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Factors affecting mercury emissions from residential solid fuel boilers

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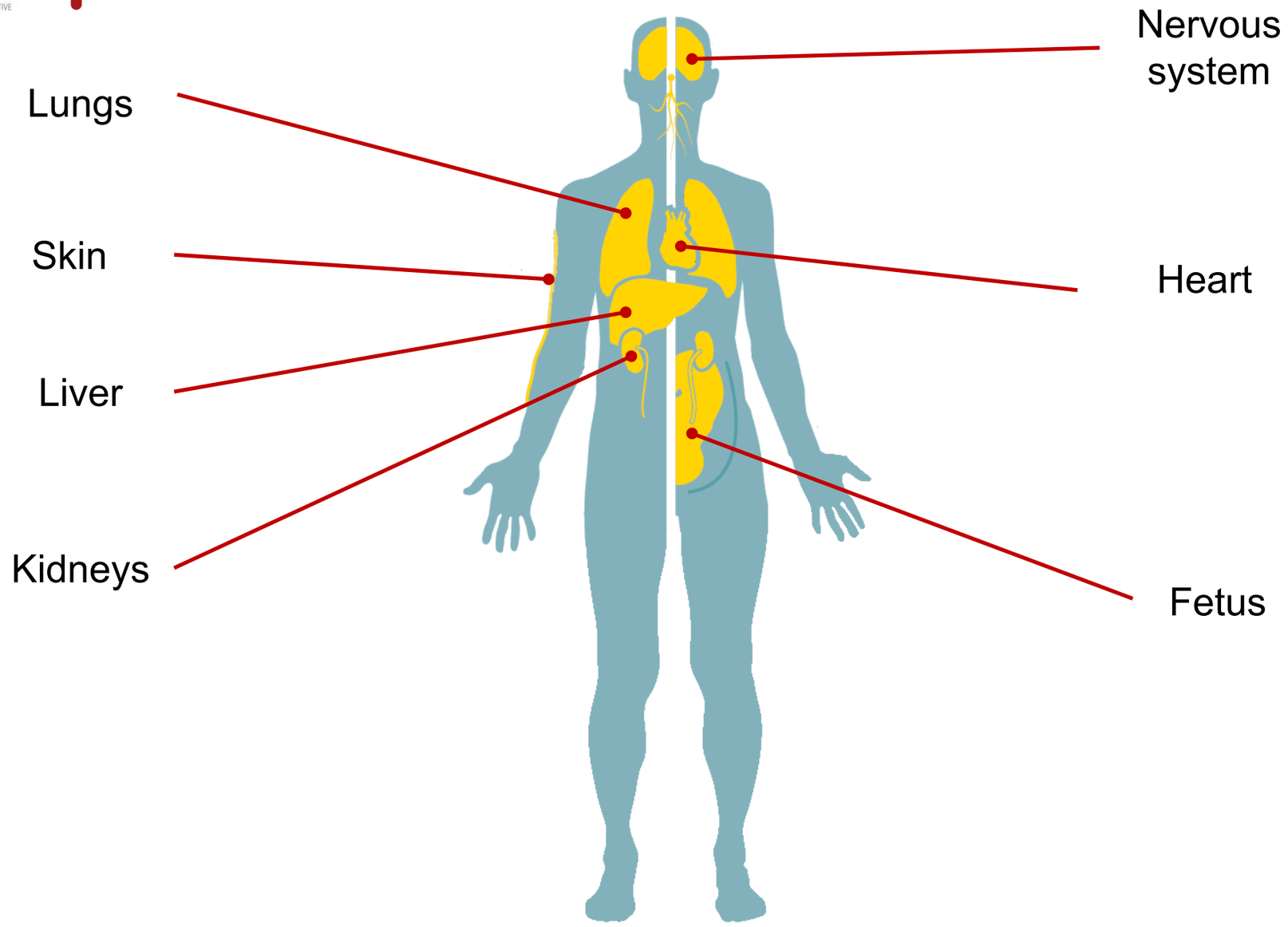
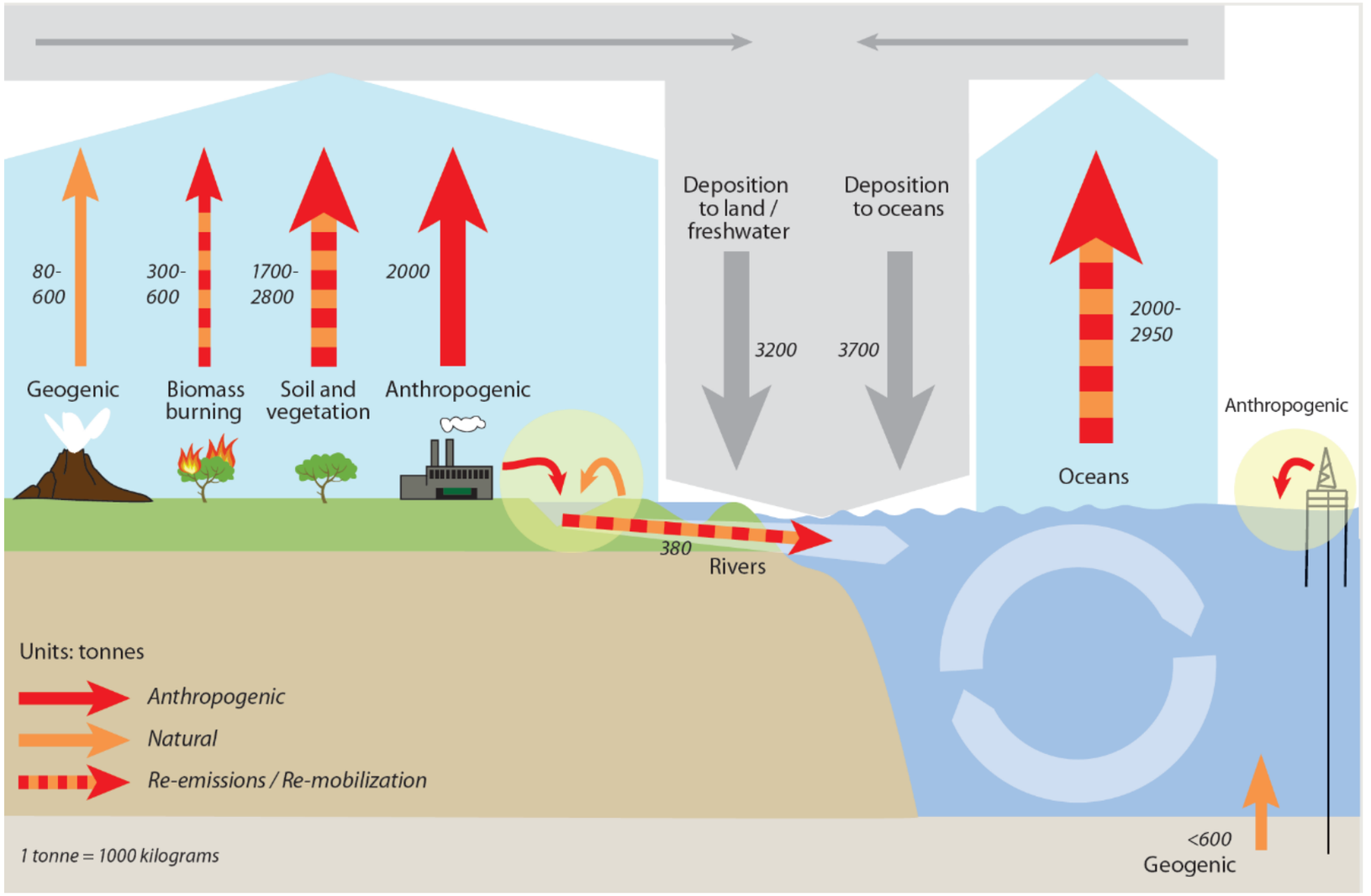
Toxic properties of mercury



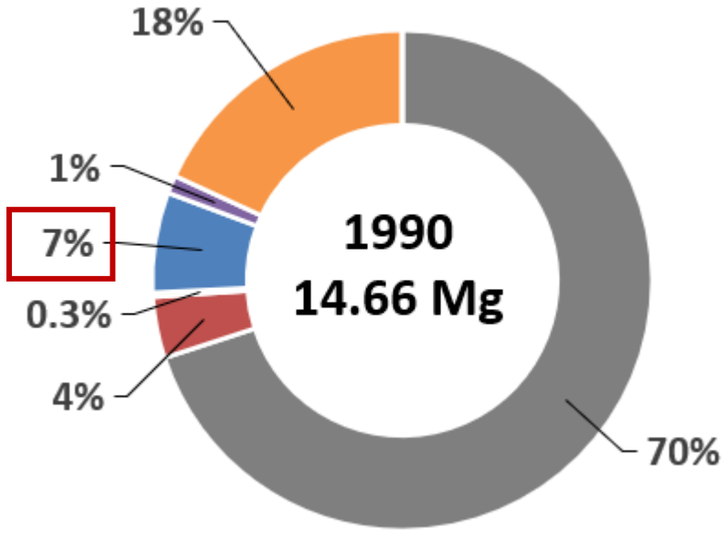
Source: UNEP: Mercury – Time to act. 2013. ISBN: 978-92-807-3310-5

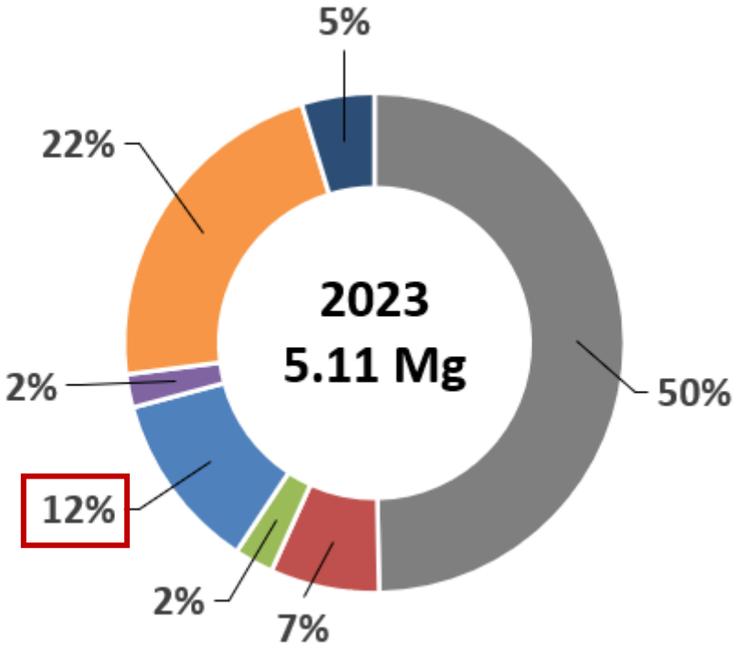
Sources of mercury emission



Source: *UNEP, Global Mercury Assessment – Sources, Emissions, Releases and Environmental Transport (2013)*

Mercury emissions in Poland



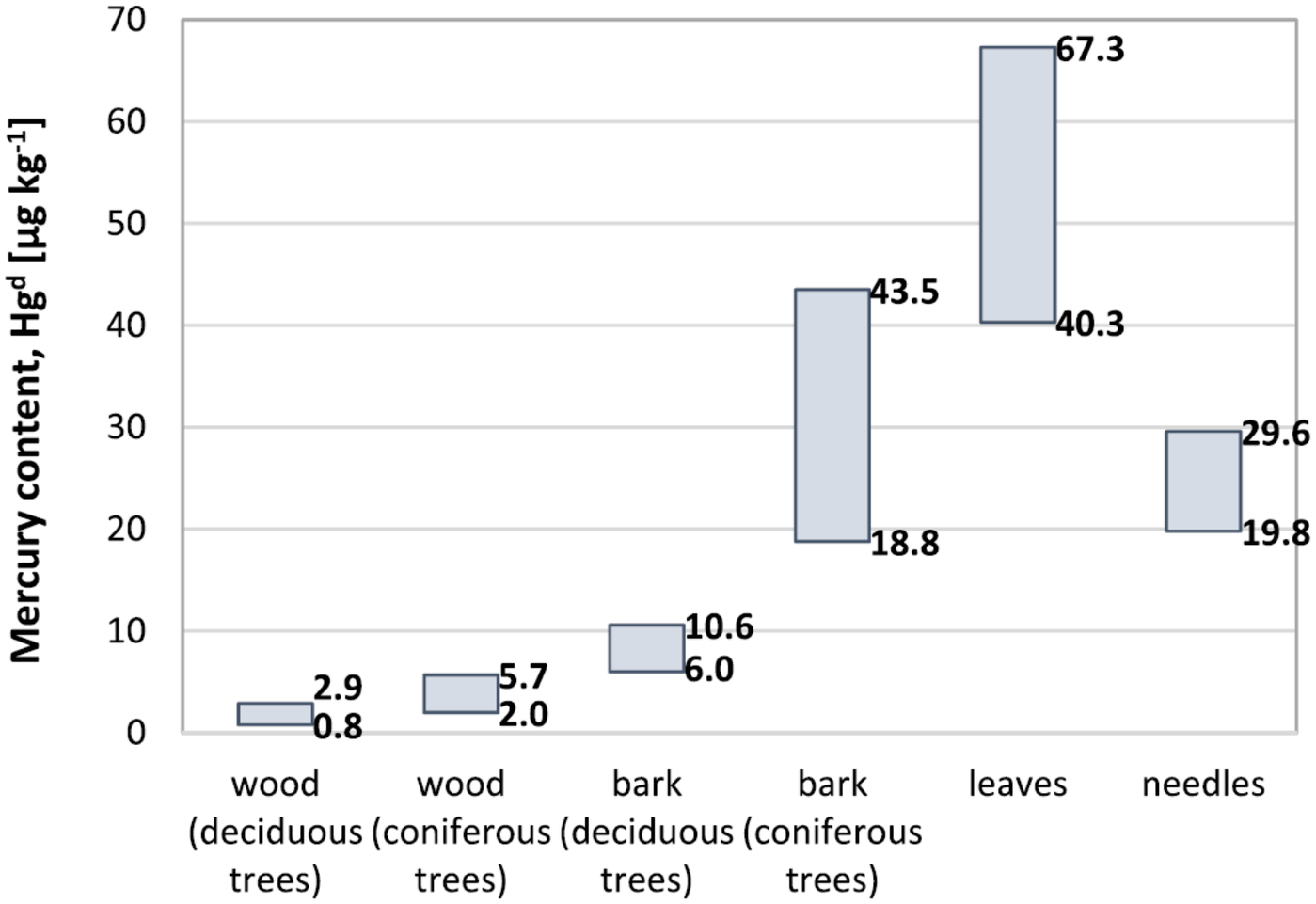


- Fuel combustion in energy production
- Fuel combustion in manufacturing industries and construction
- Fuel combustion in transport
- Small-scale fuel combustion
- Fugitive emissions from fuels
- Industrial processes and product use
- Waste

Almost twofold increase in the share of the residential sector

Source: *National Centre for Emissions Management (KOBiZE). Poland's informative inventory report 2025.Warsaw: 2025.*

High mercury content in waste biomass



Source: Dziok T., Kołodziejska E.K., Kołodziejska E.L. (2020) Mercury content in woody biomass and its removal in the torrefaction process. Biomass and Bioenergy 143:e105832.

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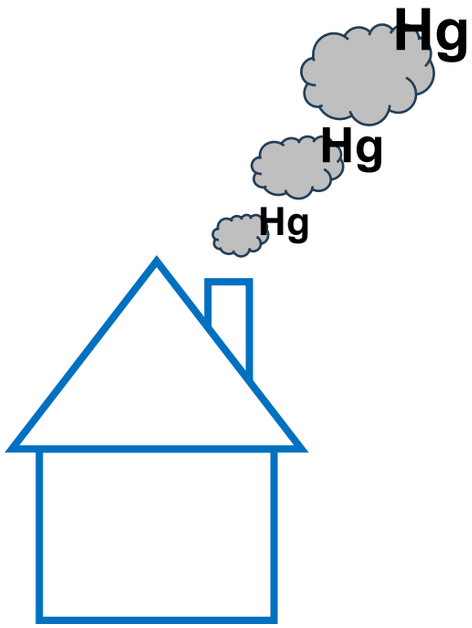
Aim of the study

- Distribution of mercury between the solid combustion by-products
- Determination of annual mercury emissions from residential solid fuel boilers (heating season)
- Identification of factors affecting mercury emissions



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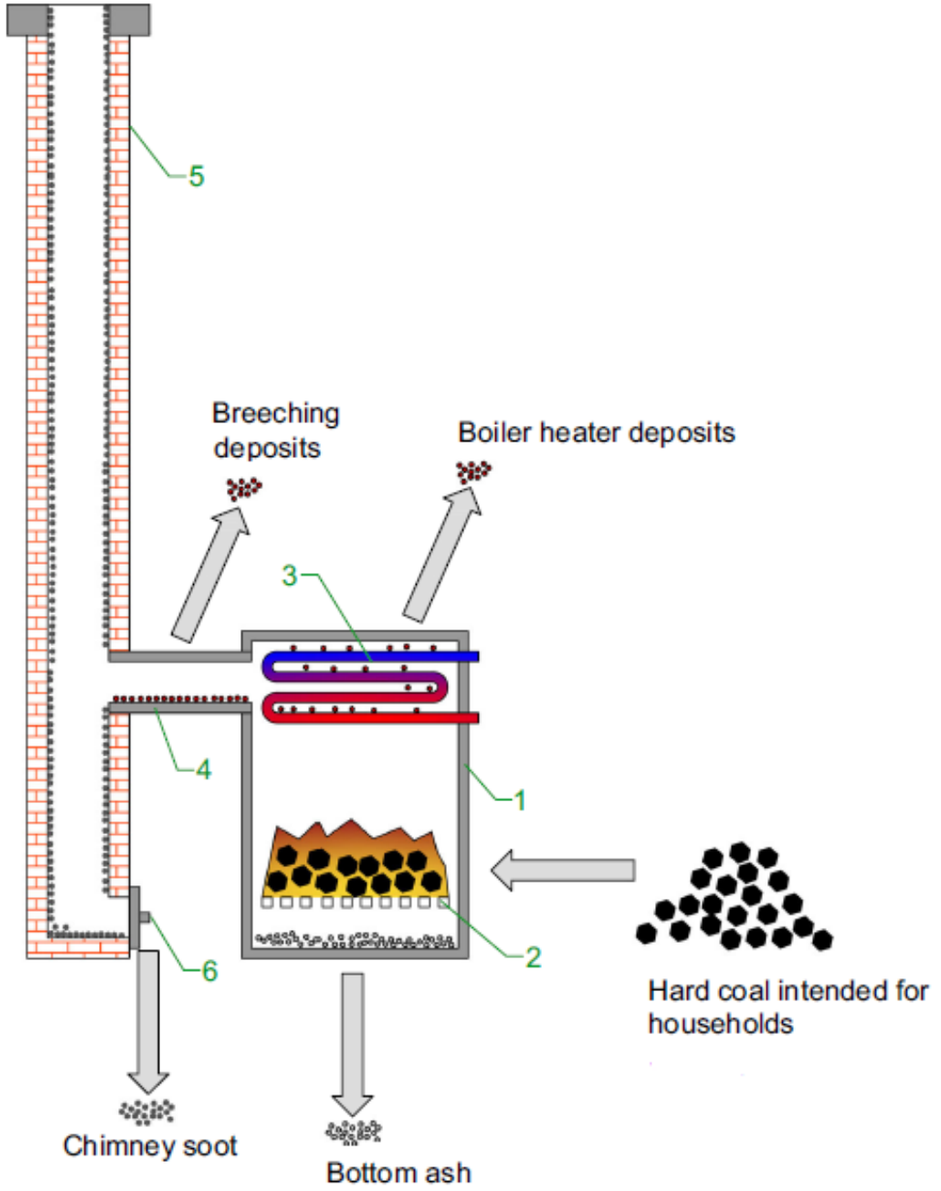
Characteristics of the investigated boilers

https://www.wozny-kotly.pl/p/ecotech/

Boiler label	Boiler class	Year of manufacture	Heat output [kW]	Efficiency [%]	Fuel type	Chimney height [m]
A	Out-of-class	2003	25	≥78	hard coal	10
B	Out-of-class	1970s	n/a	n/a	hard coal	3.5
C	3	2008	35-50	86	hard coal	9
D	3	2012	25	85	hard coal	5
E	5	2015	17	87	eco-pea coal	12.5
F	5	2017	3-10	90	wood pellets	6

Samples analyzed

1) Residential solid fuel boiler
2) Furnace with a grid
3) Heater
4) Breeching
5) Chimney
6) Cleanout opening



pixabay.com

Biomass pellets

Source: Dziok, T., Grzywacz, P. & Bochenek, P. Assessment of mercury emissions into the atmosphere from the combustion of hard coal in a home heating boiler. Environ Sci Pollut Res 26, 22254–22263 (2019)

Laboratory analyses

Analyses performed

- Moisture content (M_{ad})
- Ash content (A_{ad})
- **Mercury content** (Hg_{ad})
- Lower heating value (LHV_{ad})
- Carbon content (C_{ad})
- Hydrogen content (C_{ad})
- Sulfur content ($S_{t.ad}$)

Moisture balance
MA 110.R by Radwag

CHS-580 analyzer
Eltra

Muffle furnace
Czylok

Calorimeter IKA C6000
IKA-Werke GmbH

DMA-80 mercury analyzer
Milestone

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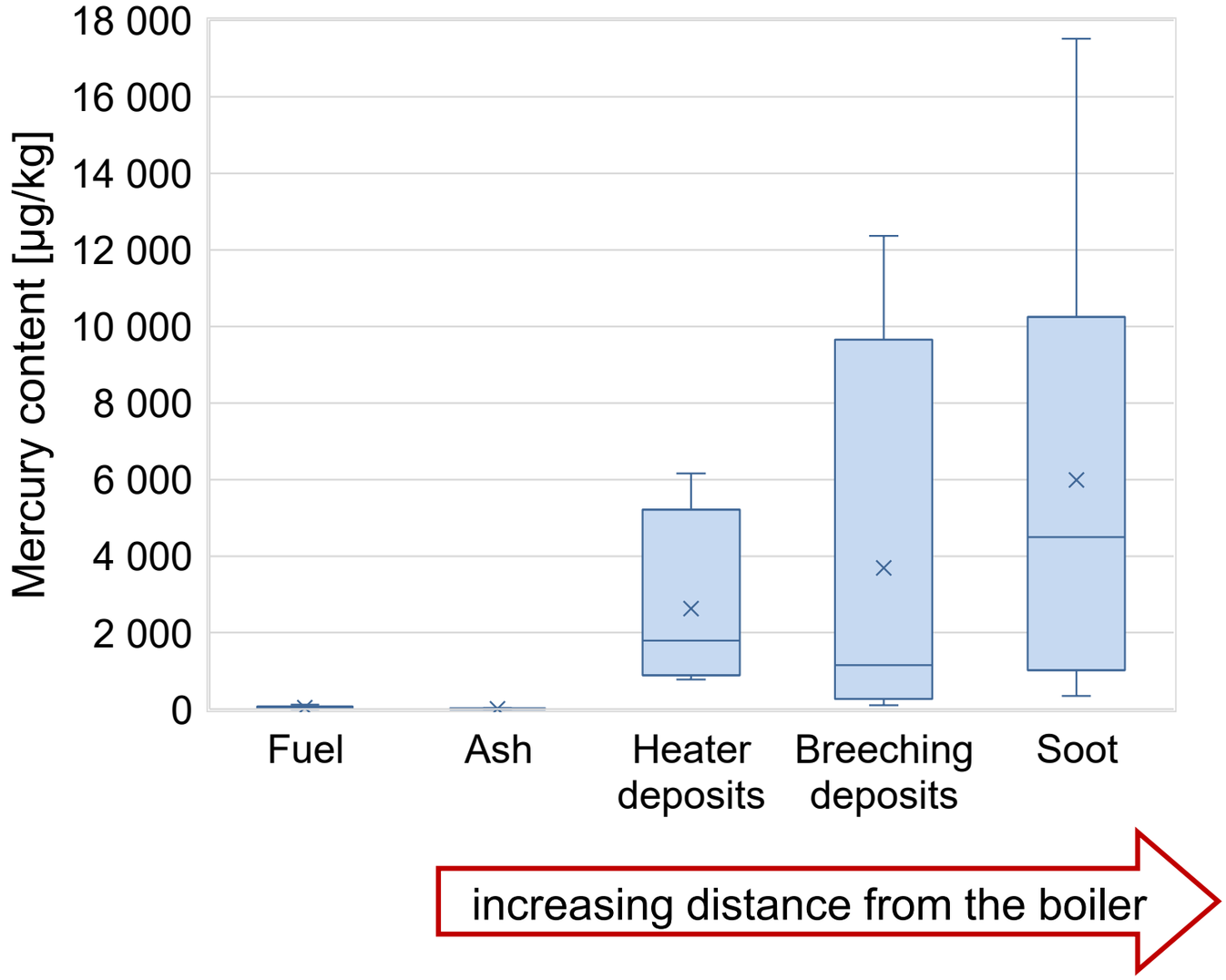
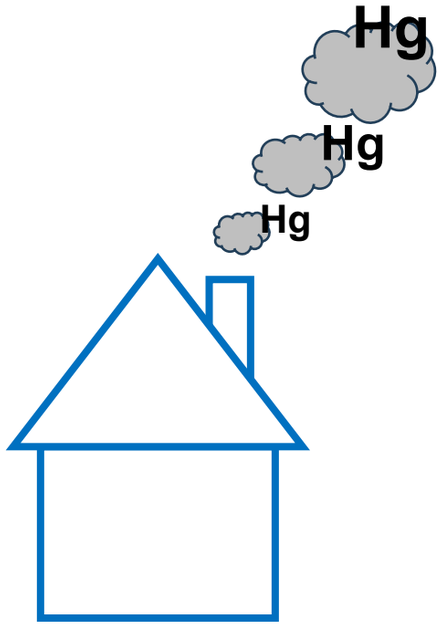
Mercury content in fuels and solid combustion by-products

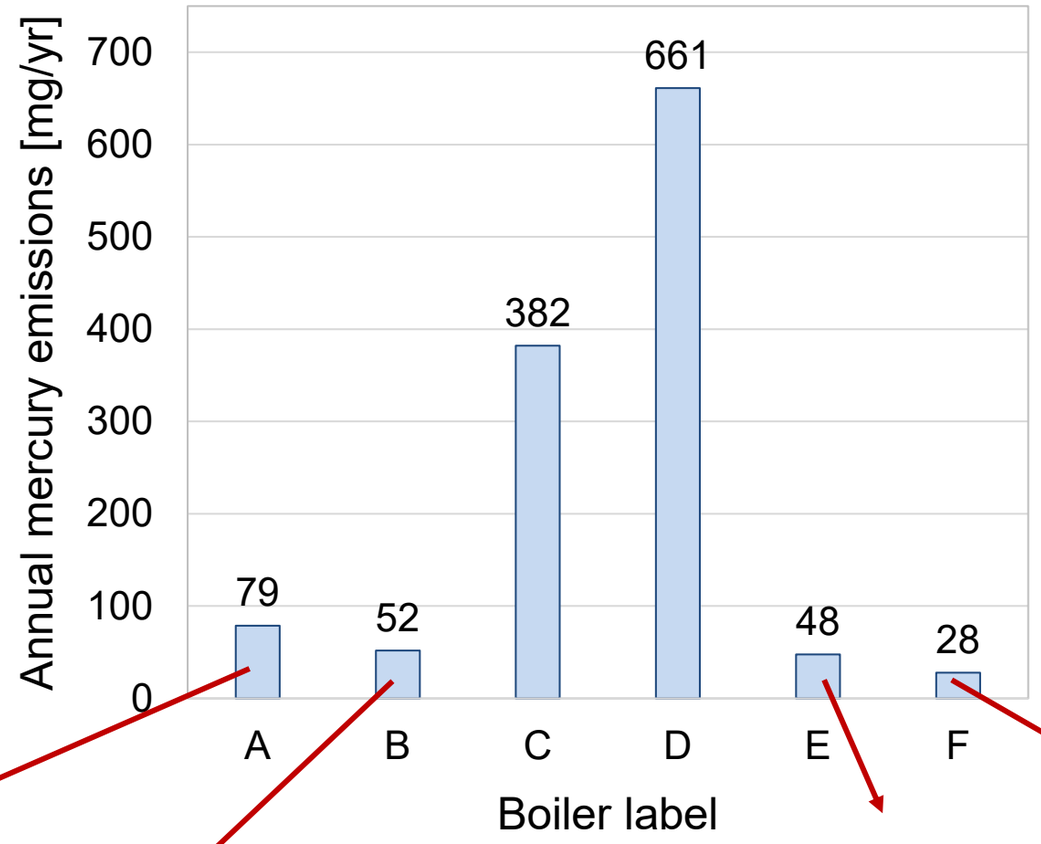


Mercury distribution among the solid combustion by-products

Boiler label	Share of mercury [%]				
	Ash	Heater deposits	Breeching deposits	Soot	Emission
A	1.4	0.1	0.1	**57.0**	**41.4**
B	1.3	n/a	n/a	3.0	**95.7**
C	1.5	2.5	0.02	5.0	**91.0**
D	1.4	0.3	0.3	5.4	**92.6**
E	9.9	0.4	0.01	**26.3**	**63.4**
F	0.1	n/a	n/a	0.7	**99.2**



Annual mercury emissions from investigated boilers



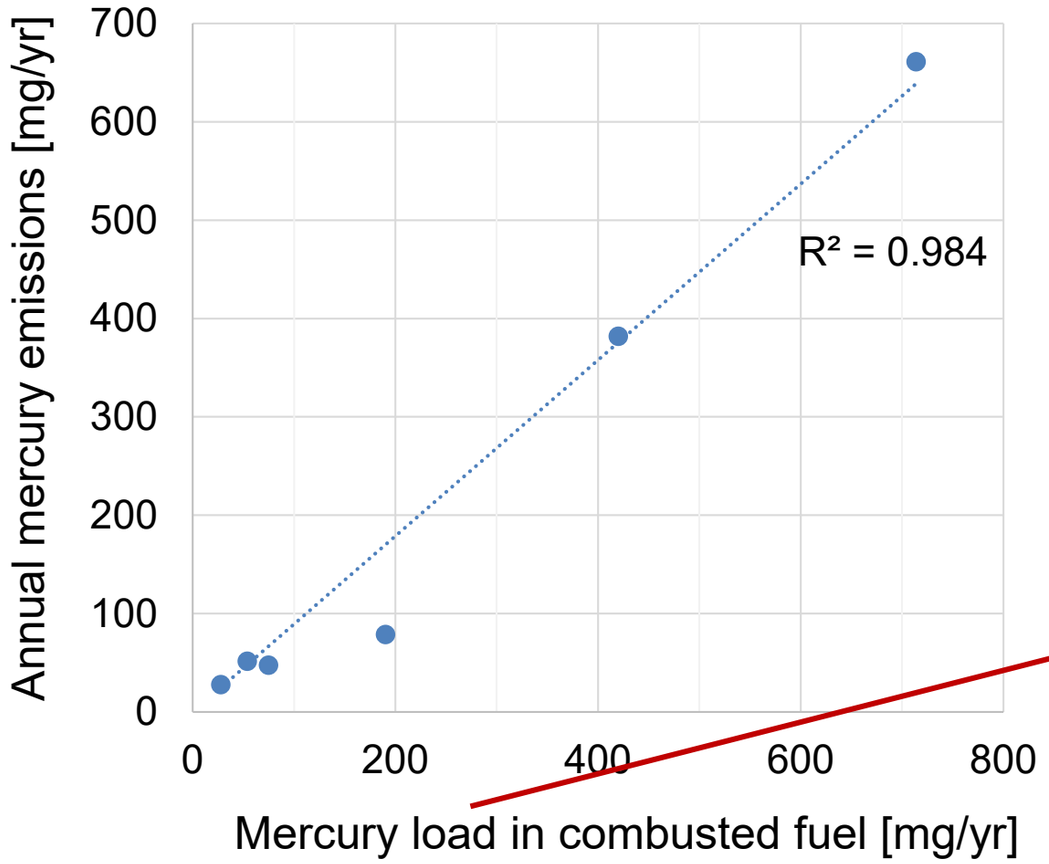
High amount of mercury adsorbed by soot
57%

Low fuel consumption
2 Mg/yr

Low mercury content in eco-pea coal
15 µg/kg

Low mercury content in wood pellets
7 µg/kg

Factors affecting mercury emissions from residential solid fuel boilers



Mercury content in fuel * **Fuel consumption**

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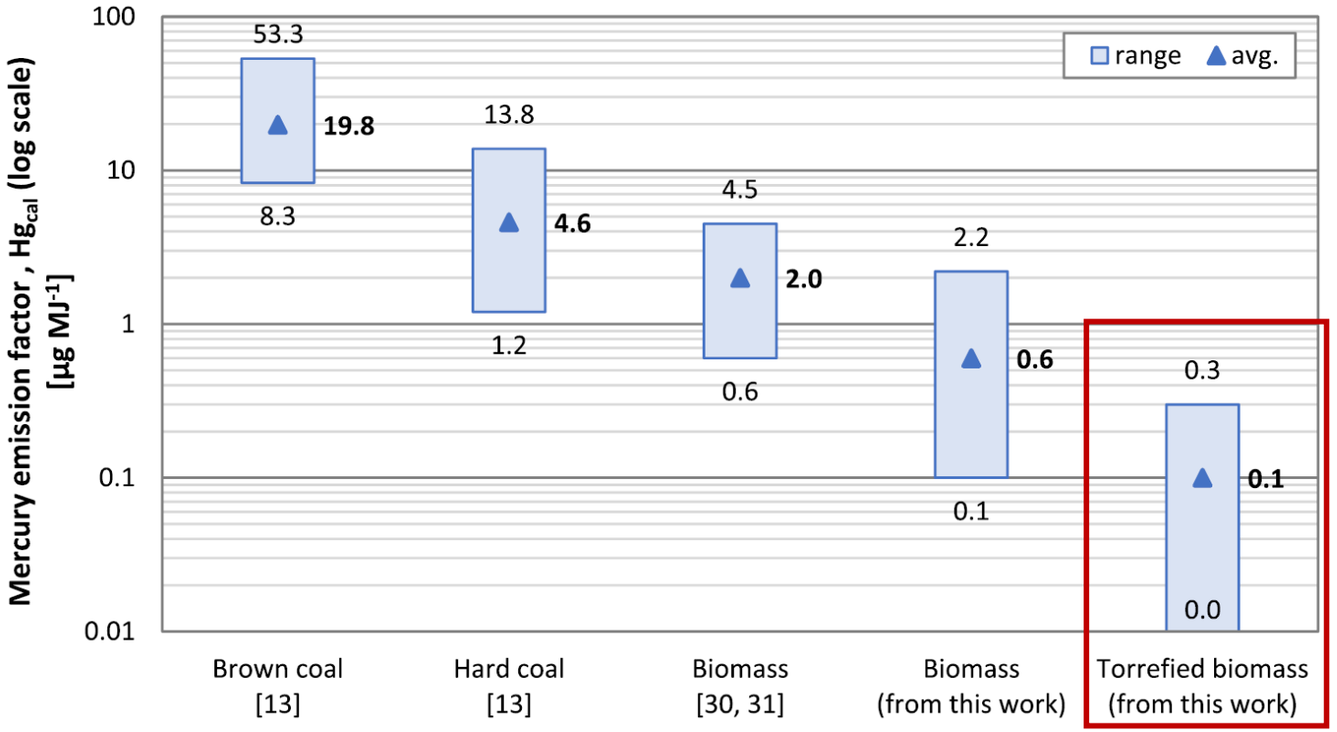
Conclusions

- The only effective method to reduce mercury emissions from residential boilers is to **use fuels with the lowest possible mercury content**.
- The use of **torrefied biomass** will successfully reduce mercury emissions from the residential sector.



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THANK YOU

ANY QUESTIONS?

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Factors affecting mercury emissions from residential solid fuel boilers

Mercury adsorbed by soot