Does subsidy towards clean stoves for residential wood combustion affect emission reductions? - A case study in Oslo Municipality

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Motivation

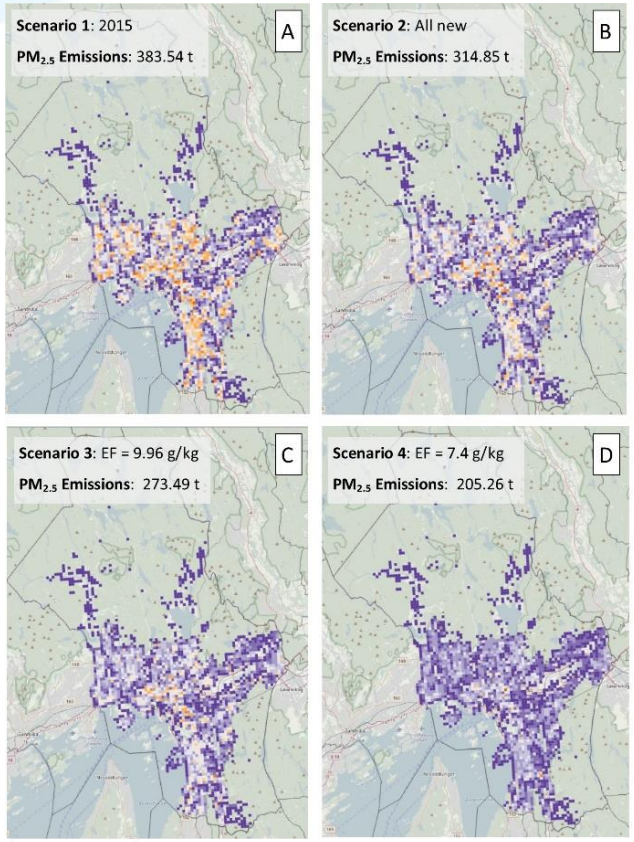
- A subsidy programme to exchange old RWC stoves for new have been in place in Oslo (Norway) since 1998.
- We assessed 1) the potential for emissions reduction and 2) to what extend the subsidy has succeeded in reducing $PM_{2.5}$ emissions from RWC in Oslo.

Conclusions

- Emissions and $PM_{2.5}$ levels were modelled to be potentially reduced by 18-46% and 3-9%, respectively, by the introduction of new stoves.
- Municipalities with and without subsidies shows no discernible differences. Oslo shows a stronger reduction in EF but also the lowest reduction in RWC emission (1.7% y^{-1}) and wood consumption at (1% y^{-1}).
- No evidence that municipalities with subsidies reduce emissions faster than others, thus additional measures targeted at reducing RWC activity are needed.

Methodology

1 Emission and dispersion modelling was carried out for 4 Scenarios of introduction of new stoves technologies



2015

A: Todays situation

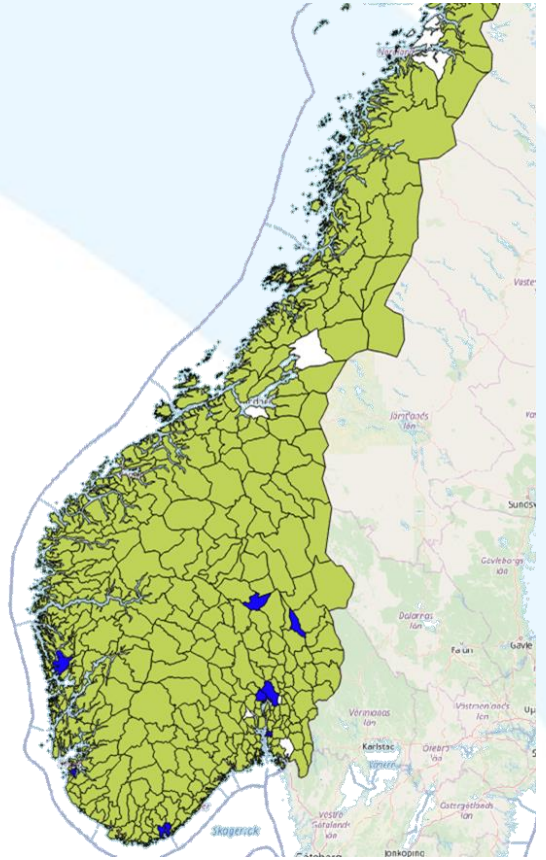
B: All stoves are new stoves

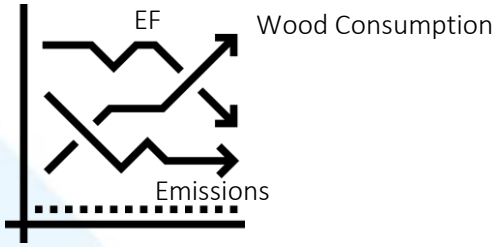
C: Continuous introduction over time of new stoves (Todays EF: 5.5 g/kg)

D: Continuous introduction of new stoves over time (Todays EF: 2.2 g/kg)

2 Emissions, wood consumption and EF trends (2005 to 2018) were analyzed for municipalities with and without subsidy

- 9 Municipalities with subsidy
- 6 Municipalities without subsidy





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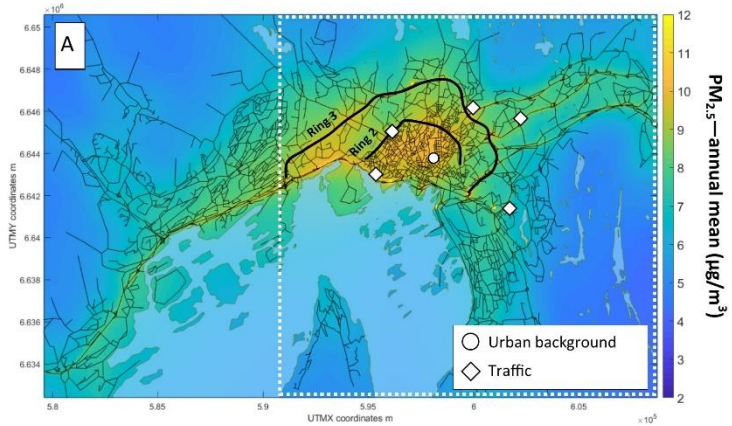
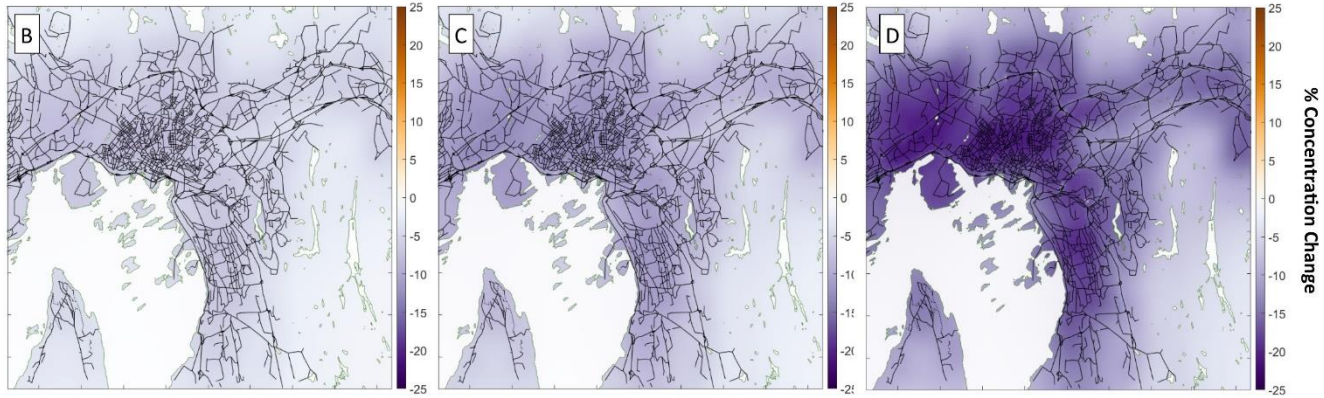
Results 1

A: Todays situation
B: All new stoves (official EF in Norway)
C: Continuous introduction of new stoves (Todays EF: 5.5 g/kg)
D: Continuous introduction of new stoves (Todays EF: 2.2 g/kg)

Modelled $PM_{2.5}$ Levels

2015



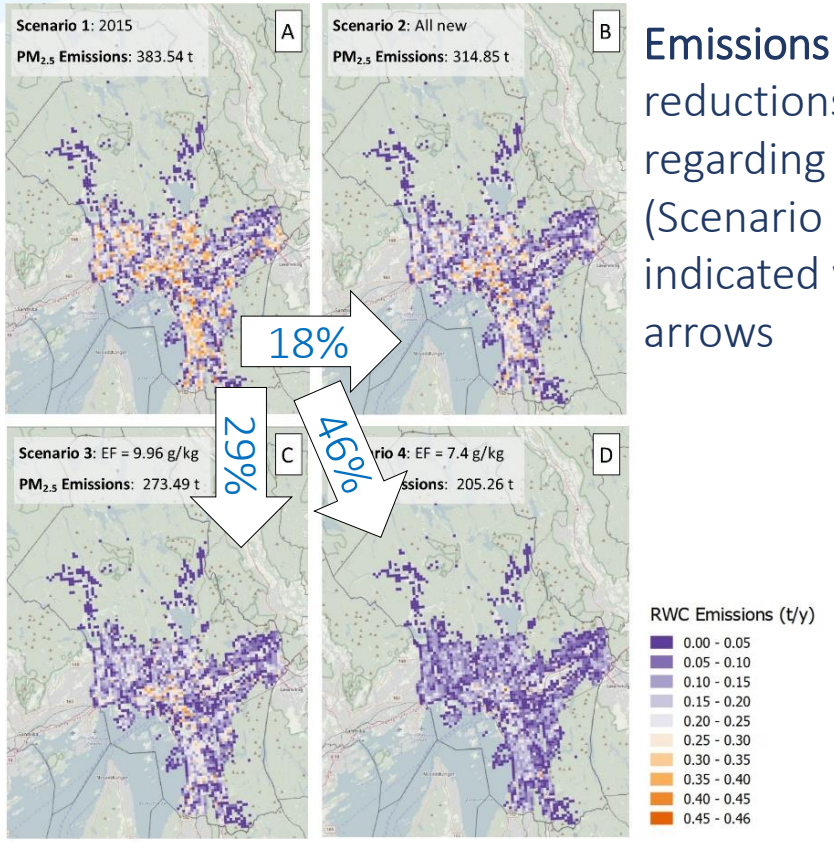


Aver: 3% (0.2 µm/m³)
Max: 8% (0.8 µm/m³)

Aver: 5% (0.3 µm/m³)
Max: 13% (1.3 µm/m³)

Aver: 9% (0.6 µm/m³)
Max: 21% (2.1 µm/m³)

$PM_{2.5}$ reduction levels regarding baseline (Scenario A)



Emissions

reductions regarding baseline (Scenario A) are indicated with the arrows

Station	Station type	Winter	HS	non-HS
Alnabru	Traffic	-4.73	-4.85	-6.63
Bygdøy Alle	Traffic	-4.46	-4.22	-3.23
Hjørtnes	Traffic	-3.07	-2.58	-1.93
Kirkeveien	Traffic	-1.46	-2.55	-4.98
Manglerud	Traffic	-3.48	-3.02	-2.54
Rv 4, Aker Sykehus	Traffic	-4.32	-5.17	-5.36
Average	Traffic	-3.59	-3.73	-4.11
Sofienbergparken	Background	-3.71	-3.57	-4.38

Observations

Average changed monthly $PM_{2.5}$ Levels at monitoring stations (% y^{-1})

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Results 1

Summary from emission and dispersion modelling

- The different scenarios constructed represent a complete transfer to new stoves or continuous introduction over time under different assumed emission factors.
- PM2.5 emissions and concentration levels were modelled to be reduced by an average 18-46% and 3-9%, respectively.
- In Oslo, the largest concentration reductions were modelled in the areas with the highest PM2.5 concentrations.
- The range in modelled average concentration reduction shows that the benefit that the subsidy could have on reducing emissions and pollution levels is strongly dependent on emission factors.
- Only 3% concentration reduction was obtained with official emission factors, whereas higher reductions were modelled for new stoves emission factors resembling stove manufacturers' claims.
- Available observations: reduction in PM2.5 in winter and the heating season appear to be similar to the remainder of the year. This indicates that the reductions are mainly caused by the other main source, e.g. traffic, which have emissions throughout the year. It is not possible to conclude, based on observation data, whether the subsidy programme has had a significant effect in reducing PM2.5 concentrations in Oslo.

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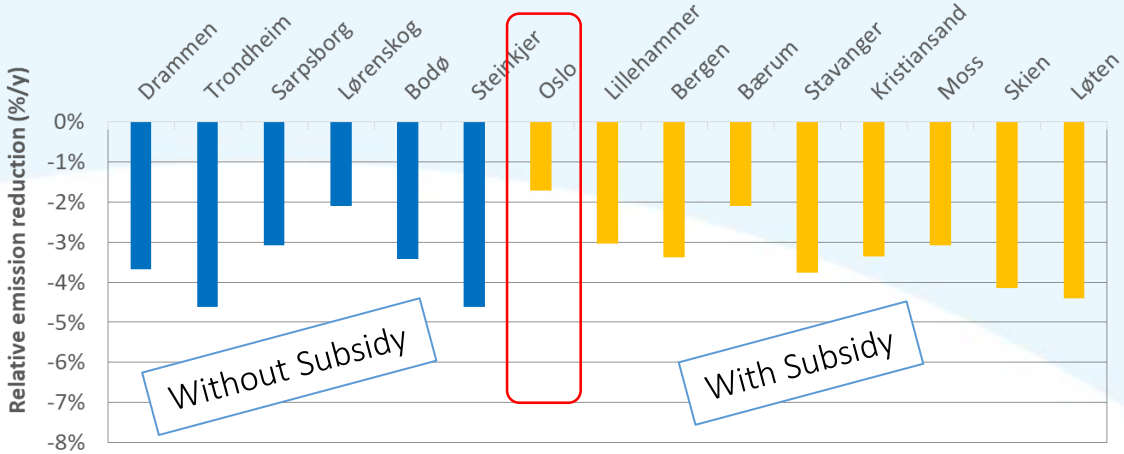
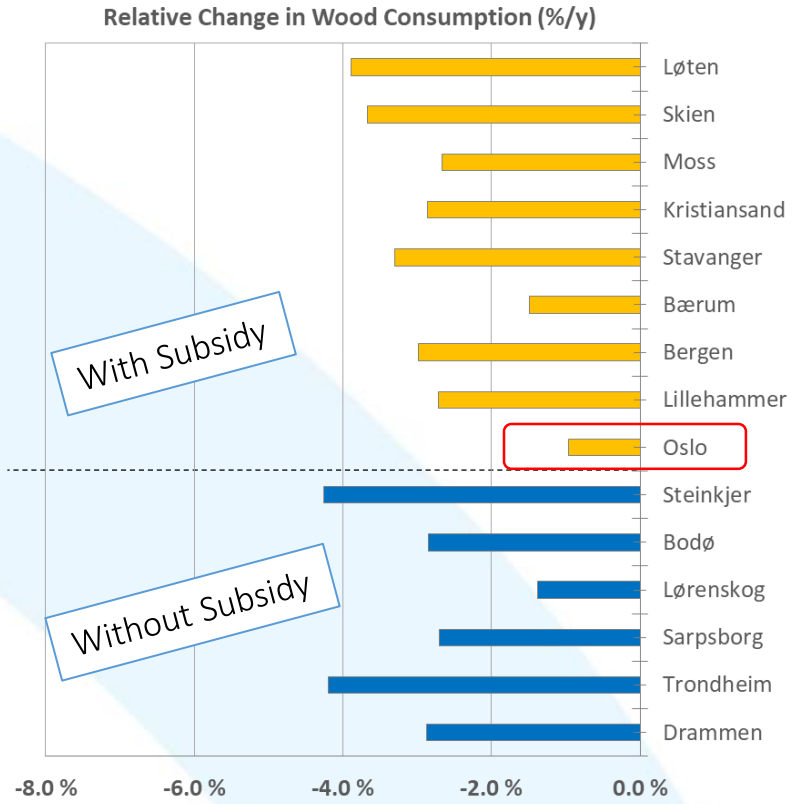
Results 2

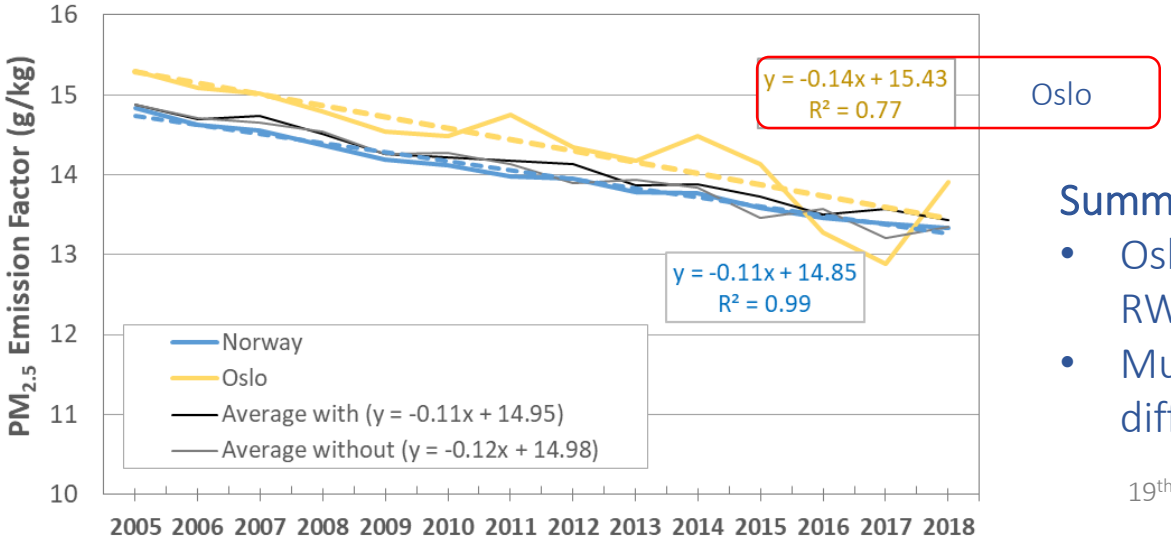
Emission Reductions



Wood Consumption Reductions



Emission Factors Reductions



Summary

- Oslo: stronger reduction in emission factors, lowest reduction in RWC emission (1.7% y^{-1}) and wood consumption at (1% y^{-1}).
- Municipalities with and without subsidies shows no discernible differences

FACTS

- 2.5 millions dwellings in Norway
- 2.1 millions RWC stoves/fireplaces
- RWC is the 2nd largest heating source

References

- Emissions are estimated with the MetVed model: Grythe H., Lopez-Aparicio S., Vogt M., Vo Thanh D., Hak C., Halse A. K., Hamer P., Sousa Santos G. (2019) The MetVed model: Development and evaluation of emissions from residential wood combustion at high spatio-temporal resolution in Norway, Atmos. Chem. Phys. vol. 19, 10217–10237.
- $PM_{2.5}$ levels are estimated with the EPISODE model: Hamer P. D., Walker S.-E., Sousa-Santos G., Vogt M., Vo-Thanh D., Lopez-Aparicio S., Ramacher M. O. P., Karl M. (2019) The urban dispersion model EPISODE. Part 1: A Eulerian and subgrid-scale air quality model and its application in Nordic winter conditions, Geosci. Model Dev. Dis., 2019, 1-57.
- **This study has been published in:** López-Aparicio S., Grythe H., (2020) Evaluating the effectiveness of a stove exchange programme on PM2.5 emission reduction. Atmospheric Environment, 231, 117529. https://doi.org/10.1016/j.atmosenv.2020.117529

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