bericht
report

BEST Bioenergy and Sustainable Technologies

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Factsheet Particulate Matter Emissions - Update 2025

Current data and outlook for 2050

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1 Introduction and approach

Biomass combustion systems make a decisive contribution to achieving the goals of Austria's climate strategy. However, small-scale biomass combustion emits air pollutants, in particular particulate matter, which impair air quality. This factsheet analyzes the Austrian Air Pollutant Inventory (Austria's Informative Inventory Report) and highlights the particulate matter emissions from small-scale biomass combustion plants in residential and commercial buildings and public facilities.

This factsheet presents the current and future status (until 2050) of particulate matter emissions in Austria based on literature data and summarizes the current state of knowledge on emissions from small-scale biomass furnaces.

The original fact sheet dates from 2019 [1]. In this 2025 update, the emission values have been updated and adjusted to the current calculation of the Austrian Air Pollutant Inventory.

2 Summary

Biomass is the most important renewable energy source in any climate-neutral energy supply scenario, although its thermal use in small-scale plants is criticized due to the emissions associated with it. Biomass heating systems account for a total of 19.0% of Austria's particulate matter emissions.

According to the Austrian Air Pollutant Inventory [2], small combustion plants used to generate space heating in residential, commercial, and public buildings are responsible for 19.8% of particulate matter emissions with a particle diameter of less than 10 µm (PM_{10}). Multi-fuel burners and natural draft boilers, outdated designs of logwood boilers, cause more than 50% of emissions from small combustion plants. In contrast, modern automatic boilers account for only 2.6% of particulate emissions, while stoves and cookers account for 3.5%.

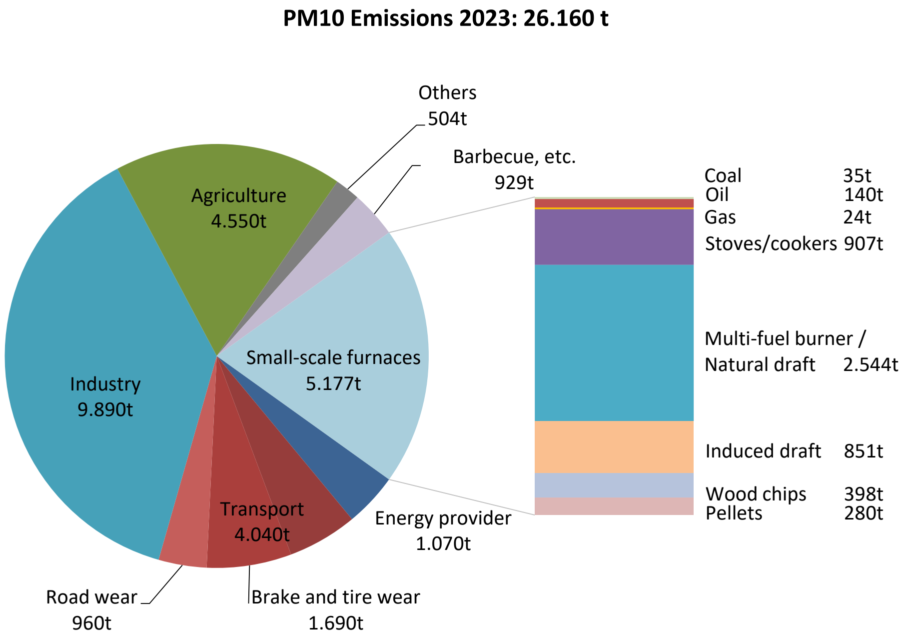

Figure 1: Source allocation of particulate matter emissions in Austria in 2023

This factsheet shows that the use of state-of-the-art equipment and its proper operation will significantly reduce particulate matter emissions from boilers and furnaces over the next few years. Biomass will therefore play an important role in future energy supply in an environmentally friendly way.

Based on current calculations by the Environment Agency Austria and the 2050 Heat Transition scenario of the EEG TU Wien [3] (with a significantly increased share of automatic biomass boilers and lower energy consumption for space heating due to efficiency improvements and building insulation), particulate matter emissions from small-scale combustion can be reduced by 90% despite the phase-out of fossil fuel heating systems, with additional reductions expected due to continuous technological progress, as the top products from Austrian biomass boiler manufacturers already emit only a fraction of the particulate matter emissions on which the calculations are based.

The most important aspect of reducing particulate matter is replacing outdated combustion systems with low-emission, modern automatic combustion systems with electronic combustion control.

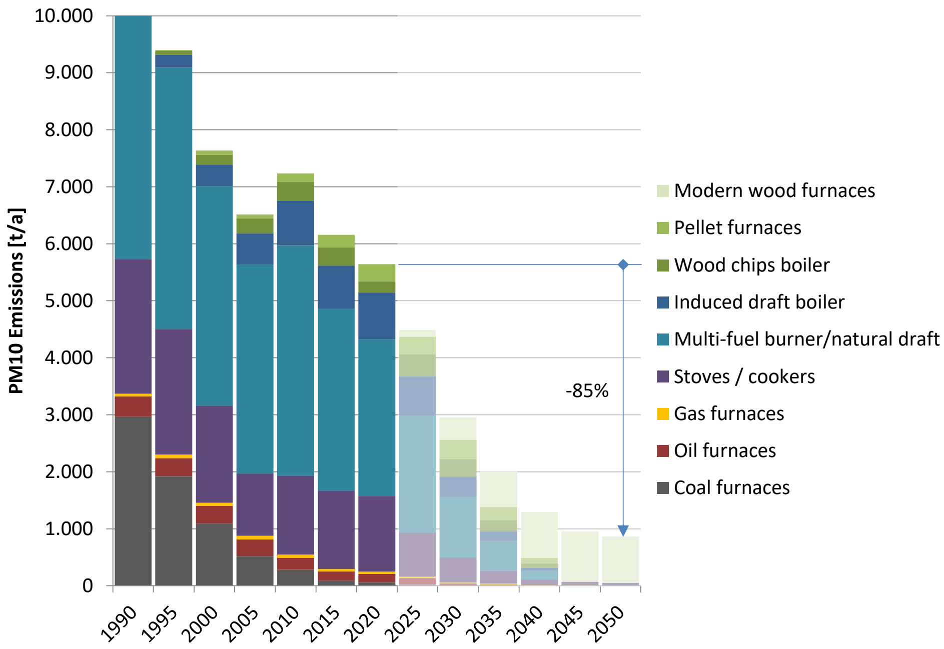

Figure 2: Reduction potential of particulate matter emissions in the 2050 heat transition scenario

In plant operation, it is important that manually fed logwood stoves and boilers are heated optimally, as the quantity and type of wood, as well as correct lighting and refueling, also have a significant impact on particulate emissions [4], [5]. Field trials have shown that emissions can be reduced by more than 50% through correct ignition and refueling of stoves.

Particulate matter particles from properly operated automated biomass boilers and furnaces are mainly inorganic in nature and exhibit significant cytotoxicity, whereas combustion residues from improperly operated plants are considerably more harmful [6]. Training courses on proper plant operation are an essential lever for reducing particulate matter emissions.

3 Calculations and results

3.1 Particulate matter emissions in 2023

In the Austrian Air Pollutant Inventory 2025 [2], emission quantities are calculated based on energy consumption in the sectors [7], the distribution of technologies, and their associated emission factors. The Informative Inventory Report contains all the information used for the calculation, but not the detailed results of the calculation. This factsheet presents detailed information on particulate matter emissions from stationary sources in NFR (Nomenclature for Reporting) sectors *1.A.4.b.1 Residential* and *1.A.4.a.1 Commercial/Institutional*, with a focus on small-scale biomass combustion, and analyzes the technological differences.

Particulate matter consists of small particles or droplets that can be inhaled by humans. Fine and ultrafine particles are particularly significant because, when inhaled, they are not trapped in the throat or bronchi but penetrate into the alveoli, where they can damage health.

Depending on the size of the particle, or more precisely its aerodynamic diameter, total suspended particulates (TSP) are divided into the following classes:

- TSP Total Suspended Particles
- PM_{10} Particles smaller than 10 µm (inhalable particulate matter)
- $PM_{2.5}$ Particles smaller than 2.5 µm (respirable particulate matter)

According to the Austrian Air Pollutant Inventory [2], biomass combustion accounts for 94% of TSP in the form of PM_{10} and 90% of TSP in the form of $PM_{2.5}$.

Small-scale biomass furnaces used to generate space heating in residential and commercial buildings as well as in public facilities will emit 4,978 tons of PM_{10} particulate matter in 2023, accounting for 19.0% of Austria's total particulate matter emissions. This is a significant improvement compared to the particulate matter emissions reported for this sector in the Austrian Air Pollutant Inventory 2019 [8]. In 2017, biomass combustion systems emitted 6,956 tons of PM_{10}, which was 24.9% of Austria's total particulate matter emissions.

In 2023, 3,448,866 tons of firewood, 871,561 tons of pellets, and 635,328 tons of wood chips were used for heat generation in small-scale biomass combustion plants in Austria. This makes biogenic fuels the most important primary energy source for space heating in residential and commercial buildings in Austria, accounting for a total share of 27.2% in 2023. In 2023, firewood was the fuel most commonly used for heating in residential buildings in Austria.

Primary energy source	Energy quantity [TJ]	Share of heat energy [%]
Natural gas	63,387	24.1%
District heating	58,242	22.2%
Logwood	49,357	18.8%
Electrical energy	35,458	13.5%
Gas oil for heating	32,364	12.3%
Pellets	15,064	5.7%
Wood chips	7,215	2.7%
Liquefied gas	1,170	0.4%
Coal and coke	309	0.1%

Table 1: Distribution of primary energy sources for building heating

Source: Austria's Informative Inventory Report (IIR) 2025 [2]

Particulate matter emissions from biomass furnaces consist of soot and tar from incomplete combustion, as well as ash and mineral salts that are carried out with the exhaust gas stream from the combustion plant. While the former only occur during the start-up and burn-out phases in modern combustion systems thanks to controlled, sensor-regulated combustion, it is much more complicated to reduce the particulate matter emissions caused by minerals. These emissions correlate strongly with the mineral salt content of the fuel, which is why pellet combustion systems have lower particulate matter emissions, as they are produced from sawdust without mineral-rich bark. To reduce these emissions, secondary dust separators such as electrostatic precipitators have become increasingly widespread in recent years, and biomass boiler manufacturers are continuously developing new combustion technologies to further reduce particulate matter emissions.

Emissions factors (IEF, implied emission factor) are used to calculate particulate matter emissions based on fuel consumption. These are available for various combustion technologies and indicate typical particulate matter emissions in real-world operation.

Although boiler and furnace testing now considers all operating conditions of the combustion system, actual boiler operation in residential and commercial buildings as well as in public facilities generally causes higher particulate emissions than on the test bench. This is usually due to poor boiler maintenance and the use of fuels that are too moist or of inferior quality. In particular, boilers without electronic combustion control can experience a sharp increase in emissions of unburned organic compounds if the boiler is not operated correctly.

These emission factors are expressed in kilograms per terajoule (kg/TJ) (=10^{12} joules), whereby one terajoule corresponds to the calorific value of approx. 65 tons of logwood or 55 tons of wood pellets and thus to the heating energy requirements of approx. 15 households.

The emission factors used come from various sources. Many of the emission factors used in the air pollutant inventory are taken from the EMEP/EEA air pollutant emission inventory guidebook

[9], i.e. they are based on pan-European average technology, which does not correspond to the Austrian level of small-scale biomass furnaces. In addition, most of the emission factors in the guidebook were derived from old measurements, as there has been little scientific work on this topic in the last 10 years.

In Austria, the last major study on actual emissions from solid fuel boilers was conducted in 1998. The implied emission factor (IEF) of 148 kg TSP/TJ determined at that time by Spitzer [10] is still used for wood stoves and cooking stoves, both conventional and advanced designs.

The emission calculations in the current Austria's Informative Inventory Report [2] are based on the emission factors listed in Table 2.

Furnace type	Combustion type	IEF for TSP [kg/TJ]
Stoves	Convent. wood-burning stoves/cookers	148
	Adv. wood-burning stoves/cookers	148
	Brick and tile stoves	100
Logwood boilers	Conventional multi-fuel burners	125
	Advanced multi-fuel burners	100
	Logwood boilers with natural draft	85
	Logwood boilers with induced draft	50
Wood chip boilers	Wood chip boilers with conventional technology	100
	Wood chip boilers with lambda probe	55
Pellet burners	Pellet stoves	30
	Pellet boilers	20

Table 2: Emission factors for different biomass combustion technologies

Source: Austria's Informative Inventory Report (IIR) 2025 [2]

The emission factors for PM_{10} are 94% of TSP, while those for $PM_{2.5}$ are 90% of these values.

It is important to distinguish between different boiler technologies, as obsolete technologies produce much higher emissions. As shown in the evaluation of the type test results in Figure 3, particulate emissions from biomass boilers have fallen significantly thanks to continuous further development.

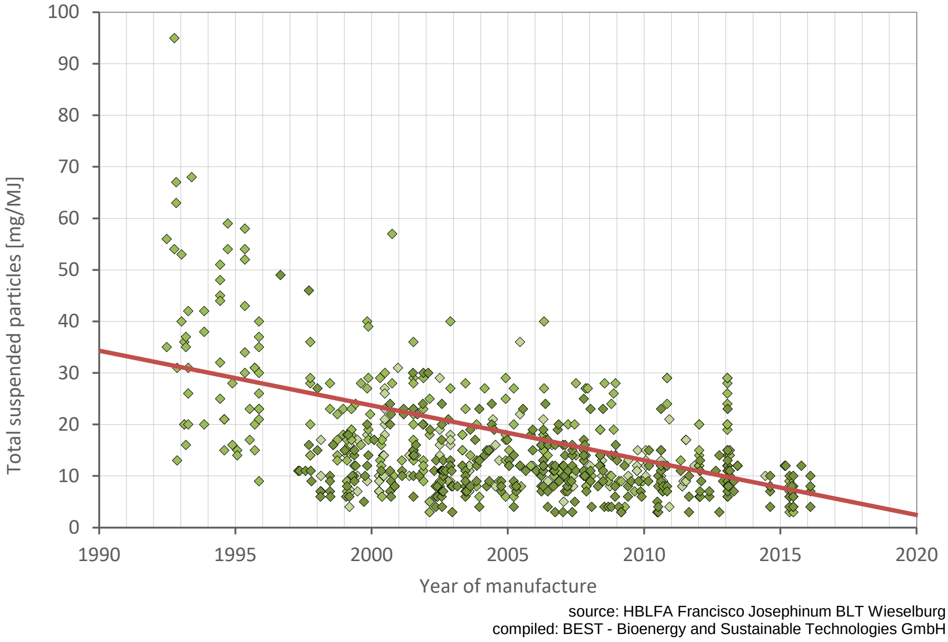

Figure 3: Particulate matter emissions determined during type testing of biomass boilers

In addition, the emission levels of organic compounds are much higher in combustion systems without combustion control. These substances are considered precursors to particulate matter; they are oxidized in the atmosphere to form anthropogenic secondary aerosols (SOA) and also contribute to particulate matter emissions.

Therefore, according to the new IEF definition, the condensable fraction of organic hydrocarbons should also be considered in the emission factors. Nussbaumer [11] has already shown that the sum of particulate matter and hydrocarbons is greater than that of particulate matter and condensates, i.e., the IEF particulate matter should be smaller than the sum of TSP and OGC emissions.

To calculate particulate matter emissions based on emission factors, the energy quantities recorded by Statistics Austria for the space heating sector [7] must be broken down according to the different combustion technologies.

Table 3 shows the data combined in the air pollutant inventory for sectors 1.A.4.b.1 Residential buildings and 1.A.4.a.1 Commercial/Institutions.

Fuel	Combustion type	Share [%]
Logwood	Conventional wood stoves/cookers	5.9
	Advanced wood stoves/cookers	2.8
	Brick and tile stoves	6.7
	Conventional multi-fuel burners	32.9
	Advanced multi-fuel burners	5.9
	Logwood boilers with natural draft	9.1
	Logwood boilers with induced draft	36.7
Wood chips	Wood chip boilers with conventional technology	8.3
	Wood chip boilers with lambda probe	91.7
Pellets	Pellet stoves	6.8
	Pellet boilers	93.2

Table 3: Share of fuel consumption of the different biomass combustion technologies
Source: Austria's Informative Inventory Report (IIR) 2025 [2]

This classification is very important, as the different types have very different IEF values. There are no statistics available in Austria on the distribution of boiler and furnace technologies; as a first approximation, this can only be estimated based on the age of the combustion plants.

Unfortunately, there are no exact statistics on the age distribution of biomass boilers in Austria. The heating system databases of the federal states only record boiler systems and only their fuel type, not the type of system. Furthermore, the coverage rate is not high; in Lower Austria, for example, it is around 40%.

Another source for boiler distribution is the biomass heating survey conducted by the Lower Austrian Chamber of Agriculture [12], which records the sales figures of many boiler manufacturers and importers. These statistics show that boiler distribution in Lower Austria is similar to that in Austria as a whole.

A comparison of the two data sources reveals an identical age distribution for biomass boilers between 5 and 20 years old. For older boilers, the heating survey [12] provides values that are too high, as many boilers are no longer in operation. For new systems, there is an overrepresentation in the analog database [13], as new systems are increasingly being entered into it.

Based on the distribution according to the Lower Austrian biomass database combined with the estimate of new biomass heating systems (0–5 years) according to the sales figures in the 2024 biomass heating survey, the distribution shown in Figure 4 is obtained.

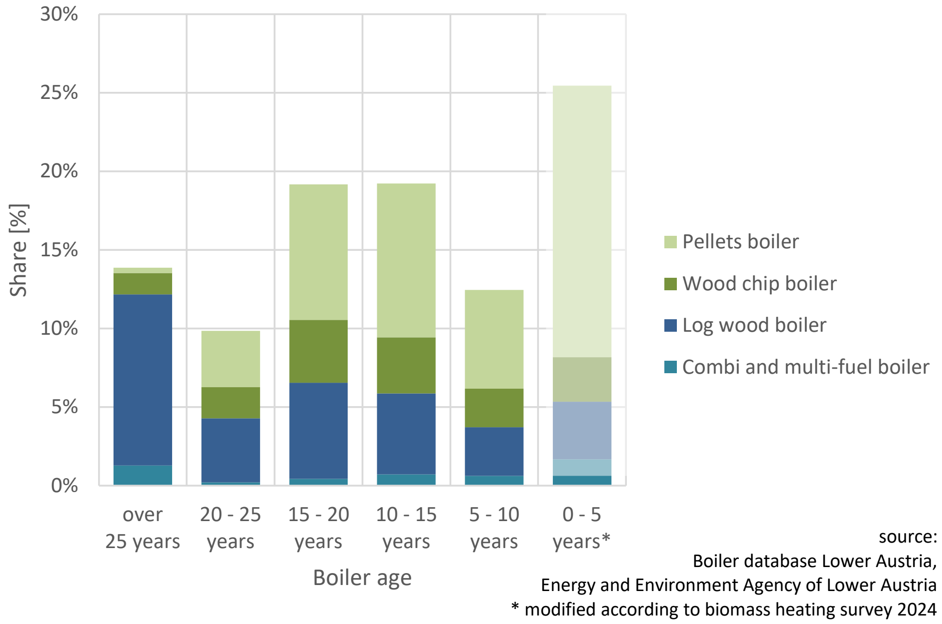

Figure 4: Age distribution of biomass boilers recorded in the Lower Austrian plant database, proportion of new boilers corrected based on the heating survey.

Source: Data from Lower Austria plant database [13] and biomass heating survey 2024 [12]

When comparing the age distribution shown in Figure 4 with the data on the distribution of wood fuel use in the various technologies (Table 4), it can be seen that the group of wood boilers with induced draft fans roughly corresponds to those boilers that have been installed since the introduction of strict emission guidelines for biomass boilers in 2008.

Furnace type	Combustion type	Share [%]
Logwood boilers	Conventional multi-fuel burners	38.9
	Advanced multi-fuel burners	7.1
	Logwood boilers with natural draft	10.7
	Logwood boilers with induced draft	43.3

Table 4: Share of fuel consumption of the different log wood boiler technologies

Source: Austria's Informative Inventory Report (IIR) 2025 [2]

Another interesting feature of Figure 4 is the sharp increase in multi-fuel boilers in recent years. However, these are not, as in the past, solid fuel boilers suitable for both coal and wood, but modern combination boilers which, in addition to biomass combustion for pellets, also have a separate logwood boiler or heat pump; only the heating control system is shared, otherwise they are two separate heat generators that can convert the fuel with maximum efficiency and minimum emissions.

By combining combustion distribution and fuel use, the biomass use can be calculated for each of the boiler types defined by the emission factors. This is shown in Table 5.

Furnace type	Combustion type	Energy Log wood [TJ]	Energy Wood chips [TJ]	Energy Pellets [TJ]
Stoves	Conventional wood stoves/cookers	2,900		
	Advanced wood stoves/cookers	1,390		
	Brick and tile stoves	3,298		
Logwood boilers	Conventional multi-fuel burners	16,248		
	Advanced multi-fuel burners	2,935		
	Logwood boilers with natural draft	4,488		
	Logwood boilers with induced draft	18,098		
Wood chip boilers	Wood chip boilers with conventional technology		599	
	Wood chip boilers with lambda probe		6,616	
Pellet burners	Pellet stoves			1,027
	Pellet boilers			14,037
Total	Small scale biomass furnaces	49,357	7,215	15,064

Table 5: Fuel consumption of different biomass combustion technologies

Multiplying by the emission factors from Table 2 calculates the dust and particulate matter emissions for biomass combustion for heat supply in residential and commercial buildings as well as in public facilities in Austria in 2023. The values obtained are listed in detail in Table 6.

Furnace type	Combustion type	TSP [t/a]	PM_{10} [t/a]	$PM_{2.5}$ [t/a]
Stoves	Conventional wood stoves/cookers	429	403	386
	Advanced wood stoves/cookers	206	193	185
	Brick and tile stoves	330	310	297
Logwood boilers	Conventional multi-fuel burners	2,031	1,909	1,828
	Advanced multi-fuel burners	293	276	264
	Logwood boilers with natural draft	381	359	343
	Logwood boilers with induced draft	905	851	814
Wood chip boilers	Wood chip boilers with conventional technology	60	56	54
	Wood chip boilers with lambda probe	364	342	327

Furnace type	Combustion type	TSP [t/a]	PM10 [t/a]	PM2.5 [t/a]
Pellet burners	Pellet stoves	31	29	28
	Pellet boilers	267	251	240
Total	All small-scale biomass furnaces	5,297	4,979	4,766

Table 6: Particulate matter emissions (TSP, PM_{10}, and $PM_{2.5}$) from various biomass combustion technologies

When considering the particulate emissions from small-scale biomass combustion for heat generation in the context of total Austrian emissions (see Figure 5), these are responsible for 19.0% of emissions. Emissions from barbecues and traditional fires, which are also attributed to the small combustion sector in the air pollutant inventory, are shown separately in this graph in order to accurately represent their significant share of particulate matter emissions.

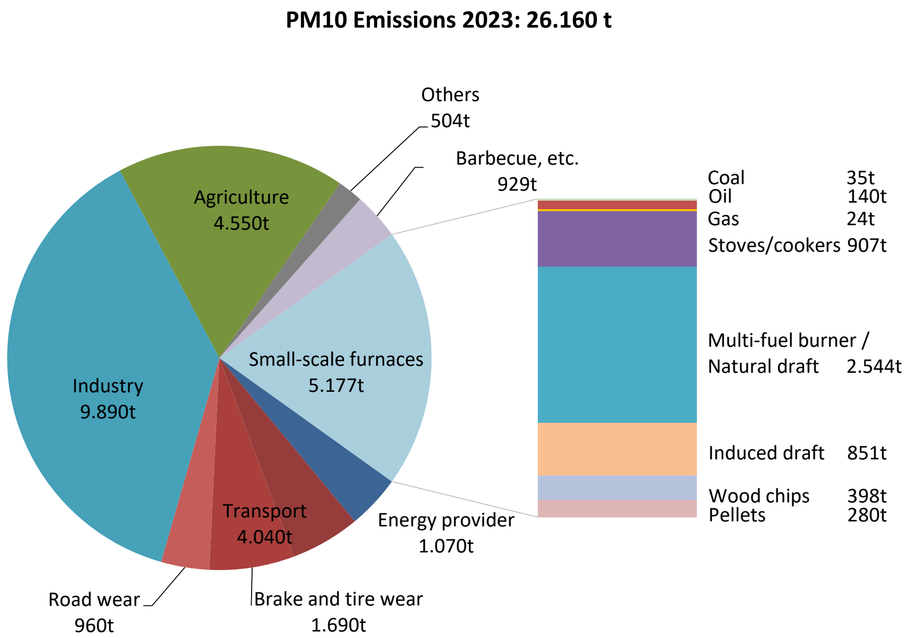

Figure 5: PM_{10} particulate matter emissions in Austria in 2023

As can be seen in Figure 5, which shows the allocation of emission quantities to the different technologies, a large proportion of particulate matter emissions come from wood-burning furnaces using old technology (multi-fuel burners/natural draft). In contrast, modern automatic furnaces that use wood chips and wood pellets as fuel account for only 2.6% of emissions.

3.2 Change in particulate matter emissions in the Heat Transition 2050 scenario

A significant contribution to achieving national climate protection goals is the reduction of energy requirements for space heating and the conversion of this sector to renewable energy sources without burdening the environment with higher emissions.

This section deals with the potential for reducing particulate emissions from small-scale biomass combustion through the continuous development of combustion plants and the predicted change in fuel use.

This fact sheet is based on a scenario developed by the Energy Economics Group (EEG) at TU Wien for the decarbonization of future energy requirements for space heating and hot water production in Austria's building stock [3]. This scenario has been adapted to reflect the significant changes in energy sources in recent years. While the total amount of decentralized biomass for heat supply for the current year was well predicted, there is a significant increase in the trend towards pellet heating (+27%), while energy supply from wood chip combustion fell short of expectations. The most significant changes were in electricity from alternative sources (electricity from water, wind, solar, geothermal), with the amount produced in 2020 already twice as high as the values forecast in this study for 2023.

Due to continuous improvements in the energy efficiency of buildings and the widespread use of heat pumps, this study predicts a further decline in household biomass fuel demand of 29% by 2050. This figure also corresponds to the average value of the WEM and WAM scenarios [14] in the model developed by the Environment Agency Austria.

The projected change in the energy sources used is shown graphically in Figure 6.

In this scenario, the proportion of logwood in biomass is reduced from 75% to 25%, while that of wood pellets, whose combustion also has much lower emission factors due to the use of a largely standardized, high-quality fuel, increases from 22% to 60%. In accordance with the calculation model used in the air pollutant inventory, the future development of particulate matter emissions can also be estimated based on the data from this forecast.

In addition, it is considered that a large proportion of existing systems will be replaced by 2050. The service life of biomass boilers is falling to 30 years due to the increasing use of electronic components, while that of furnaces is 20 years; only tiled stoves have a longer service life of 60 years.

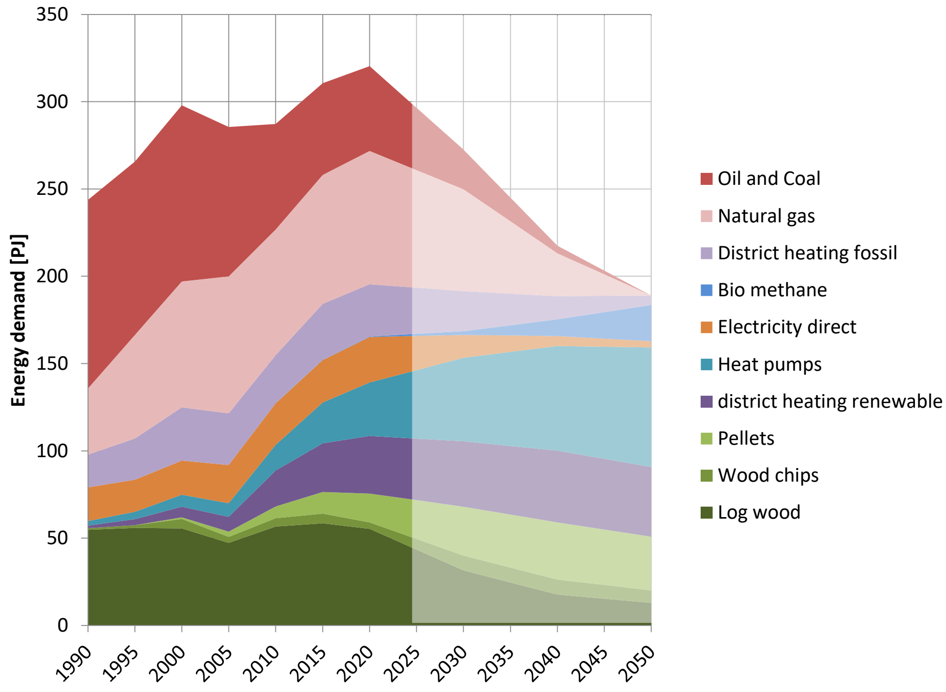

Figure 6: Forecast trend in final energy consumption for building heating and hot water production, broken down by energy source

In order to reflect technological advances in combustion plants, it is assumed that particulate emissions from new combustion plants comply with the (old) emission limits of the Austrian Ecolabel UZ37 v7.0 2021 [15], which have been in force since 2021. These limits should also be complied with by modern combustion plants in real operation, as the current UZ37 v8.0 2025 [16] guideline already has even stricter emission requirements, and because the regulations for boiler and furnace testing are becoming increasingly stringent and cover almost the entire plant operation. In addition, secondary separators are increasingly being used in modern combustion plants, which ensure effective exhaust gas cleaning even with poorer fuel qualities.

In addition to Table 2, the emission factors listed in Table 7 were therefore introduced for the forecast for modern, future installed combustion plants.

Based on the assumptions listed, the scenario anticipates a reduction in PM_{10} particulate matter emissions for NFR sectors 1.A.4.b.1 Residential buildings and 1.A.4.a.1 Commercial buildings and public facilities from 5,642 t/a in 2020 to 863 t/a in 2050.

Furnace type	Combustion type	IEF for TSP [kg/TJ]
Stoves	Modern wood stoves/cookers Modern brick and tile stoves	30 30
Logwood boilers	Modern logwood boilers	20
Wood chip boilers	Modern wood chip boilers	20
Pellet burners	Pellet stoves Pellet boilers	15 15

Table 7:Emission factors according to UZ37 v7.0 (2021) for different biomass combustion technologies

The emission factors for PM_{10} are 94% of TSP, while those for $PM_{2.5}$ are 90% of these values.

The calculation does not consider particulate emissions from barbecues and traditional fires, as these amount to 929 t/a, which is more than the predicted amount of particulate matter from all small-scale furnaces and would therefore distort the result too greatly.

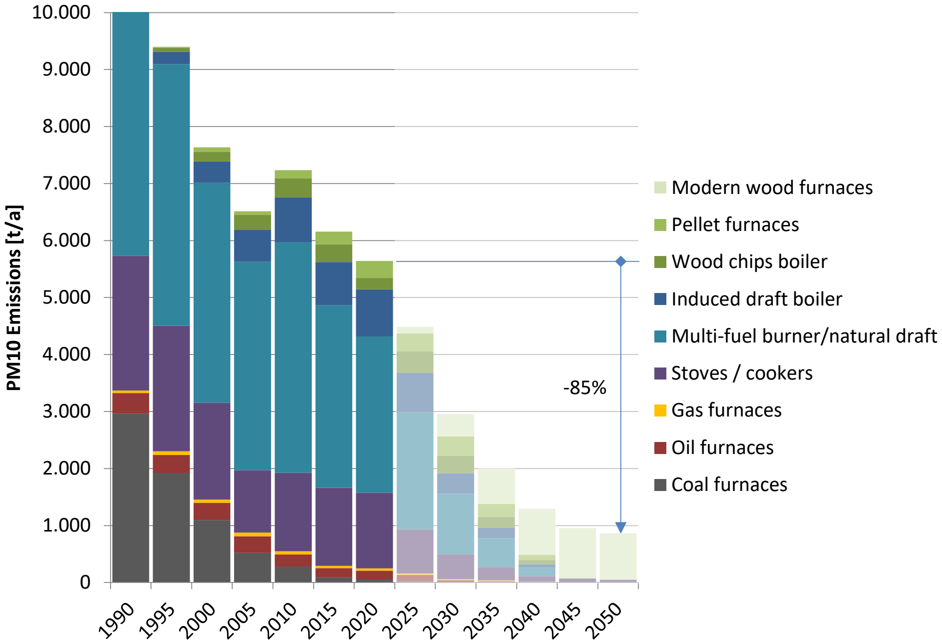

Figure 7: Reduction potential of PM_{10} particulate matter emissions in the 2050 Heat Transition scenario

Despite the significant reduction in emissions already achieved, particulate matter emissions are expected to continue to fall sharply in the coming years, as shown in Figure 7. According to the 2050 Heat Transition Scenario, the use of modern, low-emission combustion systems and the trend toward automatically fed combustion systems should reduce PM_{10} particulate matter emissions from biomass combustion by a further 85% by 2050 compared to 2020.

Immission measurements prove that particulate matter emissions in Austria are decreasing. Measuring stations in the inner Alpine region, areas where biomass combustion is widespread, show a 47% decline for the years 2005 to 2022. However, since PM_{10} emissions in the air pollutant inventory calculation only fell by 28% over the same period, the Environment Agency Austria cites the strong influence of long-range transport of air pollutants from eastern countries as the cause of the reduction in particulate matter emissions [17], [18].

3.3 Potential of modern biomass furnaces with regard to particulate matter emissions

Austria has been a pioneer in low-emission biomass combustion for many years. As early as 1994, Austria introduced strict dust emission limits of 60 milligrams per megajoule (mg/MJ) under the §15a agreement on protective measures for small combustion plants. This marked the beginning of the development of Austria's biomass boiler industry. In contrast, ÖNorm EN 303-5 standard published in 1999 still allowed total dust emissions of 200 mg/MJ for manually fed Class 1 biomass boilers in the rest of Europe. The current Austrian Ecolabel UZ37 (2025) directive [16], which has been in force since the beginning of 2025, limits dust emissions for pellets and wood chip boilers eligible for subsidies to just 7 mg/MJ. Thus, the dust emission limit - starting from already stringent regulations for its time - has been reduced by nearly **90%** over the past 30 years.

In Austria, all modern biomass combustion systems must demonstrate very low particulate emissions during type testing, when operating correctly and generally using high-quality fuel. Due to the considerable measurement effort involved, this is not tested during periodic inspections; instead, only carbon monoxide emissions are recorded as an indicator of low-emission combustion. In contrast, in Germany, where technologically equivalent biomass boilers are in use, very often by Austrian manufacturers, compliance with the particulate matter emission limits of the German 1st Ordinance for the Implementation of the Federal Immission Control Act (1. BimSchV) has been checked every two years by chimney sweeps for all biomass boilers since 2010.

As a result, most biomass combustion plants are already capable of emitting much less particulate matter than the emission factors used in the air pollutant inventory would suggest.

With regard to the quantity of PM_{10} particulate matter emissions in 2050, three additional variants were therefore examined which take this into account and whose particulate matter emissions comply with the following guidelines:

- BimschV (2010)
  All furnaces comply with the requirements of the German Ordinance on Small and Medium-Sized Furnaces of 2010.
- Directive UZ37 v8.0 (2025)
  By 2050, all furnaces will comply with the requirements of UZ37 v8.0 2025.

- BAT Best available technology (2024)
Complies with the ambitious emission standards for biomass heating systems set by the Biomass & Air Quality Platform

For this purpose, the limit values of the above regulations are used as supplementary emission factors for the various variants.

Furnace type	Combustion type	1. BimschV (2010)	UZ37 v8.0 (2025)	BAT (2024)
Stoves	Wood stoves/cookers	28	20	12
	Brick and tile stoves	30*	20	12*
Logwood boilers	Logwood boilers	14	10	6
Wood chip boilers	Wood chip boilers	14	7	4
Pellet burners	Pellet stoves	21	10	6
	Pellet boilers	14	7	3

Table 8:IEF emission factors in kg/TJ for total particulate matter (TSP) for different biomass combustion technologies in the emission variants examined

The emission factors for PM_{10} are 94% of TSP, while those for $PM_{2.5}$ are 90% of these values.

** … Limit values adopted, as no values are specified in the regulations*

If the emission factors summarized in Table 8 are now included in the calculation for the variants in accordance with the air pollutant inventory, the theoretical potential for reducing particulate matter emissions for the year 2050 can be calculated, assuming that all furnaces have been replaced with modern ones within 25 years.

Furnace type	UZ37 v7.0 (2021)	1. BimSchV (2010)	UZ37 v8.0 (2025)	BAT (2024)
Stoves, cookers, brick and tile stoves	70.5	66.4	59.1	52.5
Logwood boilers	218.0	152.6	109.0	65.4
Wood chip boilers	134.1	93.9	53.9	35.4
Pellet stoves and boilers	436.6	429.7	211.5	96.1
All biomass furnaces	859.2	742.6	433.5	249.4

Table 9: PM_{10} emissions in t/a in 2050 from different biomass combustion technologies for energy demand in accordance with the 2050 heat transition scenario [3]

The result of this calculation can be seen in Table 9. Assuming that in 25 years, all biomass combustion plants will comply on average with the particulate matter emissions currently required by the subsidy conditions of the boiler replacement renovation campaign or that are already technically feasible today, the projection for 2050 is a PM_{10} emission volume of between 859 and 249 t/a.

In the reference year of the air pollutant inventory, 1990, and thus before the use of modern biomass combustion systems with combustion control, PM_{10} particulate emissions from small combustion plants operated in Austria for space heating in residential and commercial buildings and public facilities amounted to 10,418 tons.

Compared to these values, even if the old limits of the UZ37 v7.0 (2021) [15] directive were retained, particulate matter emissions would fall by 91% by 2050. The even stricter emission limits of the current version of the UZ 37 v8.0 (2025) [16] would only bring a further reduction of 4 percentage points, and thus only a slight absolute improvement of 426 t/a. A further reduction in the limit values is likely to lead to a significant increase in system costs, which would jeopardize the competitiveness of the products, even in comparison with alternative heating systems.

A much more efficient step toward reducing emissions would be to replace old systems with modern furnaces equipped with electronic combustion control, as these old systems produce much higher particulate emissions even during normal operation. In addition, particulate emissions from these small furnaces can increase many times over due to incorrect operation or low-quality fuel.

In all scenarios considered, the emissions from small-scale combustion forecast for 2050 are below the particulate matter emissions reported for bonfires, campfires, and barbecue fires and allocated to NFR sectors 1.A.4.b.1 Residential and 1.A.4.a.1 Commercial/Institutional Fuel Combustion Activities. These types of uncontrolled combustion have been consistently assessed for years with emissions of 929 t/a of particulate matter, accounting for 3.5 percent of total Austrian PM_{10} particulate matter emissions in 2023.

	UZ37 v7.0 (2021)	**1. BimSchV (2010)**	**UZ37 v8.0 (2025)**	**BAT (2024)**
Emissions 1990 [t/a]	10,418	10,418	10,418	10,418
Emissions 2050 [t/a]	863	746	437	253
Absolute reduction [t/a]	9,555	9,672	9,981	10,165
Relative reduction [%]	92	93	96	98

Table 10: PM_{10} reduction for all small combustion plants used to generate space heating in residential, commercial, and public buildings from 1990 to 2050 at different limit values.

3.4 Health aspects

A study on the health aspects of dust from biomass combustion commissioned by IEA Bioenergy Task 32 comes to the following conclusions [11]:

It is important to distinguish between carbon-containing (organic) and inorganic pollutants, as well as primary and secondary aerosols. Organic pollutants are particularly relevant for biomass combustion in residential areas and can be avoided under near-complete combustion conditions. Particles resulting from incomplete combustion in outdated boilers or incorrectly operated manual systems exhibit high cytotoxicity, while particles from properly operated automated biomass boilers and furnaces are mainly inorganic (derived from ash components in the biomass) and have significantly lower or even undetectable cytotoxicity. In addition, inorganic particles can be effectively removed by air pollution control devices such as electrostatic precipitators or fabric filters.

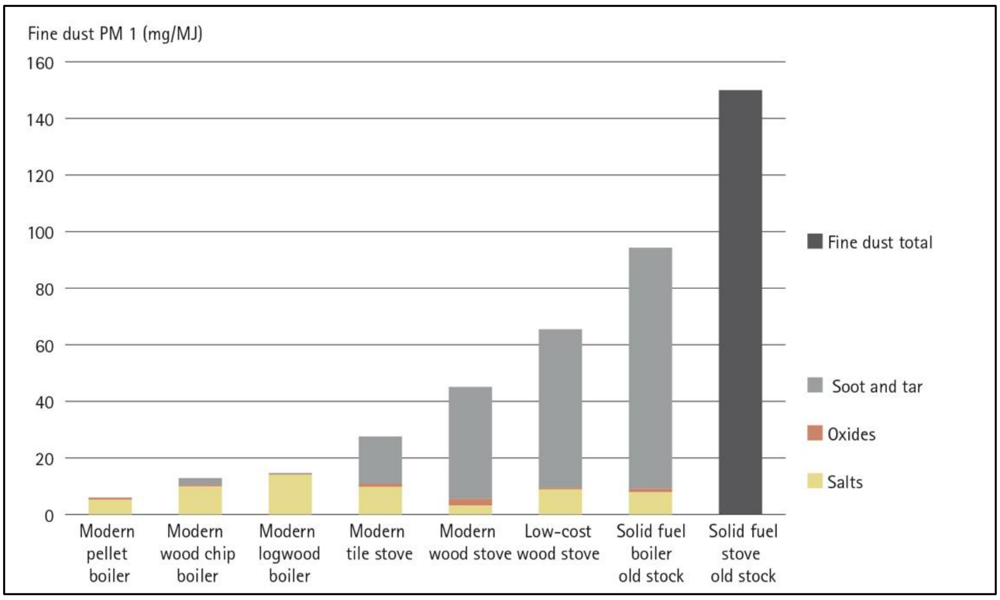

Figure 8: Comparison of ultrafine particulate matter emissions from wood-burning heating systems in load cycle measurements and their chemical composition

Explanation: Measurements from [6], emissions from existing solid fuel stoves from [19] as a comparison for scale.

Particulate matter from old, poorly regulated, or improperly operated biomass furnaces, as well as particulate matter from old oil heating systems, contains a high proportion of particles from incomplete combustion. In modern systems, the proportion of inorganic salts is over 90%. Modern systems therefore reduce both the absolute amount of particulate matter and its harmful effects. The measurements were taken in a standardized environment and show the influence of different technologies. Replacing old solid fuel boilers with new ones enables a significant reduction in particulate matter emissions and therefore has a positive impact on human health. Modern stoves and tiled stoves can also drastically reduce particulate matter emissions compared to old solid fuel stoves [6], [20].

3.5 Ovens and cooking stoves

In 2023, ovens and cooking stoves accounted for 3.5% of total particulate matter emissions, with 965 tons of PM_{10}. In the area of small-scale combustion, their share will be 17.5%.

In addition to the technology used, the user of manually fed furnaces has a significant influence on emissions. Emissions from existing systems can also be greatly reduced by lighting and refueling the furnace correctly and using the right fuel (dry, natural wood).

Incorrect or omitted adjustment of the correct air supply is the biggest source of error. Due to incomplete combustion, this can lead to an extremely high increase in particulate matter emissions, up to 6.5 times the value compared to normal operation [21].

A recent field study investigated user influence by measuring emissions before and after training. The field trial demonstrated that correct heating and reheating of furnaces can achieve a 40% reduction in particulate matter emissions; in the best case, a reduction of just over 75% was achieved [5].

4 Registers

4.1 List of tables

4.2 List of figures

5 Literature

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