EVALUATION OF EMISSION FACTORS FOR AIR POLLUTANTS FROM BIOMASS COMBUSTION IN LITHUANIA

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Overview

Air pollution is closely linked to climate change – the main driver of climate change is fossil fuel combustion which is also a major contributor to air pollution. Air pollution impacts our health, environment and economy. The United Nations Economic Commission member states signed the Convention on Long-range Transboundary Air Pollution (CLRTAP) to improve air quality. The joint effort has been successful: with reference to the main air pollutants, SO_x showed the greatest reduction in emissions across the EU (in 2017, SO_x emissions were about 90 % less than in 1990) [1].
In compliance with the CLRTAP Lithuania each year provides a national inventory of air pollutant emissions according to the relevant source categories. After the detailed review of the National inventories for 2017, experts from the European Commission recommended to use the country specific emission factors (EFs) for the estimation of air pollutant emissions in the energy sector. In order to ensure the reliability and accuracy of data, it was necessary to assess national EFs according to the fuel type and technology in the energy sector. This study is focused on biomass combustion as biomass are widely used in all Lithuanian economy sectors, especially in residential sector and releases a large part of pollutants into the atmosphere.

Method

The methodology for evaluation the EFs based on actual measurements and consisted from four steps presented below.

I step. Concentration		
Indicator	Concentration	Volume flow rate
Mark	A	B
Unit	mg/m^3	Nm^3/h
II step. Fuel data		
Indicator	Heating value	Fuel consumption
Mark	C	D
Unit	MJ/kg	kg/h
III step. Air pollutants		
Indicator	Emissions	
Mark	E=A x B	
Unit	mg/h	
IV step. Emission factor		
Indicator	Emission factor	
Mark	$F=E/(CxD)/10^3$	
Unit	g/GJ	

For measurement purposes the technologies were grouped by power (up to 50 kW, 50 kW to 1 MW and 1 MW to 50 MW) and by fuel type taking into account that different fuel combustion technologies and different fuel types emit diverse amounts of air pollutants. Measurements of CO, SO_2, NO_x, NH_3, NMVOC, $PM_{2.5}$ emissions during the combustion process were carried out in various economic sectors, including residential sector. All measurements were made at maximum capacity of the units. During the study period emissions of air pollutants were measured from 26 different biomass combustion technologies in various economic sectors, of which 15 in residential sector. In residential sector emissions were measured in different types of biomass heating equipment (automatic stoves, manual stoves and fireplaces). The concentration of air pollutants was measured by portable gas analyser Testo 350 XL and FTIR Gasmet DX-4000, absorption tubes and Agilent 78902A GS series Quadrupole mass spectrometer gas chromatograph.

Results

In this study EFs for CO and non-CO (SO_2, NO_x, NH_3, NMVOC, $PM_{2.5}$) pollutants were evaluated. The comparison of measured $PM_{2.5}$ EFs with default EMEP Guidebook EFs are presented in Figures 1 and 2. $PM_{2.5}$ EF for biomass combustion technologies (1-50 MW) varied in a broad range from 1 to 32.3 g/GJ and for residential technologies – 0.1-165.4 g/GJ. The experimental values of EF are significantly lower than default values. Continuous improvement of technologies leads to the development of advanced technologies with high productivity and low emissions.

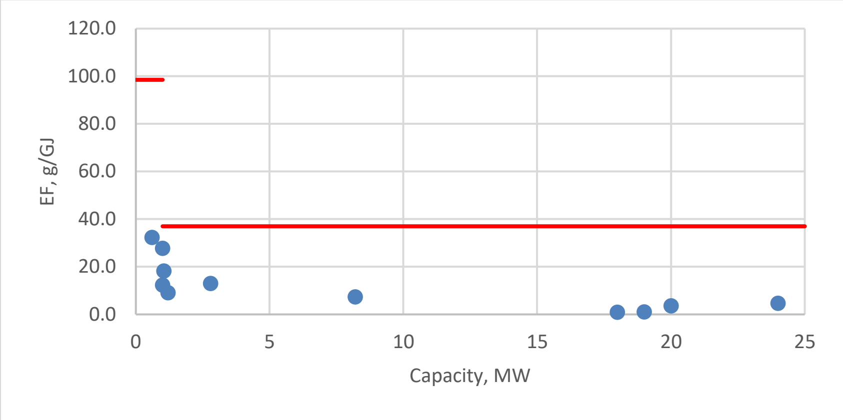

Fig. 1. $PM_{2.5}$ EFs for biomass combustion technologies (1-50 MW)

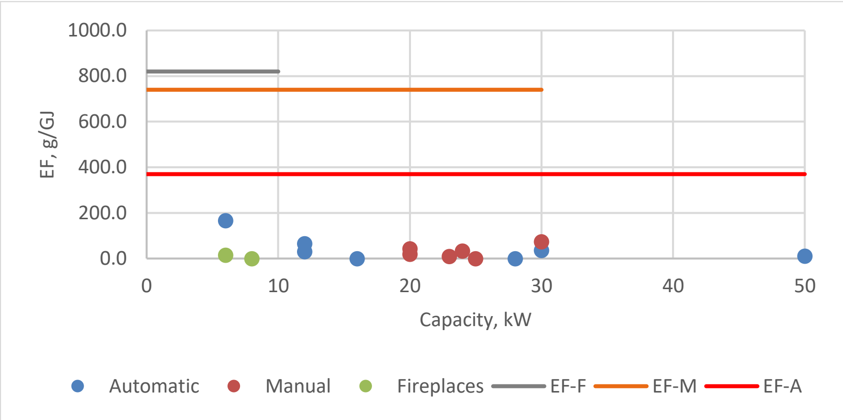

Fig. 2. $PM_{2.5}$ EFs for residential biomass combustion technologies (<50 kW)

The comparison of country specific EF values with default values is presented in Table 1. The evaluation of country specific EFs were based on median which better than average reveals the position of the data in the row containing the exclusions.

Table 1. Comparison of determined $PM_{2.5}$ EF with default EF values

Technology	Default EF (EMEP, 2017), g/GJ	95% confidence interval (EMEP, 2017)		Evaluated EF, g/GJ	95% confidence interval	
		Min	Max		Min	Max
Residential biomass combustion technologies (up to 50 kW)						
Fireplaces	820	410	1640	17.3	13.2	21.3
Manual stoves (<50 kW)	740	370	1480	25.9	8.4	51.1
Automatic stoves (<50 kW)	370	285	740	13.2	3.3	45.7
Biomass combustion technologies (1-50 MW)						
Boilers (50 kW – 1 MW)	98,5	38,5	154	27.7	4.2	39.7
Boilers (1 - 25 MW)	37	18	74	5.9	3.0	11.4

Conclusions

Obtained research results will reduce uncertainties of air pollution emissions data and increase accounting reliability. Air pollutants emissions depend on the fuel type, on the boiler operating mode, on the optimization of combustion process and other technical features therefore evaluation of country-specific EFs will ensure more accurate accounting of national emissions. Performed analysis showed that boilers have extremely low $PM_{2.5}$ emissions when complete biomass combustion is ensured. Biomass boilers (>10 MW) with installed condensing economizers behind multicyclones ensure very high suspended particles (including $PM_{2.5}$) emissions reduction efficiency (up to 99%). Measurements showed that modern residential biomass boilers (<50 kW) has low $PM_{2.5}$ emissions, in particular boilers with flexible control of fuel and air supply.

References

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