PARTICULATE EMISSIONS FROM RESIDENTIAL WOOD COMBUSTION: IMPROVING ESTIMATIONS IN DENMARK AND PORTUGAL

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Residential wood combustion (RWC) in fireplaces and conventional stoves is the main contributor to fine particulate matter ($PM_{2.5}$) emissions in Denmark and Portugal representing more than 30% of the total emissions [1;2]. Such estimations are uncertain concerning the wood consumption and official emission factors, not taking into account actual burning conditions in dwellings [3]. There is limited knowledge on the real-life performance and spatial distribution of existing appliance types. Few studies have been targeting to understand the influence of fuel operation habits on PM2.5 emissions within a specific "wood burning living area", but one Danish study exists [4]. In previous inventories distinct combustion air operation modes and the growing penetration of automate wood-burning stoves have not been considered. The present work aims to discuss opportunities for improving the available estimations for Denmark and Portugal, suggesting a methodology to increase the accuracy of activity data and emission factors. This work is based on new studies carried out to quantify the PM2.5 emissions in daily life through field experiments in Danish dwellings and by considering typical Portuguese combustion practices in laboratory tests. This study highlights that the previous $PM_{2.5}$ emission inventories in Denmark and Portugal did not consider the possible variations on fuel moisture, dimensions of wood-logs and air-inlet operation patterns, although they are very important, especially in places where there is a large amount of "non-trained users". In Denmark, inventories rely on information on emission factors for 4 different categories of wood-log stoves while in Portugal there is available information only for 2 types of wood-log combustion systems. Field measurements in a Danish village indicated that for the community in question the measured average emission factor was approximately half of the official country value. Laboratory experiments in Portugal demonstrate that differences in fuel operating techniques can result in particulate emission factors twice as high when operating low fuel loads as when operating high loads [5]. In both cases, there is a need to improve the quality of activity data to reflect real-life situations.

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References:

[1] C. Gonçalves, C. Alves, C. Pio. Inventory of fine particulate organic compound emissions from residential wood combustion in Portugal. Atmospheric Environment, 50, 297-306, 2012.
[2] O. K. Nielsen, M. S. Plejdrup, M. Winther, M. H. Mikkelsen, M. Nielsen, S. Gyldenkærne, P. Fauser, R. Albrektsen, K. Hjelgaard, H. G. Bruun, M. Thomsen. Annual Danish Annual Inventory report to UNECE, 2015.
[3] United Nations Economic Commission for Europe. EMEP/EEA Emission Inventory Guidebook, 2013.
[4] H.R. Olesen, P. Wåhlin, J. Illerup, R. Bossi, S.S. Jensen. Characteristics of residential wood combustion – results from a Danish case study, 2012.
[5] E.D. Vicente, M.A. Duarte, A.I. Calvo, T.F. Nunes, L. Tarelho, C.A. Alves. Emission of carbon monoxide, total hydrocarbons and particulate matter during wood combustion in a stove operating under distinct conditions.