clean heat

# Layman's Report

## Clean Heat –
## reducing particle emissions from residential wood burning

A campaign of: Deutsche Umwelthilfe

THE DANISH ECOLOGICAL COUNCIL

Supported by: Life

## What is Clean Heat about?

Sitting in front of a firewood stove is considered traditional, natural and cosy. Wood burning is also often praised as a green way of heating homes since it does not use fossil fuels. However, in reality, residential burning is the biggest source of harmful substances such as particulate matter and black carbon in Europe. Effective exhaust cleaning technology exists but is currently not standard for small-scale combustion. Even new appliances typically sold on the market today are far from clean.

To reach our climate targets and reduce air pollution from heating systems, improving building efficiency is key. But in addition, the use of sustainable and clean heat sources needs to be promoted and encouraged. Wood burning can only be a viable solution in the future if appliances become a lot cleaner. To achieve this, effective emission reduction technology has to become mandatory for wood burning stoves and boilers, as it is in the vehicle sector. And firewood, woodchips and pellets can only be a renewable alternative to heating with fossil fuels if they originate from local, sustainable forestry.

To debunk myths and advance solutions in this area, Deutsche Umwelthilfe (DUH, Environmental Action Germany) and Danish Ecological Council (DEC) launched the information campaign Clean Heat in 2015, funded by the LIFE programme of the European Union. The campaign initially started in Germany and Denmark and later spread to other European countries.

The Clean Heat project had three clear objectives:

- To raise awareness of the health and climate impacts of wood burning and generate public support for more ambitious legislation
- To contribute expertise and knowledge to the political debate around wood burning and shape the legislative framework at EU, national and local level
- To enable and encourage transfer of knowledge and campaign activities to other Member States

## Focus on wood burning in private households

When it comes to particulate pollution, many people think of industry, large combustion plants or transport as the main culprits. But a closer look reveals that the small chimneys have the biggest impact: Domestic heating with wood and other solid fuels is the predominant source of numerous air pollutants, according to the European Environment Agency (EEA) and the IIASA research institute. Firewood stoves are particularly polluting. They are usually fired with logwood and are used to heat one or two adjacent rooms. Boilers that mostly use pellets and wood chips have a higher output than stoves. They supply heat and hot water to an entire house or several buildings.

*Air pollution from wood burning usually occurs in residential areas where no air quality monitoring stations are installed.*

## What is coming out of the chimney?

The most harmful pollutants from residential burning is particulate matter, including black carbon (soot) as well as benzo(a)pyrene (BaP) and dioxins. Benzo(a)pyrene is a polycyclic aromatic hydrocarbon and is highly carcinogenic. The particles emitted by stoves and boilers are usually very small. 80 to 90 percent of particles are less than one micrometre in size. For comparison: a human hair has a diameter of about 50 micrometres. Many particles are even smaller than 0.1 micrometres and are called ‚ultrafine'. They cannot only penetrate deep into the lungs, but even into the bloodstream.

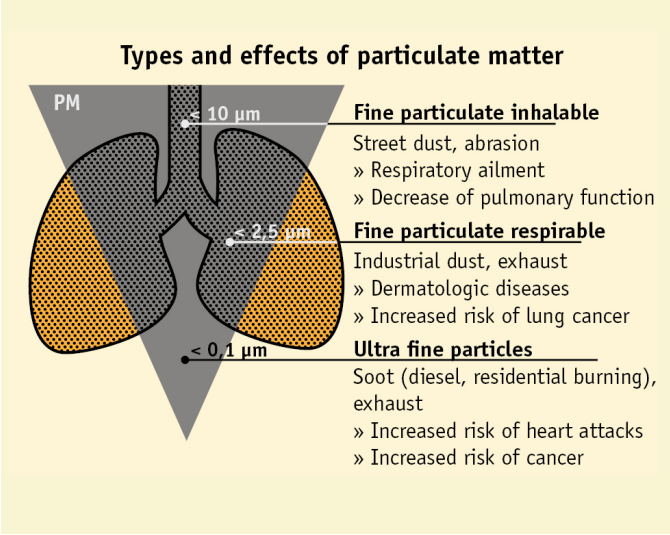


*Figure 1: Types and effects of particulate matter | Source: DUH*

When particles – especially the ultrafine ones – enter the human body, they can cause and aggravate a variety of serious health problems: cardiovascular disease, heart attacks, cardiac arrhythmias, lung disease such as asthma and even cancer (see figure 1). The EEA estimates that around 400,000 premature deaths are caused by particulate matter pollution in Europe every year. Four out of five people live in urban areas with higher particulate pollution than the World Health Organization (WHO) recommends. Even in Germany, WHO recommendations for particulate matter concentration were exceeded at three out of four measuring stations in 2018.

## Neglected in the public discussion: the climate impact of wood burning

Emissions from small wood burning appliances also have a substantial carbon footprint. That statement may surprise you: After all it is often claimed that wood burning is carbon neutral because it only releases the amount of $CO_2$ that the trees have previously absorbed while growing. But a closer look shows that this is not true: Due to incomplete combustion, stoves currently sold in the market actually produce considerable amounts of black carbon – a powerful short-lived climate pollutant.

Due to its small size, black carbon disperses in the atmosphere. Its dark colour absorbs the sunlight and heats up the environment. According to latest estimates, the climate impact of a firewood stove can be similar to that of a gas heating. Domestic heating is the biggest source of black carbon pollution in Europe – and there is no sign of that changing (see figure 2).

The supposed carbon neutrality of wood burning is also highly doubtful due to another issue: Often the level of reforestation is inadequate and wood is used faster than it regrows. That means that the process overall leads to substantial net emissions of $CO_2$ into the atmosphere. In addition, forests and forest floors serve as crucial carbon sinks which must be protected to achieve global climate targets.

## Current EU legislation as a driver for low-emission appliances?

The huge pollution due to wood burning clearly demonstrates the need to take action at political level. There are three main pillars of the EU's policy on air quality: maximum limits for the concentrations of air pollutants such as particulate matter in the ambient air, overall national emission limits, and source-specific emission standards. With regard to the latter, most important are new Ecodesign requirements for stoves and boilers that set EU-wide minimum standards for both efficiency and emissions. Due to this harmonisation, existing legislation in the EU member states will be replaced from 2020 for boilers and 2022 for stoves.

In reality, the EU's air quality policy is a political compromise that does not reflect the ambition needed to protect human health and does not take into account best-available technique. However, even the lax EU air quality limit values for particulate matter are exceeded in many Eastern European countries. Besides, there are often no effective emission limits for appliances such as firewood stoves in these countries. In these cases, the existing and upcoming European standards can help promote appliances with lower emissions.

| | WHO air quality guidelines | EU limit values |
|---|---|---|
| $PM_{2.5}$ | 10 µg/m³ annual mean<br>25 µg/m³ 24-hour mean maximum (3) | 25 µg/m³ annual mean<br>- |
| $PM_{10}$ | 20 µg/m³ annual mean<br>50 µg/m³ 24-hour mean concentration (3) | 40 µg/m³ annual mean<br>50 µg/m³ 24-hour mean concentration (35) |

*Table 1: WHO air quality guidelines vs. EU limit values.*
*In brackets: number of max. exceedances per year.*

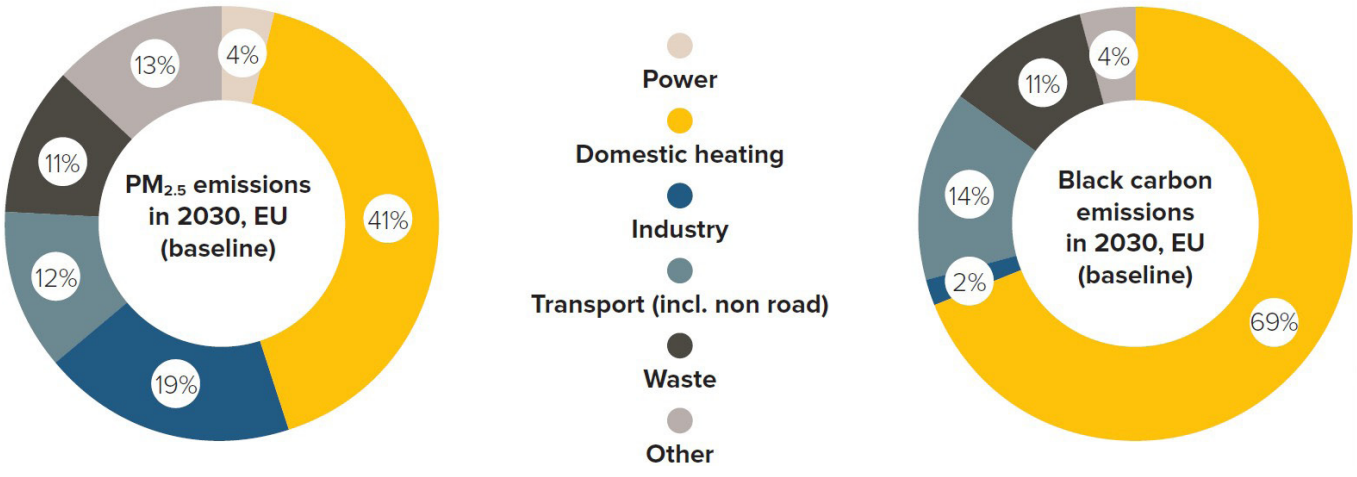


*Figure 2: Emission projections based on IIASA GAINS model | Source: EEB*

## What needs to be done at the political level?

- Adoption of WHO recommended limit values for particulate matter air pollution as minimum standard and introduction of limit values for the concentration of ultrafine particles. Restriction of residential burning e.g. by allowing municipalities with district heating to ban residential burning without effective air exhaust cleaning technology.
- Stricter emission limit values for stoves and boilers based on state of the art technology: effective emission reduction technology needs to become standard! Introduction of a more realistic measurement method for type approval that includes measurement of particle number.
- Stricter requirements for old appliances (shutdown or retrofitting). Ban of coal and lignite burning in stoves and boilers.
- Pollution-based taxation of usage of stoves in order to promote filters and environmentally friendly alternatives to residential burning of solid fuels.
- Stricter requirements and additional economic incentives for energy efficient renovation and insulation of existing buildings. Funding programmes for solar heat, heat pumps and biomass appliances with effective exhaust cleaning are also required.
- Effective control mechanisms for market surveillance with random checks of appliances sold on the market. Effective controls and sanctions to avoid illegal burning and misuse of appliances: High fines and increased use of ash testing.
- Better information for consumers: Mandatory proof of origin for firewood and pellets and establishment of ambitious eco-labels for stoves and boilers.

In Denmark and Germany, the weak EU limit values for particles in ambient air are met virtually everywhere, and national emission standards are already at least as strict as the new EU Ecodesign requirements. Here, the EU legislation fails to exert any further pressure to act and makes it difficult to push for clean air with legal action.

The Clean Heat project partners therefore focused on promoting stricter legislation at local level, generating support for adoption of the much stricter air quality guidelines of the WHO (see table 1) as well as better consumer information and improvement of standards through eco-labels.

## How to improve technical standards?

In countries like Germany and Denmark, firewood stoves are mainly used as additional heat sources. If a sustainable district heating system is available, the best solution is not to use stoves at all. If stoves are used, they need to be equipped with effective exhaust cleaning technology.

When we look at typical stoves sold today, we find something that is familiar from the automobile sector: real-life emissions are usually much higher than the manufacturer claims. There are two main reasons for that: Using a stove incorrectly or with the wrong fuel can lead to extremely high emissions. But even if it is used properly, emissions are typically much higher than they should be because the type approval testing doesn't occur under realistic conditions. For instance, the ignition phase of the stove is not considered. In addition, only particle mass is measured – concealing the problem that stoves produce huge numbers of very small particles that do not contribute much to overall mass.

Even if a stove or a boiler does meet the upcoming Ecodesign requirements in the real world, they still produce more particles than 15-year-old diesel trucks without any filter. Such appliances without effective emission reduction technology are harmful to human health and should have no prospects. For vehicles, effective filters to reduce particulate matter and black carbon emissions have been standard for years. So why is this not the case with stoves and boilers?

Back in 2016, DEC was involved in a test with an electrostatic and a bag filter for stoves and small boilers in Denmark. The two filter systems showed high removal rates (85-99%) for soot particles, fine particles and ultrafine particles.

To push such low-emission technology, Clean Heat initiated a new eco-label for firewood stoves in Germany and conducted a pilot retrofitting project with a pellet boiler operated by a Berlin ice-cream maker.

*The Blue Angel is the most well-known and trusted eco-label in Germany. Thus, we initiated an new Blue Angel eco-label for firewood stoves.*

## Firewood stoves: new Blue Angel eco-label as a blueprint

For the new eco-label for firewood stoves, we worked with the German Federal Environment Agency which is in charge of the Blue Angel (Blauer Engel), the most well-known and trusted eco-label in Germany. We convinced the eco-label jury to start the process of drawing up the award criteria in 2017. The final Blue Angel award criteria for firewood stoves were discussed in two expert hearings. In December 2019, the eco-label jury gave the green light to the award criteria, which will enter into force from January 2020.

The new eco-label addresses the key issues with stoves currently sold on the market through:

- A more realistic test procedure, including measurement of the number of particles emitted
- Very ambitious emission limit values that will make precipitators (filters) obligatory
- Effective technical provisions to reduce operating errors, such as an automatic combustion air control and a monitoring of the burning process (e.g. prompting the operator to refuel)
- Requirement that stove and precipitator need to be installed and operated together

There are currently no stoves on the market, which meet all the requirements, but we expect first appliances to be sold with the new eco-label in 2020. This will help guide purchasing decisions of consumers, but the eco-label should also serve as a minimum standard for new stoves in residential areas and provides a blueprint for the revision of European standards. Initially, stoves with the Blue Angel label are likely to be comparatively costly, but with increasing volumes they will doubtless become more affordable.

## Boilers need to become cleaner as well

In contrast to stoves, the burning process in boilers is automated and the fuel quality is more consistent due to fuel standards for pellets and wood chips. That means that boilers usually emit less black carbon and particulate matter than stoves. However, they still produce huge numbers of small particles. Therefore, precipitators or filters should be standard with these appliances as well.

To demonstrate that boiler retrofitting with a precipitator is a viable solution, we worked with the Berlin ice-cream maker Florida Eis. The company is known for its efforts to reduce its environmental and climate footprint and runs a pellet boiler to provide heat and hot water for its production facilities. Clean Heat convinced the Florida Eis owner Olaf Höhn to retrofit his boiler with a very effective precipitator in 2018 (see photo and quote on the next page). Our measurements showed that the number of particles emitted was reduced by more than 80% due to the exhaust cleaning (see figure 3).

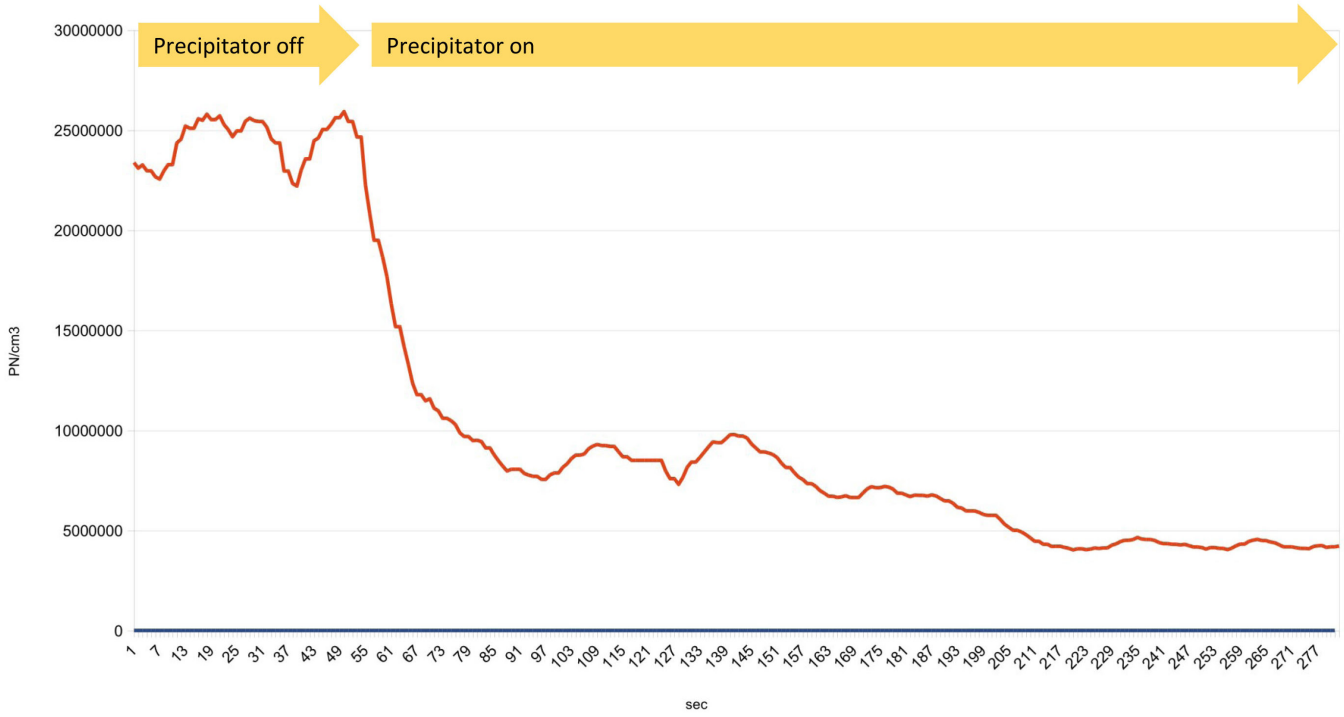


*Figure 3: Our measurements showed that number of particles emitted can be reduced substantially by retrofitting a pellet boiler with a precipitator.*

*Olaf Höhn, owner of Florida Eis: „It is our goal to produce our ice cream completely climate-neutral. The heat for our factory is supplied by a boiler using certified regional pellets. However, burning pellets should not have negative effects on air quality. After consultation with DUH, we therefore decided to retrofit our boiler with a particle precipitator."*

## Finding suitable partners for Clean Heat

To reach citizens and policy makers and maximise our impact, it was crucial for us to win support by other actors in the field of residential burning and by NGOs in other Member States. Over the past four years, we succeeded in establishing a strong network of partners. This allowed us to expand our campaign to several additional European countries, cooperating with organizations in Hungary (Clean Air Action Group Hungary), the Czech Republic (Centrum), Slovakia (Cepta), Poland (Frank Bold Poland), Bulgaria (Energy Agency of Plovdiv/ Za Zemiata) and Slovenia (Focus). At EU level, our umbrella organization European Environmental Bureau (EEB) joined Clean Heat.
These are only a few of the organizations, institutions and other stakeholders that support our campaign. In total, we collaborated with more than 200 stakeholders, many of whom can be found with a supporting statement on our website.

## Raising awareness: the starting point to take action

Until the technical solutions for stoves and boilers that Clean Heat has promoted will be mandatory, it is crucial to avoid excessive pollution due to existing stoves. Awareness raising is key to enable and encourage behavioural change of stove owners, citizens in general and policy makers. Thus, several actions of Clean Heat focused on providing information to stove owners to raise awareness of the environmental impacts of stoves and to encourage more environmentally friendly practices when operating stoves. In addition, we approached the general public to generate support for more ambitious legislation on wood burning.

## Liaising with those that reach (potential) stove owners

To reach out to stove owners, we collaborated with those who are directly in touch with them. The federal association of chimney sweeps in Germany was actively involved in our campaign and disseminated our information material on their regular visits to stove operators. A survey among chimney sweeps showed that more than 90% found our flyer helpful to raise awareness with their clients. Another key partner was toom Baumarkt, one of the leading DIY companies in Germany. The company distributed our flyer with tips on how to operate a stove in its 300 stores across the country and included the advice in its stove catalogue. Through these channels, we were able to reach at least 240.000 consumers.

*Chimney sweeps found our flyer helpful to raise awareness with their clients.*

Toom also helped spread our photo competition that we initiated at the beginning of the project. In the context of this action, we asked citizens to send us photos related to wood burning. Although the number of photos submitted was lower than expected, the contributions reflected a broad range of attitudes people have towards wood burning. The photo competition was successful in making the public aware of our project and triggered large numbers of email and phone requests by citizens, most of whom were seeking advice regarding bad air quality due to wood burning in their neighbourhood. Over the course of the project and together with our partners, we provided direct advice to more than 1,000 citizens in Germany, Denmark and Hungary.

The citizen requests also showed a clear need for better information about the local impacts of wood burning. This inspired us to create a mobile exhibition to approach municipalities and to attend local fairs with environmental focus. The mobile exhibition includes details on the health and climate effects of particulate pollution as well as tips on how to operate a stove in the most environmentally friendly way possible. The exhibition travelled to more than 40 venues and events in Germany, Bulgaria and Hungary. It was often combined with supporting activities such as media work and information events for the local population.


*Our mobile exhibition was shown at numerous local events and venues.*

## Being visible online

Of course, many people are looking for information online. Our project website serves as a vital source of knowledge on wood burning and related topics – our online survey found that more than 90% of visitors considered our information about wood burning and stove operation helpful and informative. Clean Heat was also active on social media and produced a short film that has reached over 170,000 people so far. We are proud that almost two thirds of viewers watched the film until the end – this very high value clearly demonstrates the strong interest in the topic.

## Media work: Giving environmental concerns a voice in the public debate

When we launched the Clean Heat campaign in 2015, the media were very much focused on emissions from transport when reporting about particle pollution. And when wood burning was mentioned, reports usually conveyed the doubtful message that new stoves and proper operation would solve the pollution problem. In addition, media frequently repeated the incorrect claims by the industry that wood burning in stoves is beneficial to the climate.

*The Clean Heat short film debunks the central myths related to private wood burning.*

Over the past four years, we succeeded in establishing Clean Heat as a leader in the critical debate about wood burning in Germany, Denmark and several other EU member states. To achieve this, we used a broad range of tools related to media work. The project partners supplied journalists with unbiased background information in numerous individual conversations. In addition, we issued a large number of press releases and attracted journalists with press events. As a result, the project team and its partners in other Member States were popular interview partners for the media.

*The project team conducted many outdoor measurements with an ultrafine particle counter.*

To illustrate the impact of wood burning on outdoor and indoor air quality, we conducted numerous measurements with a mobile particle counter (see box) and disseminated the results through media reports. This meant that the complex issue of wood burning regularly featured in TV and radio, as well as in print and online media. We reached at least 60 million people through reports in well-known television programmes such as ZDF WISO and Report Mainz and in high-circulation newspapers such as Politiken, DIE ZEIT and Welt am Sonntag. In all our media work, we consistently highlighted the following issues:

- Environmental impact of stoves and high real-world emissions
- Indoor pollution and pollution of ambient air in residential areas due to wood burning and the related health impacts
- Need for making effective exhaust cleaning technology mandatory in wood burning appliances

The reporting on wood burning triggered a public debate, which put pressure on decision-makers in politics and the stove industry.

## Indoor, outdoor and exhaust measurements

Air pollution from wood burning can be illustrated and quantified by measuring particles. DEC and DUH carried out over 50 measurements with an ultrafine particle counter and a black carbon measuring device which provided us with important information regarding the level of particle pollution caused by wood burning and enabled comparisons with other emission sources:

- Indoor: Due to the use of a firewood stove, indoor concentrations of ultrafine particles can increase substantially (from 2,000 to more than 100,000 particles per cm3).
- Outdoor: Residential areas in which a lot of wood burning occurs experience similar or even higher pollution levels than the most highly polluted roads.
- Exhaust cleaning technology: The number of particles emitted by a stove or boiler can be reduced by at least 80% by using effective precipitators or filters.

## Improving the policy framework around wood burning

Since wood burning has now become a hot topic in the public debate, we were able to conduct a broad dialogue and push for ambitious legislation. One of the main obstacles we encountered – especially in Denmark and Germany – was that policy makers and authorities often hesitate to take any measures beyond the existing legal obligations arising from Europe's weak air quality standards. In addition, many politicians are not prepared to question the myth of wood burning as a climate-friendly alternative.

Despite these challenging circumstances, we have built up our reputation as a competent partner and important voice on the subject over the past few years, which helped us communicate our campaign objectives to decision-makers in industry and politics. This is reflected in the over 60 presentations given by the project partners at professional events carried out by the European Commission, by national ministries, by renowned research institutions as well as industry associations.

As part of our information campaign, we organized seven conferences in other Member States, two webinars and ten expert talks in Germany and Denmark as well as numerous bilateral meetings with individual stakeholders. Throughout these events, we discussed both technical and political solutions with ministries, public authorities, research organisations, and industry. The progress we achieved in pushing for a more ambitious policy framework clearly shows that it was the right strategy to provide comprehensive background information and foster exchange with own professional events.

*With our events, we reached far more experts and decision makers than initially planned.*

At EU level, we could bring particle number measuring of stoves to the table in the committee that is responsible for future standards. In addition, we submitted action plans with specific policy recommendations in Germany, Denmark, Hungary, Slovenia, Czech Republic and Slovakia to enable compliance with the EU reduction targets for fine particles in these countries. To ensure that increased use of biomass in the energy transition toward renewables does not lead to more particle emissions, we raised the need for effective safeguards in the national implementation of the respective EU legislation on renewable energy. The current national policies show that this is crucial: For instance, the European Commission asked the German government to specify the air quality impact of the planned measures in its National Energy and Climate Plan.

The current national emission standards for boilers in Germany are stricter than the upcoming Ecodesign requirements. Clean Heat successfully encouraged policy makers to take action in order to prevent a slip in standards: the German government has requested an exemption from the European Commission to keep the stricter German provisions. Growing awareness about this issue has led to a legislative initiative for stricter requirements for chimneys. In Denmark, several of the major political parties have adopted the campaign´s policy recommendations and now propose a national framework that allows cities to restrict wood burning and require the use of filters. The green party in Germany adopted a resolution, which says that wood burning appliances need to be equipped with effective emission reduction technology.

One of Clean Heat's key demands is that the more stringent health based WHO air quality guidelines should be the minimum goal for adopting policy measures at local level. We therefore recommended restricting residential burning without exhaust cleaning. In Denmark, we initiated a public debate about taxa-

tion of residential burning. Despite challenging conditions due to weak EU standards, several cities have now implemented stricter requirements for wood burning appliances or are planning to do so. This is also a result of the campaign's contribution to public consultation processes and our collaboration with local actors. One of our key successes are the upcoming requirements in the city of Berlin. In 2019, Berlin, Copenhagen and other cities of the C40 alliance committed themselves to the goal to meet the WHO recommendations on air pollution within the 2020s. In order to achieve this, Berlin is planning to tighten emission requirements substantially for new stoves and boilers. For stoves, the new Blue Angel label initiated by Clean Heat will serve as minimum standard. This is a great success and shows how technological solutions and policy regulation should work together.

*Winner photo of our competition: Nobody has to freeze in the future if wood burning becomes substantially cleaner and sustainable alternatives are promoted.*

## Outlook und future challenges

Clean Heat achieved a lot in the past four years: We raised awareness among stove users, the general public and policy makers, we contributed to a critical public debate about wood burning and we pushed effective technical and policy solutions. However, with huge climate and air quality related challenges in the heating sector across the EU, our campaign must and will be continued. In the coming years, we will concentrate our efforts on the following areas:

- Pan-European Ecodesign standards for stoves and boilers will be revised and need to be tightened
- National programmes to meet the EU reduction goal for particulate matter will be implemented and revised
- More ambitious legislation and more effective implementation is required to address the harmful air pollution in many local neighbourhoods
- Huge numbers of old wood burning appliances have to be taken out of operation and replaced by clean alternatives, accompanied by effective measures to improve building efficiency
- Based on the Renewable Energy Directive, Member States need to implement policies to increase use of renewables in the heating sector

Across these areas, significant reduction of ultrafine particle pollution and at least compliance with the WHO air quality recommendations must be the guiding principles. The heating sector must adopt an ambitious integrated approach to achieve climate protection and better air quality.

clean heat

## About Clean Heat

With our project Clean Heat, we aim at a significant reduction of particulate matter and soot caused by private wood burning. Together with our Danish partner DEC (Danish Ecological Council) and NGOs in other European countries, we press ahead with technical and political solutions and provide information for consumers.

Clean Heat was co-financed by the LIFE programme of the European Commission from autumn 2015 until end of 2019.

As of December 2019



**Environmental Action Germany**

Headquarters Berlin

Hackescher Markt 4
Entrance: Neue Promenade 3
10178 Berlin

www.duh.de
www.clean-heat.eu

Contact

Patrick Huth
Project Manager Transport and Air Quality

Phone: +49 30 2400867-77
Fax: +49 30 2400867-19
E-mail: huth@duh.de

Deutsche Umwelthilfe