Policy Brief

Ecodesign regulations on residential solid fuel heating:

Applying best available technologies will reduce emissions of black carbon (soot) and other key pollutants to the benefit of public health and the climate

Summary

In the EU, residential burning with wood and coal is the main source of many health and climate damaging pollutants such as black carbon, fine particulate matter and ultrafine particles. Emissions from new stoves and boilers are covered by Ecodesign regulations that will be revised in 2025/2026. The current emission requirements for these appliances are very weak compared to other sectors. Besides, the regulations lack provisions for black carbon and ultrafine particles as well as for preventing indoor air pollution from stoves. There is a huge potential to reduce emissions by applying best available technologies (BAT): precipitators (filters), automated combustion controls and catalytic converters must become standard equipment. Hence, the European Commission and national authorities are advised to include much stricter emission limit values in the revised Ecodesign regulations to the benefit of society.

Pollution from residential burning

More than 80 million EU households use solid fuel for heating or just to create a cozy atmosphere.[1] However, residential burning of wood and coal in small stoves and boilers is the predominant source of health hazardous and climate damaging pollutants in the EU: These appliances are responsible for 62% of fine particulate matter ($PM_{2.5}$), 36% of black carbon (soot), and 91% of benzo(a)pyrene.[2] Particles emitted from stoves and boilers are usually very small in size. Black carbon (BC) is a component of particulate matter. Black carbon from wood burning is as toxic as the black carbon emitted from diesel cars.[3]

Figure 1: Pollution from residential burning is especially an issue in areas with single-family houses.

The consequences are dramatic: 259,000 deaths in the EU in 2022 were caused solely by air pollution from fine particulate matter exceeding the WHO guideline level.[4] In addition, newer studies suggest that stoves can pollute the indoor environment to substantially higher particle levels than those measured close to polluted streets during rush hours.[5] The smoke from residential burning is composed of the same harmful pollutants (particles and PAHs) as tobacco smoke, which increase the risk of cancer, blood clots, cardiovascular diseases, asthma, bronchitis, COPD and other illnesses.[6] Hence, residential burning contributes significantly to morbidity and premature mortality in the EU, being an expensive burden to society and making many families and children sick.

Shortcomings of current regulations

The Ecodesign regulations for stoves ((EU) 2015/1185) and for solid fuel boilers ((EU) 2015/1189)[7] contain two

major shortcomings: insufficient requirements for health-damaging pollutants and conditions for emission testing that are far from real-life.

Due to the weak limit values for particulate matter, solid fuel appliances have much higher emissions per energy fuel unit than other sources (see figure 2). As a result, emission reduction technologies like precipitators (filters) and catalytic converters are currently not required for stoves and boilers, while having been standard for vehicles for many years.

Moreover, particulate emissions from stoves and boilers are only measured as total particle mass. This means that size and composition are not considered: the current regulations do not include measurement and emission limits for ultrafine particles and black carbon. Thus, emission testing is not aligned with the pollutants considered by the revised Ambient Air Quality Directive.[8]

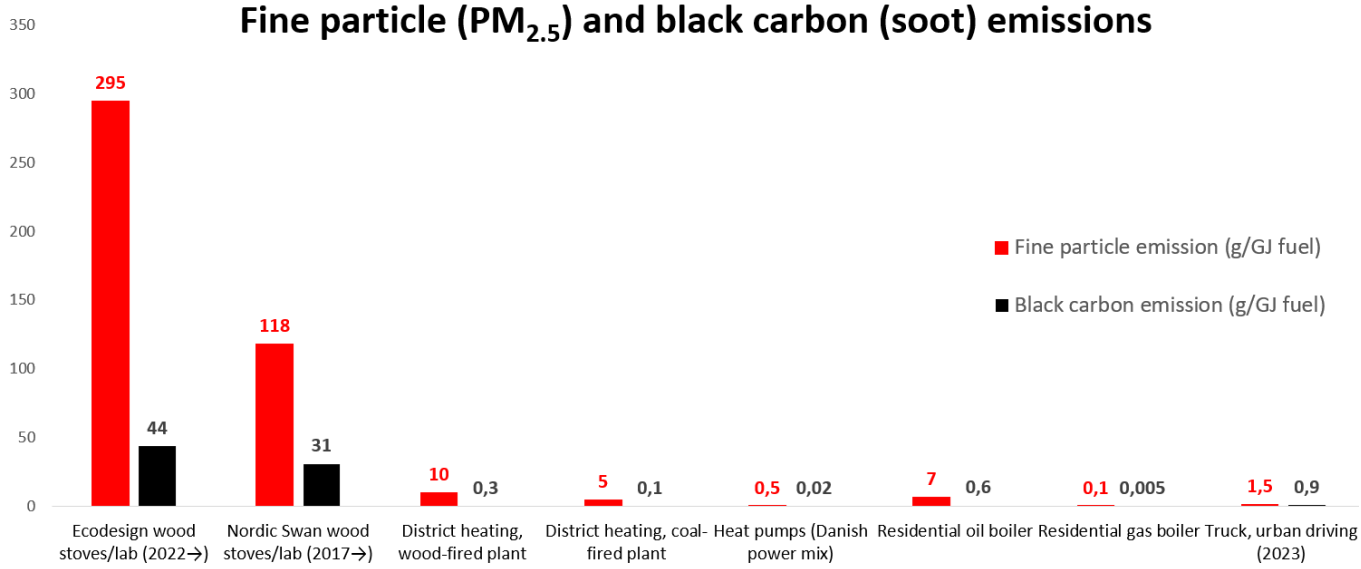
Requirements for reducing black carbon would be particularly important for stoves. Emission factors published by the European Environmental Agency suggest that up to 55% of fine particulate matter from newer logwood stoves consist of black carbon.[9] Latest research also indicates that pellet stoves can produce substantial amounts of black carbon.[10] Furthermore, black carbon's global warming potential per kg for the 20-year period (GWP_{20}) is – on average – about 3,200 times higher than for CO_2.[11] Thus, burning wood in stoves has a double adverse effect on climate change: By releasing the CO_2 that is bound in the wood immediately and by formation of black carbon.[12]

Current testing conditions for stoves are far from real life stove use for several reasons.[13] The test cycle does not cover all relevant burning phases (e.g. ignition). There is no continuous measurement of emissions and cycles or batches with higher emissions can be excluded. High fuel load or partial load as typical user errors are not considered. The fuel used in laboratory testing is also not the fuel that is commonly used in homes. Tightness of a stove which also affects indoor pollution is not tested. Besides, condensed particles which are formed during cooling of the exhaust after leaving the chimney, are not included in the single European particulate matter testing standard foreseen in the revised regulations. Although, condensed particles make up most of the toxic particle emissions.

Key facts

1. Residential burning is the biggest emission source of fine particulate matter ($PM_{2.5}$), black carbon (BC) and benzo(a)pyrene in the EU.
2. 259,000 deaths in the EU in 2022 were caused solely by air pollution from fine particulate matter exceeding the WHO guideline level.
3. Stoves in the EU are currently allowed to emit more than 100 times the particle pollution of a ten-year old diesel truck meeting the EURO VI standard (per fuel energy use).
4. Up to 55% of fine particulate matter emitted from newer logwood stoves consist of black carbon.
5. Black carbon from wood burning is as toxic as the black carbon emitted from diesel cars.
6. Black carbon emissions from logwood and pellet stoves have a substantial negative impact on climate and health.

Figure 2: Comparison of fine particle and black carbon emissions from stoves, other heat sources and a truck.[14]



Best available technologies and costs

Optimizing the burning process and use of technology for exhaust gas cleaning as done in other sectors are key to reduce emissions of residential burning. Based on comprehensive studies, the Technical University of Aachen (Germany) clearly states that catalytic converters and electrostatic precipitators are *"effective and, above all, commercially available reduction technologies*".[15] Electrostatic precipitators can mitigate the number of particles emitted by stoves and boilers by more than 90% (see figure 3).[16] In addition, automated combustion air controls can significantly reduce operating errors with stoves.

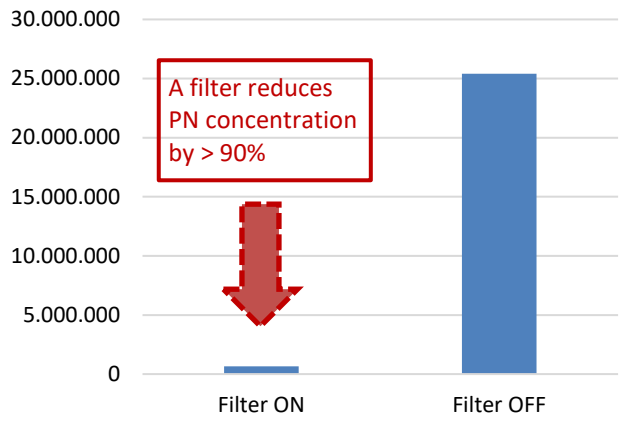


Figure 3: Particle number reduction of stove with precipitator (filter), unit: particle number (PN) per cm^3.

These technologies are already used in stoves with the German Blue Angel eco-label as well as in biomass boilers meeting the requirements of the German national funding scheme for central heating systems. While being quite costly at the moment for smaller appliances like stoves, a substantial price reduction is expected for precipitators and catalytic converters when produced in larger quantities.[17] Furthermore, potential negative effects of higher costs due to stricter Ecodesign requirements on individuals affected by energy poverty can be mitigated by (i) hardship provisions, (ii) targeted funding of clean heating technologies like heat pumps as well as (iii) supply of inexpensive and green district heating in EU Member States. Lastly, expected savings from public health spending can be diverted for these investments.

Key policy recommendations

In general, the best solution is to move away from the use of solid biomass for residential heating. The draft of the revised Ecodesign regulations has been published in January 2025.[18] In the further Ecodesign revision process, the following key recommendations should be implemented:[19]

1. **Stricter provisions for particle mass and introduction of a limit value for particle number:** Limit values for particle mass should be aligned with BAT (i.e. Blue Angel eco-label). In addition, a strict limit value for particle number (PN) needs to ensure a reduction of ultrafine particles by more than 90%, so that precipitators become standard equipment. This would also reduce black carbon.
2. **Consider other harmful pollutants:** Introduce limit values for black carbon (soot), benzo(a)pyrene, and dioxins. As foreseen: Tighten limit values for organic gaseous compounds (OGC) and carbon monoxide (CO), so that technologies like catalytic converters will be mandatory for stoves.
3. **Bring test conditions for stoves closer to real-life:** As proposed, all burning cycles need to be included in testing (i.e. also: ignition). In addition: Measurement should be conducted with different loads, including overloading. Condensed particles need to be measured. Tightness of stoves must be checked to avoid indoor pollution.
4. **Make automated combustion control obligatory for stoves (as foreseen).**
5. **Make provisions for recurring on-site controls** to ensure that emission limits are met under real-life conditions.
6. **Bring emission requirements close to those of trucks in the long run:** From 2035, solid fuel appliances must fulfil the comparable emission limits per fuel energy unit as EURO VI trucks.
7. **Ban all new coal or coke fired appliances in European market.**

The revision of the Ecodesign regulations for stoves and boilers represents a key opportunity to cut emissions from EU's main air pollution source. This will improve public health, mitigate near-term climate change and help prevent irreversible melting of the Arctic ice due to deposition of black carbon. It also supports policy goals in the UNECE Gothenburg Protocol, WHO air quality guidelines and EU legislation (including National Emission Reduction Commitments Directive, Ambient Air Quality Directive and the overarching Zero Pollution Ambition).

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