

PM

EFFICIENCY

FUEL QUALITY

6

BIOENERGY EXPLAINED

**SLASHING EMISSIONS
FROM RESIDENTIAL
WOOD HEATING**



AIR POLLUTION - EU CONTEXT

The impact of air pollution on our health and environment is so important that it is considered the second biggest environmental concern after climate change. Today, EU citizens rightfully expect legislators to tackle this problem with the most efficient and rational solutions.

Air pollution is a complex problem that requires a good understanding of its cause, of the transformation and transportation of pollutants in the atmosphere over time and its impact on people and the environment.

Wood burning is CO₂ neutral and cost-effective solution for domestic heating, but it has come under scrutiny for its contribution to air pollution in winter time, due to the emissions of some pollutants into the atmosphere. While old and inefficient individual stoves and open fires are big contributors to the problem, new technologies and the use of district heating networks can today provide EU consumers with clean and efficient options that fit the needs of the clean energy era.

Biomass combustion can happen at different scales. While the basic principle is the same, technologies vary considerably depending on the size of the installation, from a wood stove commonly found in households to industrial-size boilers supplying hundreds of MW of electricity and/or heat to hundreds of thousands of citizens. This paper will focus on the most challenging part: individual appliances found in households.

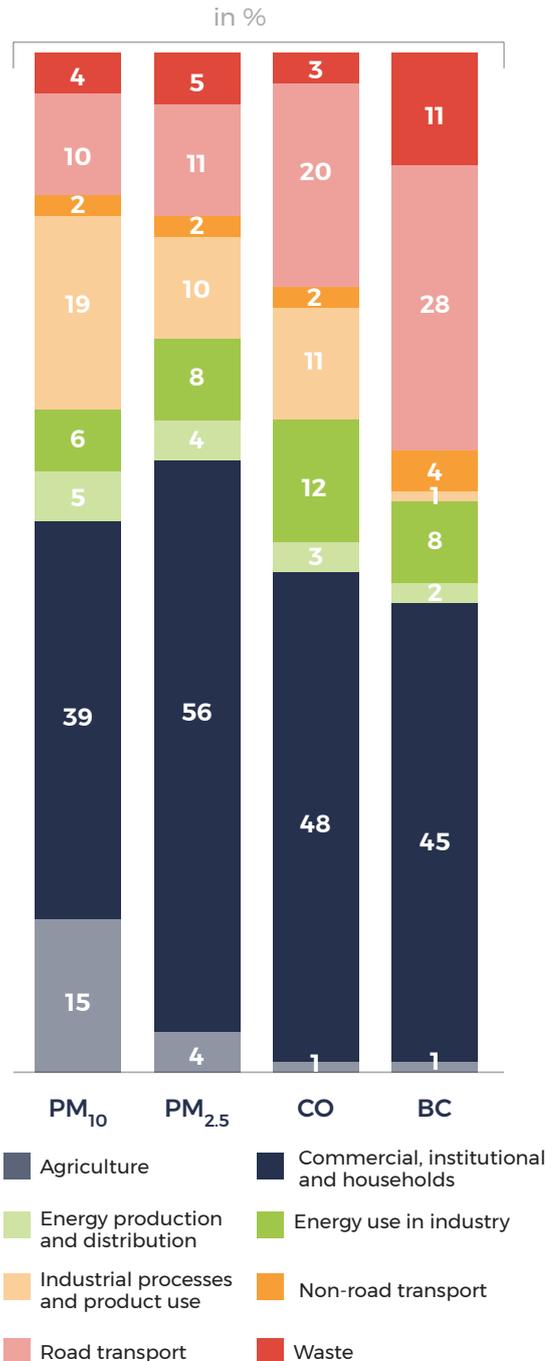


RESIDENTIAL BIOMASS HEAT

The European Environment Agency's (EEA) annual report on air quality in Europe (2018) identifies the residential heating sector (registered by EEA itself under the label "commercial, institutional and household") as the main emitter of PM₁₀, PM_{2.5}, CO and black carbon in the EU28 in 2016 (see figure 1). While the contribution of biomass to this sector cannot be precisely quantified, the EEA¹ recognises that residential solid fuel (including biomass) combustion participates significantly to PM emissions within this category.

However, it is important to draw attention on the concentration factor. While around 50% of PM_{2.5} emissions are emitted by individual heating systems, the harmfulness of air pollutants is largely dependent on their concentration within a certain area. Urban areas are the most touched

by harmful air pollution most often due to very dense road traffic. Conversely, residential wood combustion occurs mostly in rural and sparsely populated areas, with a much more dispersed concentration: policies to limit emissions should focus on urban areas, the hotspots of air pollution and therefore the biggest threat to our health.



Source: EEA Annual Report 2018

Figure 1: Contribution to EU-28 emissions from main source sectors in 2016 of primary PM₁₀, primary PM_{2.5}, CO, and BC

The contribution of residential wood combustion to PM₁₀ and PM_{2.5} concentration in winter, when our heating needs are at their highest, ranges from around 5% to 40% of the daily means² (see figure 2).

If residential biomass combustion is a large contributor to PM emissions in Europe, not all stoves are alike. Old stoves and open fires pollute much more than a modern wood appliance. Old stoves are part of the problem, new stoves are part of the solution. When compared to modern appliances, old stoves and boilers release much larger quantities of dust and other pollutants into the atmosphere while showing a low energetic efficiency (as low as 30%) due to their incomplete combustion processes.

Today's technology in contrast is able to drastically boost the efficiency of stoves (up to 95% for a pellet stove) as well as lower emissions by 95% compared to an old stove. This leaves room for an impressive potential for improvement of air pollution from the residential biomass sector, as described in the following section.

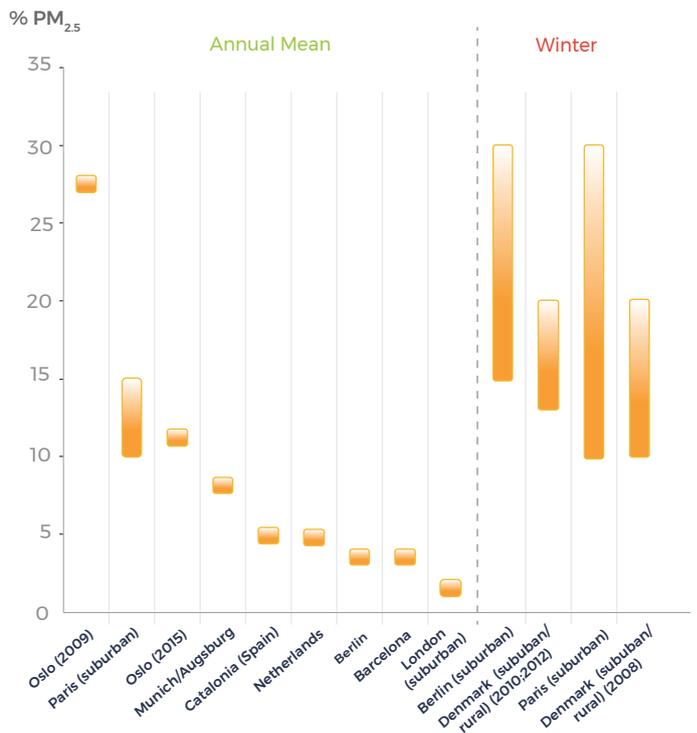


Figure 2: Importance of PM_{2.5} emissions from residential wood combustion

Source: ETC/ACM, 2016a

HOW IMPORTANT IS BIOMASS IN THE RESIDENTIAL HEATING SECTOR?

The residential sector is still heavily reliant on fossil fuels. The largest contributor of low carbon energy to this sector is by far bioenergy (solid biomass or wood products in this case), representing 15% of the energy consumption, or 43Mtoe – twice the total final energy consumption of Romania. This tells us about the paramount importance of the sector for our environment and economy.

Today, at time when a large number of European citizens rely on bioenergy to heat their homes, it is crucial to ensure they continue doing so in a clean way - a practice that also has spill over effects in terms of the employment figures in rural areas where the biomass feedstock is harvested, conditioned and sold.

The current lack of data makes it hard to draw an exact picture of the existing stock of wood appliances. Improved data collection would give a much better understanding of the kind of wood appliances in use (e.g. open fire vs sealed appliances, their respective age, and efficiency levels, etc.), which in turn could help calibrate emission reduction measures in regions of Europe where wood burning contributes the most to air pollution.

Better and more granular data could also allow policy makers to approach the matter rationally and evaluate different measures via accurate cost-benefit analyses.

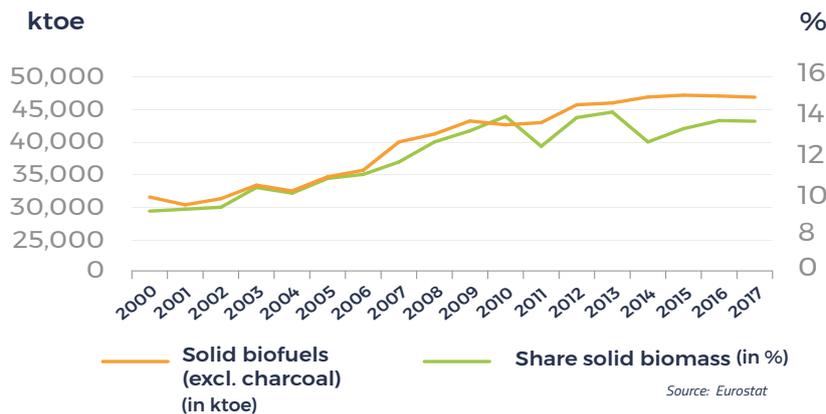


Figure 3: evolution of solid biomass consumption within the residential sector in EU28 (in ktoe & %)

Source: Eurostat



HOW TO TACKLE THE ISSUE OF EMISSIONS FROM DOMESTIC BIOMASS COMBUSTION?

#1 Replacement of existing appliances

Old wood appliances in Europe are characterized by low efficiency rates and incomplete combustion performance: at the lower end of the spectrum, open fires are the most polluting because the least efficient combustion method (efficiency below 30%). This is due to the fact that in an open fire, it is impossible to control the combustion process, which increases the chances of incomplete and therefore particularly polluting combustion. On the contrary, newly designed stoves are proven to be many times more energy efficient than the obsolete ones.

In France, 1/3 of the existing domestic wood appliances are considered old and inefficient and are assessed to emit 2/3 of emissions pointed out by the EEA report. Replacing these appliances would slash emissions, lower wood consumption

Cutting emissions from residential wood combustion is possible. Different parameters affect the quality of the combustion and therefore the level of air pollution a stove can emit. In order to reduce these emissions, a four-step approach is recommended:

and empower citizens by cutting their energy bills (see the case study below). Figure 3 shows how replacing the old stock with modern installations can improve the efficiency levels and significantly reduce air pollution.³

The type of appliance has a significant impact on the emissions, as shown in the figures below. It should however be noted that these emissions levels are approximate as the exact levels of emissions depend on many different factors such as the type of fuel used or the geographic location. However, it can be claimed that the emissions from one old open fire are equivalent to the emissions of approximately 278 most modern appliances such as pellet stoves.

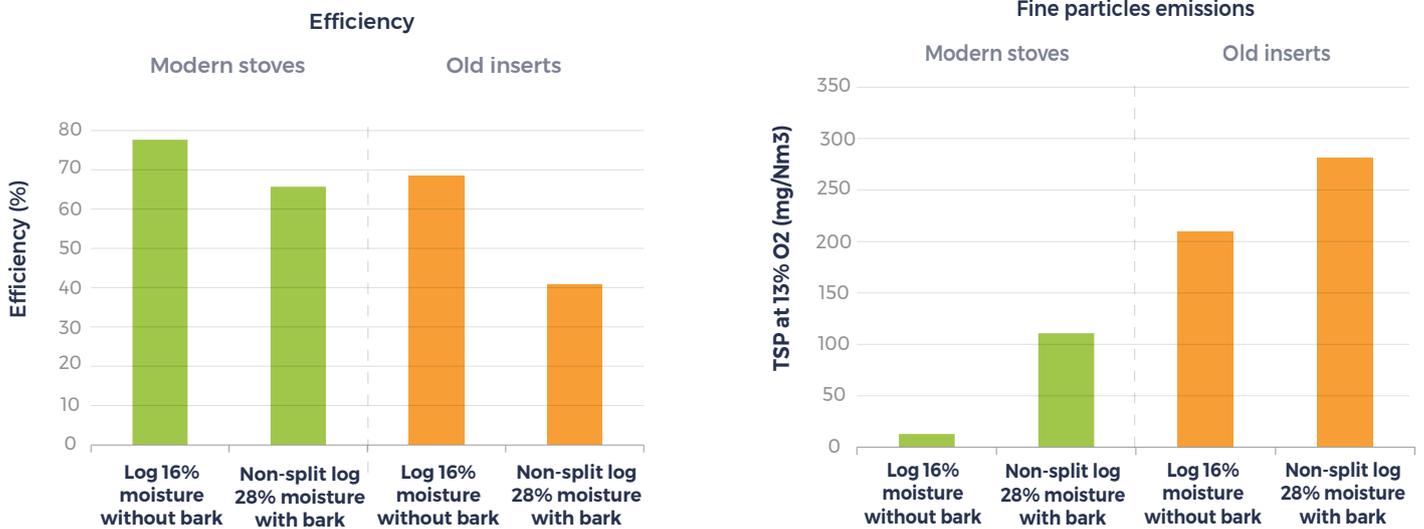


Figure 3: efficiency and PM emissions improvement between old and new stoves

Source: Impact of the quality of firewood and the evolution of the wood burning appliances on the quality of air CERIC, 2017.⁴

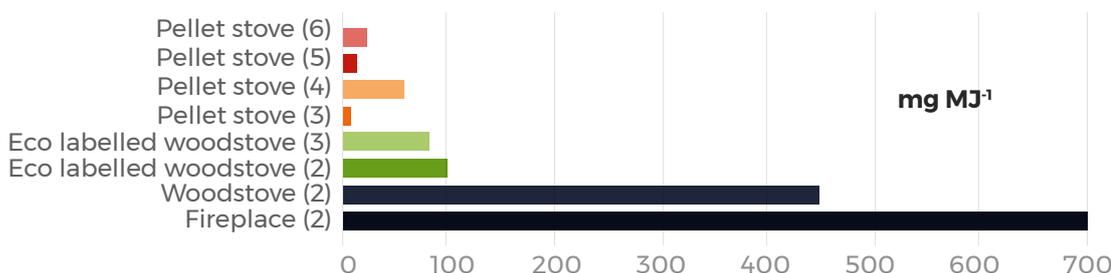


Figure 4: particle emissions for various residential combustion appliances⁵

Source: Technical guide to reduce biomass burning emissions, AIRUSE, 12/2016.⁶

#2 Improvement of fuel quality

Fuel quality has a strong impact on air emissions as shown in figure 5. Requirements for quality wood are simple: to achieve ideal combustion performance, wood logs should be split, dried for two years (or kiln-dried) to bring humidity levels down to a maximum of 20%. Playing with these variables shows the potential for emissions reduction is considerable: a case study realized by CERIC in France (see box on the right) shows that a population using only 40% quality wood (with moisture content below 20%) emits 4 times more than a population using 100% good quality wood. This is also about energy efficiency: indeed, the more water the wood contains, the more energy must be used to evaporate it, the same energy that is not available to heat the room. Burning dry wood can reduce the annual consumption of wood by 1.5 times: which means that if a consumer was burning 9 m³ of wet wood a year, he would need only 6m³ of dry wood to obtain the same quantity and quality of heat.

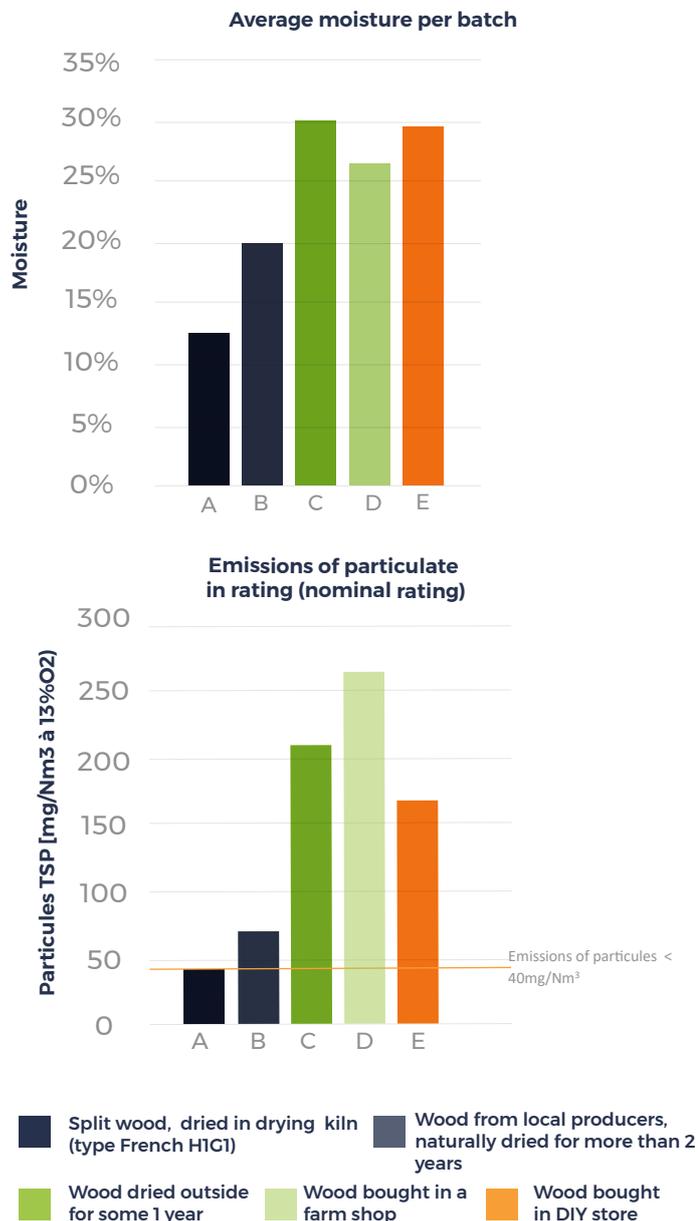


Figure 5: particle emission for various residential combustion appliances

Source: CERIC, 2017



A case study⁷ realized by CERIC in France supports the theory that replacing the old stock of appliances will significantly slash PM emissions. The study simulates the evolution of emissions up to 2030, based on the current replacement rate of domestic wood appliances through dedicated support schemes, and predicts increase of the domestic wood stoves stock from 7,4 to 9 million between 2012 to 2030 while PM emissions will drop by 74% (see graph below).

Still, this scenario is not based on the most optimistic conditions, since it entails only a 40% of consumers using high quality wood (with moisture content below 20%). In fact, in order to further decrease emissions a more optimistic scenario is presented in which all consumers both replace their appliances and use only high-quality wood. Emission levels would drop by 92% in 2030 compared to the level of 2012.

Who would not see this as a priority measure?

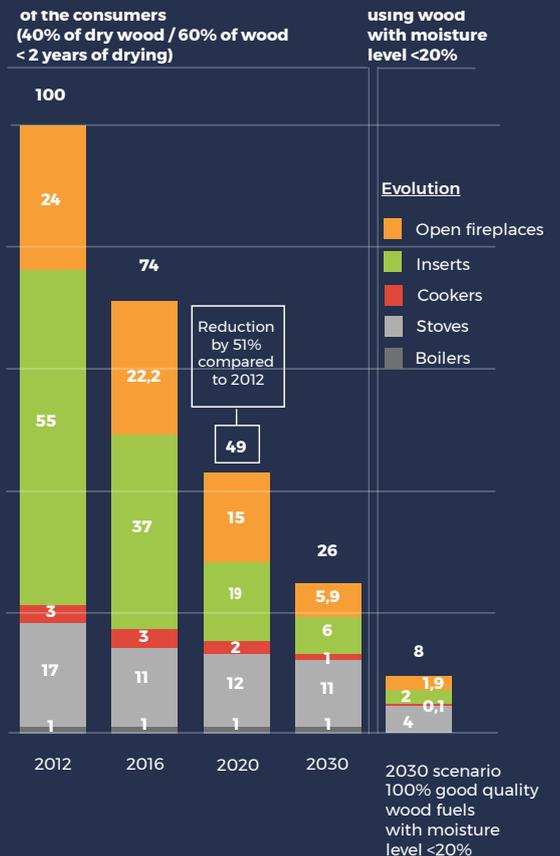


Figure 6: simulation of the reduction of the emissions of particulates (indicator 100 in 2012)

Source: CERIC, 2017

#3 Installation & maintenance

Proper design, dimensioning and annual maintenance of chimneys are prerequisites to the correct functioning and safety of wood appliances. While countries like Germany have implemented mandatory inspections of chimneys and a liability system from chimney sweepers towards the installations, other member states have not yet taken the same direction, leading to much slower replacement rate of inefficient installations and to latencies in fighting air pollution. Consumer should make sure that the installers they contract are competent professionals or, even better, certified by national schemes when available.

#4 Users' behaviour

The way households use their heating installations can have a considerable influence on emission levels. This is particularly true for installations operated manually, for which fuel loading, reloading and fire starting procedures and proper use of air controls are key factors. The effect of operating conditions on PM emissions was studied within the European project AIRUSE (figure 8). Emissions can be easily avoided by educating users to change their burning habits.

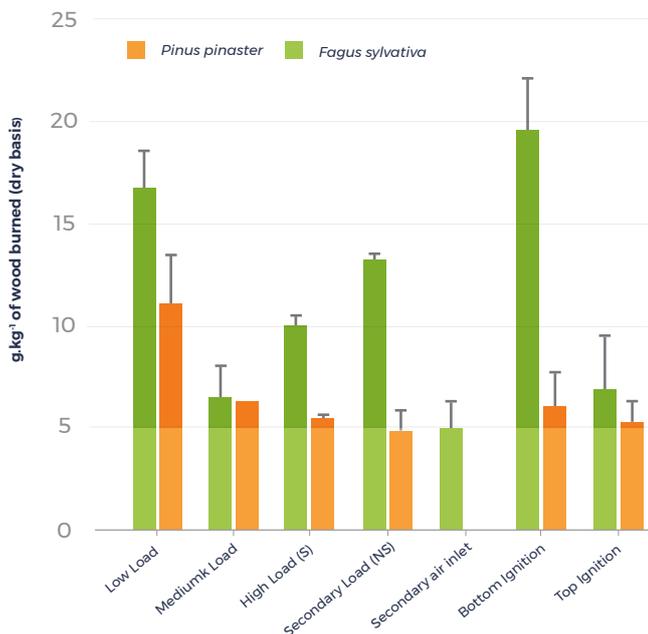


Figure 7: PM emission factors for different burning conditions (S – split logs; NS – non-split logs).

Source: results obtained within the European project AIRUSE⁸

In Wallonia, an awareness campaign has been launched to educate end users on the best practices to operate wood combustion in the cleanest way, through a series of tutorials. It can be learned how to choose the best logs, how to dry wood, how to start a fire, etc.



WHAT POLICIES ARE IN PLACE TO DECREASE EMISSIONS FROM RESIDENTIAL BIOMASS HEATING?

Emissions from all types and sizes of biomass combustion is submitted to emission limit values (ELVs).

- For large size installations (above 50 MW), the Industrial Emissions Directive (Directive 2010/75/EU)⁹ sets ELVs for all fuels, including biomass;
- For medium size installations (between 1 and 50 MW), emissions from bioenergy production are capped by the Medium Combustion Plant Directive (Directive (EU) 2015/2193)¹⁰;
- As for residential heating, the new eco-design scheme for solid fuel boilers (Commission Regulation (EU) 2015/1189)¹¹ and local space heaters (Commission Regulation (EU) 2015/1185)¹² set minimum efficiency and maximum emissions levels for biomass heating installations to be put on EU market. These requirements ensure all new biomass heating installations emit minimum levels of emissions.

The table in the next page provides a summary of PM emission limit values (ELVs) for solid biomass:

Ecodesign (at 13% O₂ content)	MCP (at 6% O₂ content)	IED (BAT) (at 6% O₂ content)
Stoves: 50 mg/m³ for open fronted 40 mg/m³ for closed fronted 40 mg/m³ for cookers 20 mg/m³ for pellets	Existing < 20MW 50 mg/m³ Existing > 20 MW 30 mg/m³	Existing < 100 MW: 2-15 mg/m³ (yearly average) Existing > 100 MW and < 300 MW: 2-12 mg/m³ (yearly average) Existing > 300 MW: 2-10 mg/m³ (yearly average)
Boilers: 40 mg/m³ for automatically stoked solid fuel boilers 60 mg / m³ for manually stoked solid fuel boilers	New < 5 MW 50 mg/m³ New > 5 MW and < 20 MW 30 mg/m³ New > 20 MW 20 mg/m³	New plants > 50 MW: 2-5 mg/m³ (yearly average)

Other legislative acts such as the *Energy Performance of Buildings Directive* (Directive 2010/31/EU), the *Energy Efficiency Directive* (Directive 2012/27/EU) or the *Energy Labelling Regulation* (Regulation (EU) 2017/1369) contribute to reducing the emission of atmospheric pollutants by decreasing primary and final energy consumption.



HOW TO TACKLE THE ISSUE OF EMISSIONS FROM DOMESTIC BIOMASS COMBUSTION?

Slashing air emissions from wood burning is entirely possible, but it will require a comprehensive approach based on 4 pillars:

#1 Incentivise the replacement of the existing stock with modern and efficient biomass heating installations

Ecodesign requirements, that will enter into force in 2020 for biomass boilers and 2022 for biomass stoves, will guarantee that any new biomass appliance put on the market is compliant with above ELVs. This will ensure that incentives to change old biomass installations are leading to concrete efficiency and emissions improvements. In addition, in some Member States, a certification system has been established (Aria Pulita in Italy, Flamme Verte in France, etc) to inform consumers on the different levels of efficiencies emissions among the eco-design-compliant appliances. An incentive system linked to the best installation is established thanks to these existing certification schemes to guarantee a maximum positive impact on air emissions.

Work is currently being done to establish a European Quality Label to harmonise certification among EU member states. This will allow a differentiation between good and best technologies.

Political and financial support should be given to end-consumers to foster a switch of appliance

- Investment grants to reduce the higher investment costs compared to traditional installations
- Fiscal incentives (tax rebate on appliance sales)
- Information campaigns to increase awareness about biomass heating and availability of financial supports
- Investment grants should be proportioned and/or conditioned to the lower-emission factors of the appliances

#2 Introduce requirements on fuel quality

A better quality of fuels should be incentivised. This can be done thanks to standards and certification schemes.

Requirements on fuel quality should be introduced.

- Promoting and/or regulating the sale of fuel (e.g.: sales of A1 or A2 pellet only (case of Italy))
- Voluntary industry schemes promoting the sale of cleaner fuels to guarantee fuel quality (e.g.: Wood Fuel Quality Assurance Scheme in Ireland, GoodChips® for woodchips, ENPlus® for pellets, etc.)
- Information campaigns to increase awareness on the importance of the quality of the fuel (e.g.: "La Maitrise du Feu"¹³ campaign in Wallonia which is an initiative funded by local authorities and which aims at increasing awareness on a clean and efficient combustion process.)

#3 Ensure proper installation and maintenance

Installers and chimney sweepers have an important role in improving the well-functioning of a biomass stove through proper installation and maintenance.

Installers and chimney sweepers should be given a central role

- Systematize and improve training for installers on the installation and maintenance of renewable heating solutions
- Establish lists of qualified installers (conditioning attribution of support schemes)
- Promote inspection of chimneys and create an inventory of all the existing appliances

#4 Increase awareness on users' behaviour

Proper burning techniques should be disseminated among end consumers.

Consumers' knowledge on proper burning techniques should be improved

- Information campaign at national or local levels to improve consumers' burning techniques (e.g.: "La Maitrise du Feu"¹⁴ campaign in Wallonia)
- Incentivise the sale of automatized appliances that reduces the impact of users' behaviours



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Bioenergy Europe is a non-profit, Brussels-based international organisation founded in 1990, bringing together more than 40 associations and 90 companies.

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