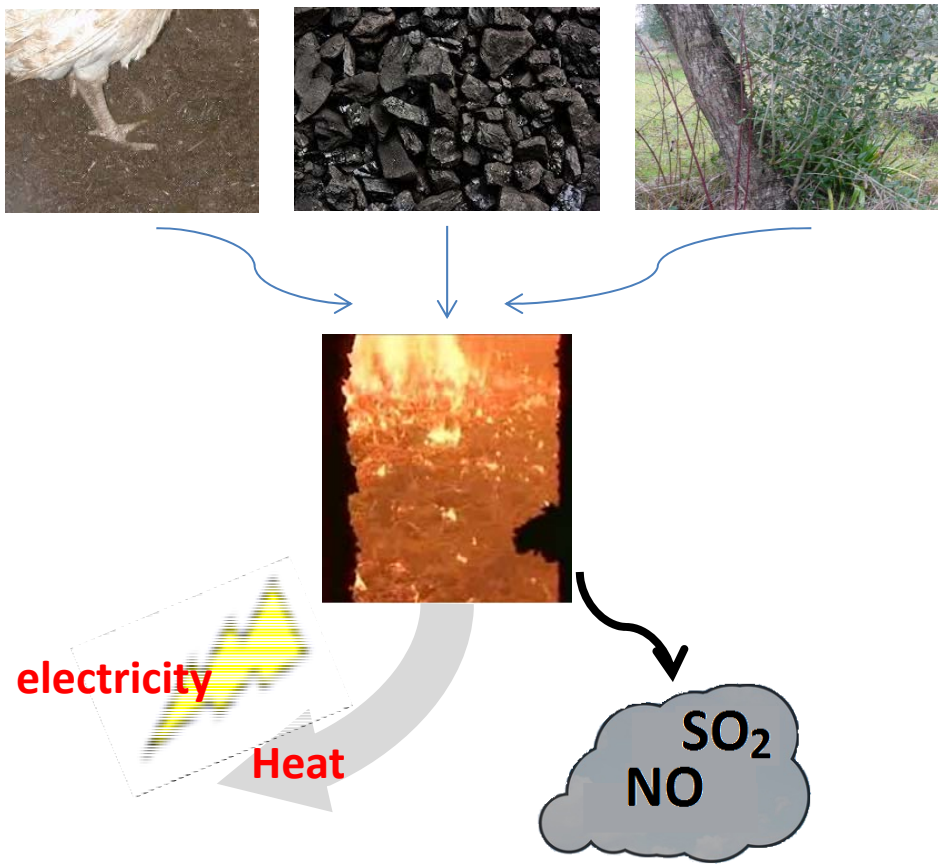
PRESENTATION OUTLINE

- General Aspects
- Methodology
- Results
- Conclusion



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Why co-combustion ?

- ✓ simple and economically feasible way of utilizing biomass/waste for replacement of fossil fuels
- ✓ reduction in net CO_2, SO_2 and often NOx emissions

Biomass /waste challenges

- ✓ Low heating value
- ✓ High moisture content
- ✓ Hygroscopicity
- ✓ Excess smoke
- ✓ Low combustion efficiency

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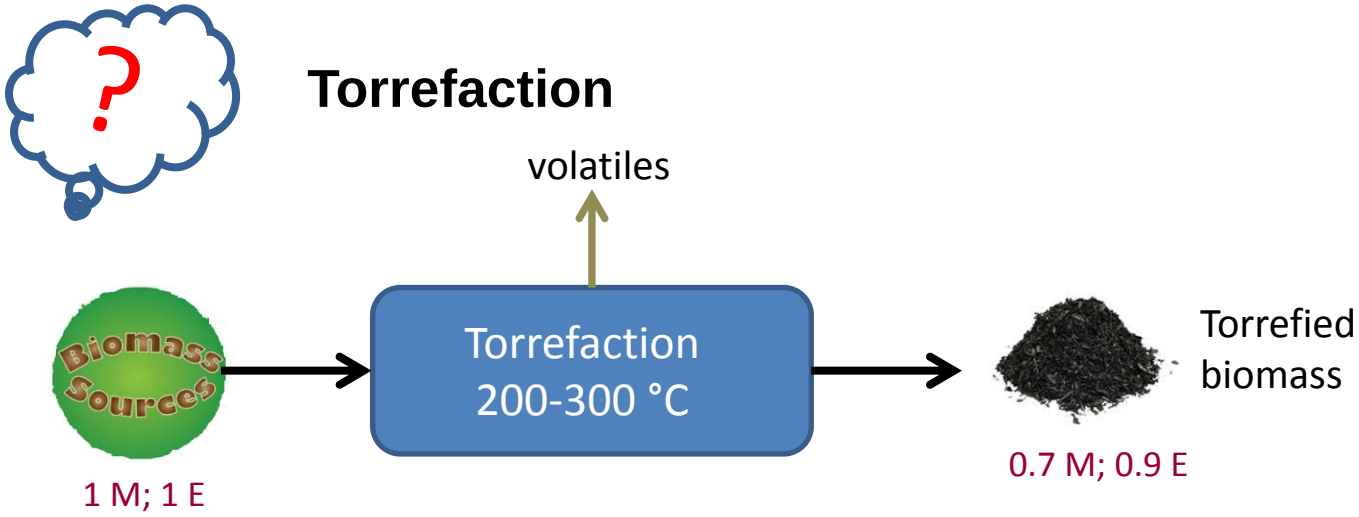

- ✓ Higher energy density – lower transportation cost
- ✓ Improved grindability – suitable for dust burners (coal power stations)
- ✓ Hydrophobic – does not absorb water
- ✓ No biological degradation – can be transported and stored in the open air
- ✓ Clean combustion – suitable for indoor heating/cooking

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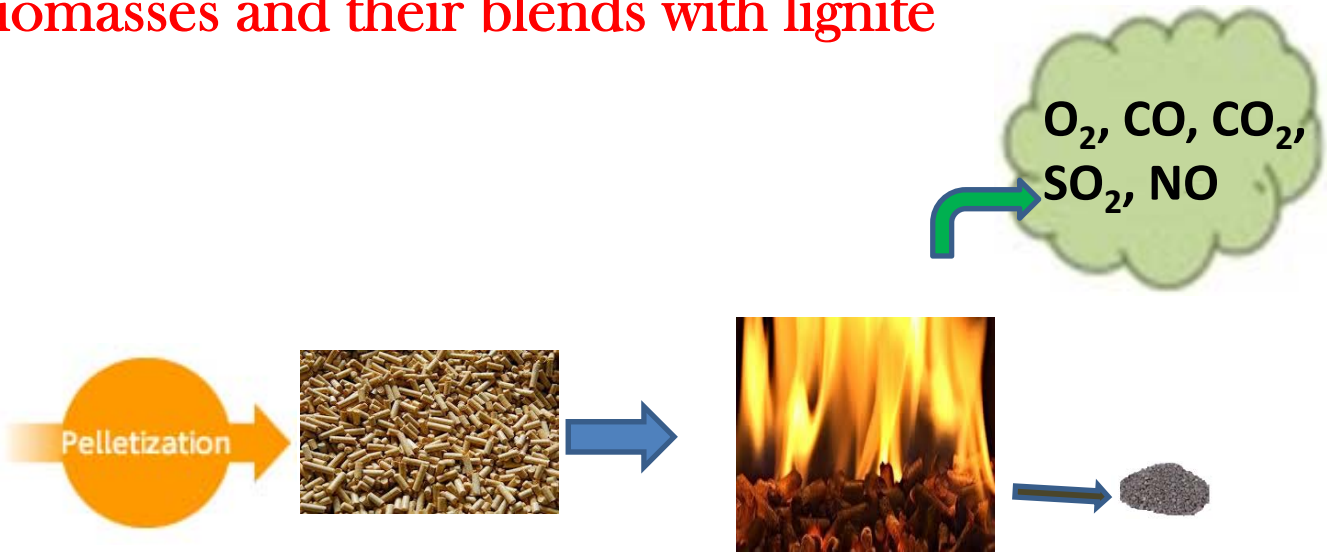
Fuel
Lignite
Poultry litter (PL)
Olive tree pruning (OP)
Torrefied PL and OP
Blends (1:3, 1:1, 3:1)



Aim ⇨ Investigation of NO and SO_2 release from blends of lignite with four different biomasses

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	Lignite	PL	OP	PL-B	OP-B
Proximate analysis (wt.% dry basis)					
Ash	11.5	8.2	3.3	12.8	4.1
Volatile matters	49.9	68.3	71.6	44.3	54.3
Fixed carbon	38.6	23.5	25.1	43.1	41.6
HHV, MJ kg^{-1}	25.1	14.4	17.8	22.9	22.3
Ultimate analysis (wt.% dry basis)					
C	63.92	35.7	43.47	57.39	54.79
H	4.25	5.27	5.78	4.40	5.35
N	1.51	9.61	1.29	5.88	1.62
S	1.11	0.24	0.18	0.48	0.27
O	17.71	40.98	45.98	19.05	33.87
Ash analysis (wt.% dry basis)					
Na_2O	0.76	5.11	2.09		
K_2O	1.41	26.53	22.48		
CaO	2.48	39.52	59.78		
MgO	1.73	6.22	6.94		
SiO_2	53.71	4.73	5.59		
Al_2O_3	24.08	1.09	0.86		

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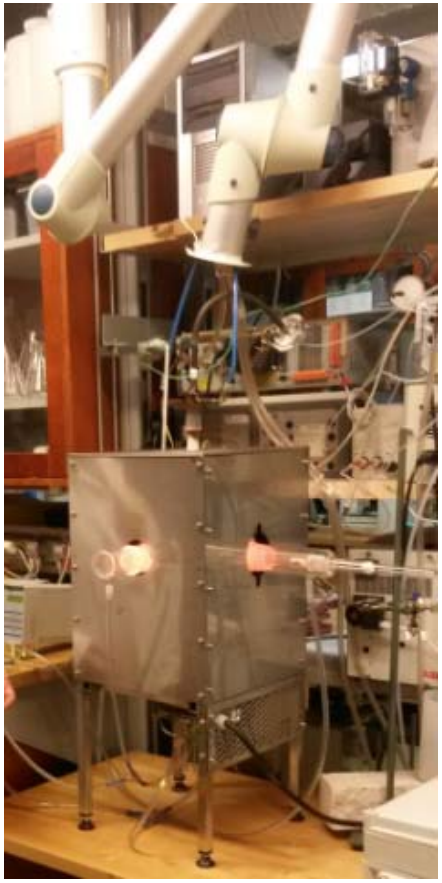

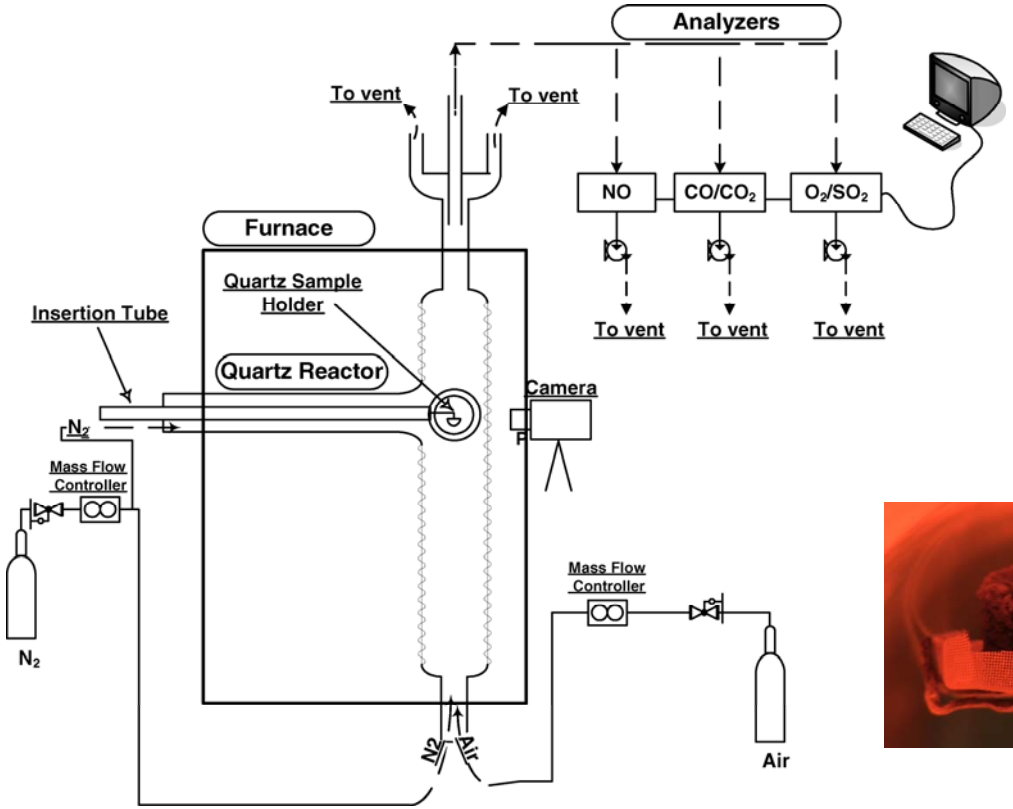

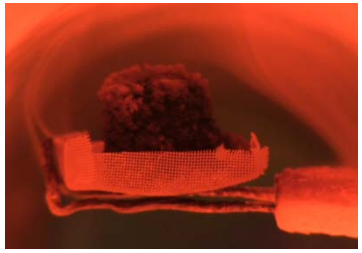

flow rate: 220 l/h

Single-particle furnace at Åbo Akademi University.

Published in: Jacopo Giuntoli; Wiebren de Jong; Adrian H. M. Verkooijen; Patrycja Piotrowska; Maria Zevenhoven; Mikko Hupa; *Energy Fuels* **2010,** 24, 5309-5319.
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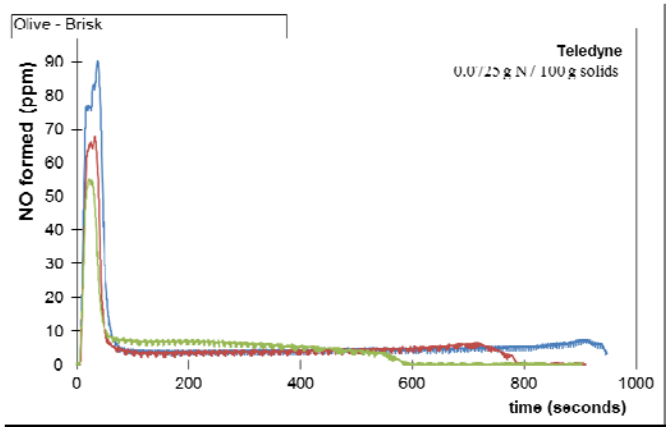

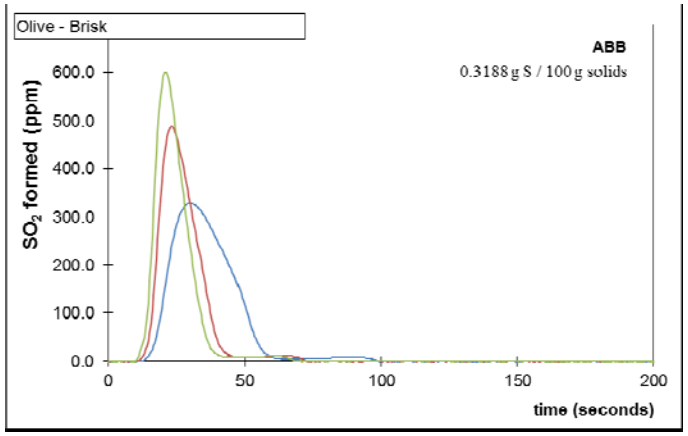

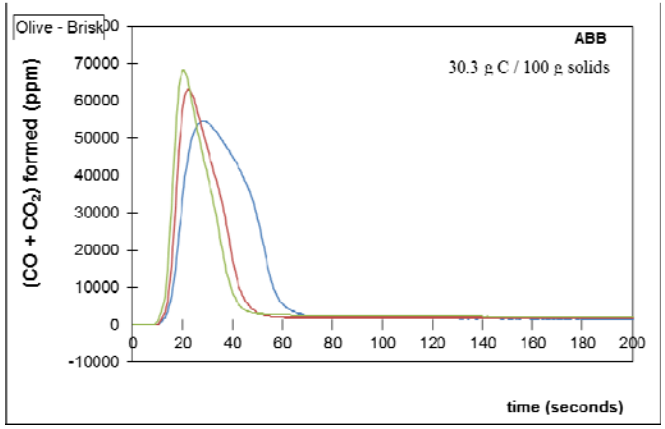

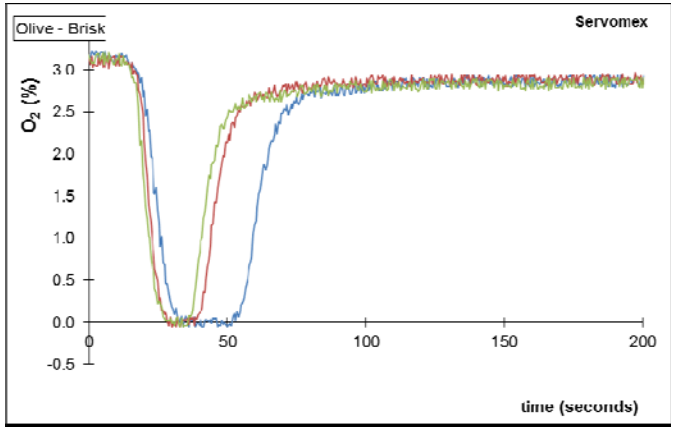

Combustion time: 15 min for olive pruning
20 min for poultry litter
30 min for biochars / lignites

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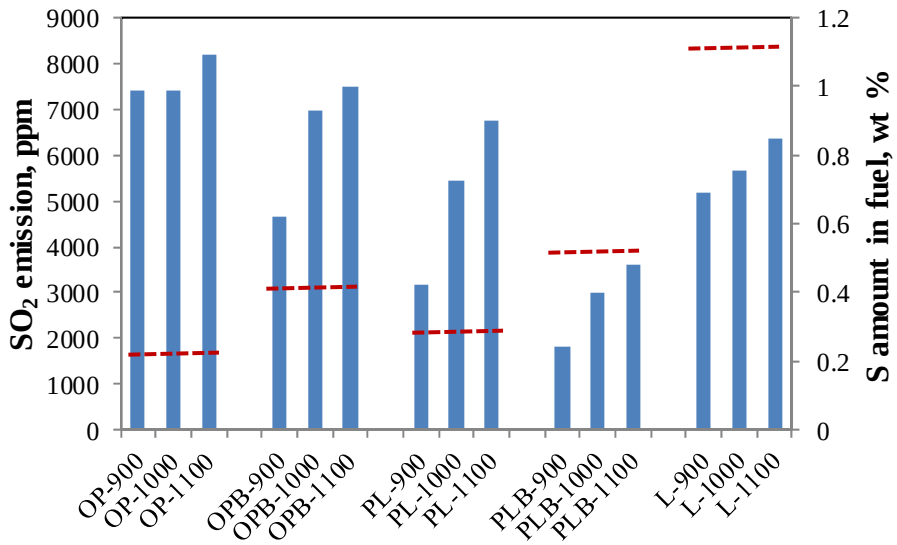
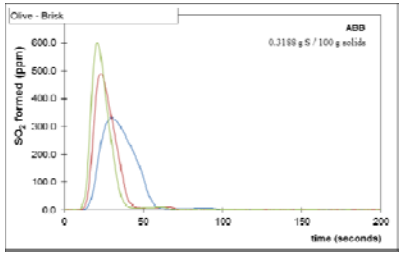
Total SO_2 emissions at different combustion temperature





- no clear relation between the sulfur content of the fuel and the SO_2 emissions
- SO_2 emission depends on the amount and the composition of the mineral content of the fuel rather than on the sulfur content
- SO_2 emissions from torrefied biomasses are lower than that from that from raw biomasses despite their higher sulfur content
- temperature had effect on the SO_2 release

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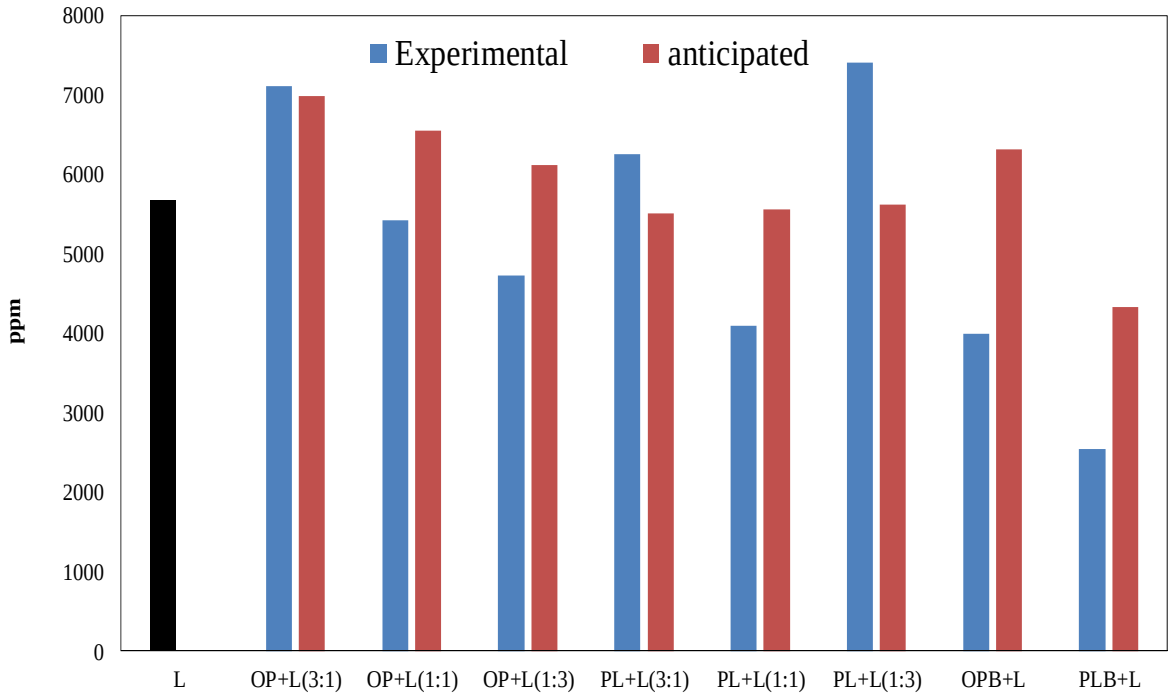
Total SO_2 emission from co-combustion at 1000 °C



- SO_2 emissions cannot be predicted based on the results obtained using pure fuel.
- blending of lignite with torrefied biomass significantly decreased the SO_2 emission compared with the lignite case

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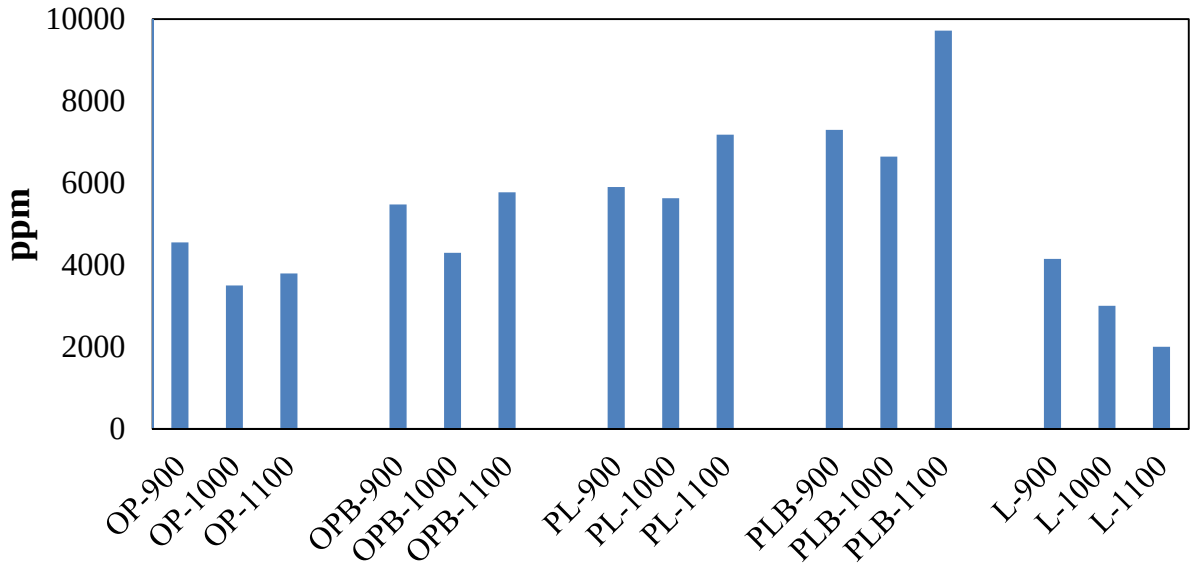
Total NO emissions at different combustion temperature



- NO emission is not purely depend on nitrogen content in fuel, high fuel-N content could enhance De-NOx reaction
- NO release from biomasses was lower than those from torrefied biomasses

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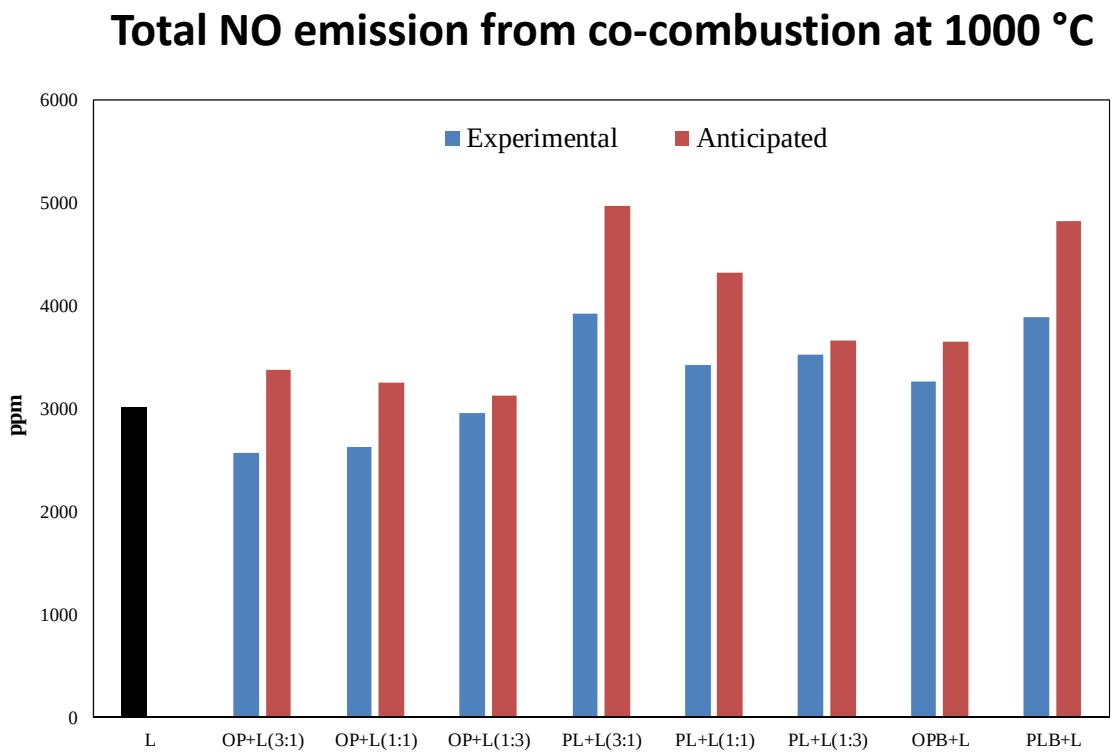

- experimental NO emission values for all blends were lower than the anticipated one.

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CONCLUSION

- SO_2 emissions increased with increasing combustion temperature (except olive pruning).
- Although the torrefied biomasses had higher sulfur content, SO_2 emissions from the torrefied biomasses were lower than those of the untreated raw biomasses.
- Co-combustion of lignite with torrefied biomasses had a beneficial impact on SO_2 release.
- no benefit of co-combustion on NO release could be observed for blends of torrefied biomass with lignite.

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ACKNOWLEDGEMENTS

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