Low Emission Zone in the Heating Sector: Sofia case study

This is one of four city case studies prepared by the Institute for European Environmental Policy for the Clean Air Fund. The study investigates the design and the implementation of a Low Emission Zone (LEZ) in the heating sector in Sofia, the first measure of its kind in Europe. In addition, this brief further explores the societal impacts of the measure, with a focus on vulnerable communities and households at risk of energy poverty.

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Author:
Ange Manon Tang, Chiara Antonelli

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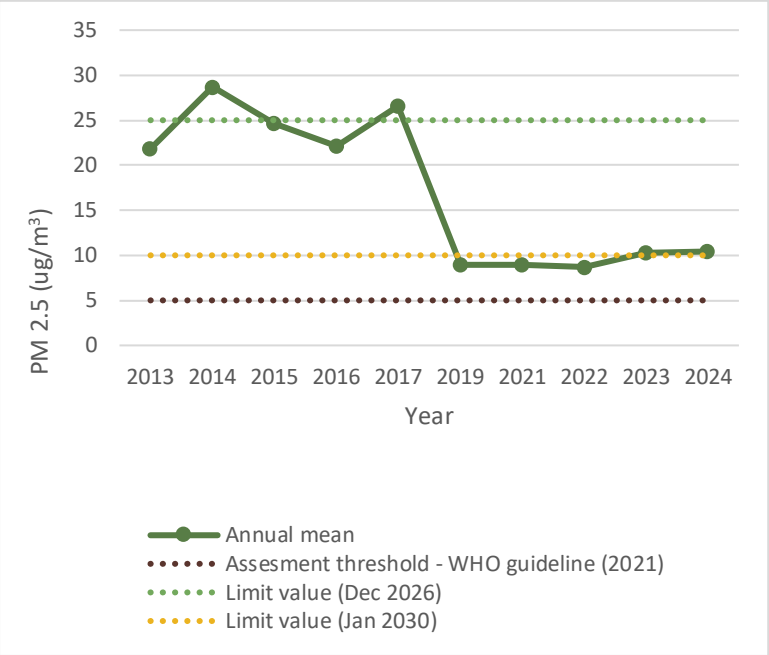
Sofia, the capital city of Bulgaria, located in southeastern Europe, is the most populous Bulgarian city and the country's economic centre. Despite being wealthier than the rest of the country, Sofia remains well below the EU annual wage average (Annex 1 for detailed socio-demographic data). Within this context, the city faces air quality problems caused in part by burning solid fuels for residential heating. In response, the municipality adopted a resolution in 2023 introducing **the country and EU's first Low Emission Zone (LEZ) targeting residential heating**. While LEZ are typically used for vehicles, in Sofia it has been applied to the heating sector, establishing a zone where using solid fossil fuels for residential heating is prohibited.

Sofia-specific air pollution challenges



Air pollution level in Sofia is no exception to the national situation[1], as it exceeds both the EU and WHO air quality standards[2] for diverse pollutants, including particulate matter (PM) 2.5, Figure 3, (EEA, 2024), PM 10, benzo(a)pyrene and nitrogen dioxide (NO_2). One of the main sources of air pollution is solid fuel appliances (i.e. coal and wood) used for domestic heating, used by approximately 32,000 households in the city (Sofia Municipality, 2022). This high number of unclean appliances results in 80% of PM exceedances in winter (Sofia Municipality, 2024). Moreover, the contribution of biomass burning, including wood and coal, accounts for about 42% of PM10 (National Institute of Meteorology and Hydrology , 2020)[3]. Among the households burning solid fuels, the majority likely burns wood (38%), followed by coal (19%) and a mix of both (8%)[4],[5] (Alpha Research, 2024). Low-income groups, including the Roma community and people living in single-family home districts, mostly in suburban areas, the elderly, the unemployed and retired people, are more likely to burn only solid fuels (ibid), (Interviewee 1, 2026), while higher income groups tend to combine this energy source with more environmentally friendly ones, such as air conditioning or pellets (Alpha Research, 2024). Additionally, peripheral neighbourhoods often face a combination of inefficient housing stock, limited access to gas networks and district heating, and higher exposure to pollution during winter (Novakova, 2026).

Overall, households with higher exposure to air pollution are also often at greater risk of energy poverty[6]. However, research indicates that **pollution hotspots do not perfectly overlap with socioeconomic deprivation**. Rather, vulnerability to air pollution arises from a combination of geomorphology, fuel use and population density (Burov, 2026). This highlights the significance of Sofia's geomorphological features, which make the city particularly susceptible to persistent poor air quality (Khomenko et al.,

[1] For further information on the national situation, check Annex 2, and Annex 3.
[2] Based on Annex II – assessment threshold of the *Air Quality Directive 2024/2881*
[3] It is worth noticing that some investigations have found that PM is not the only contributor to air pollution in Sofia, NO_2 being also an important pollutant to address (Za Zemiata, 2024).
[4] Data based on a survey conducted by Alpha Research, including 300 households in Sofia Municipality, indicating that most houses in the city are mainly heated by solid fuels with the given percentages.
[5] According to Burov (2026), historically, coal was the cheapest source of energy, so it was widely used by low-income households. In the South, people with access to the forest would use wood and logs, including illegal logging. This illegal activity was also done in Roma quarters close to the western park.
6 , Energy poverty can be comprehensively identified as a combination of different factors, including income, housing quality, energy efficiency and the ability to maintain adequate indoor temperatures (Interviewee 3, 2026)

2025).[7] Due to these combined factors, air pollution significantly impacts the health of Sofia's population, leading to respiratory, cardiovascular, gastrointestinal, and neurological diseases. During peaks in air pollution that can persist with a delay up to three days, a 10% increase in emergency ambulance contacts has been observed (Helath Effects Institute , 2022). Such health issues related to poor air quality affect Sofia's economy: estimates of health costs associated with air pollution reach EUR 2.6 billion annually, or approximately EUR 2,000 per capita (Tcolova & Vladimirov, 2023). In 2019, 13.4% of local GDP was foregone due to reduced labour productivity and labour absenteeism attributable to air pollution (Deloitte, 2021).

Local legal pressure and policy response

In 2021, the Sofia city court[8] ordered the municipality to adopt measures to improve air quality following a complaint brought by the Clean Air Group, an ad hoc coalition of citizens and NGOs, which argued that the city had allowed excessive particulate matter (PM) emissions, endangering people's health (European Union Agency for Fundamental Rights, 2024). In parallel, the municipality undertook the implementation of the Air Quality Programme (AQP) covering the period 2021-2026, which establishes over a hundred measures, including LEZs, to improve air quality (Sofia Municipality, 2021).

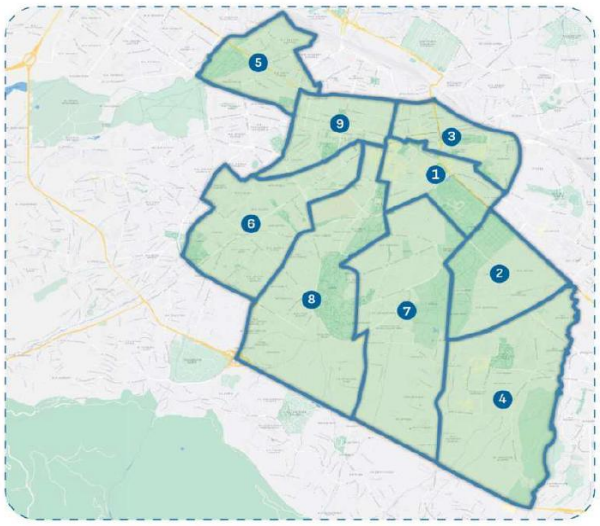


Figure 4: Metropolitan areas in Sofia where the ban on solid fuel heating applies to buildings from January 1st ,2025. From (Sofia Municipality, n.d.)

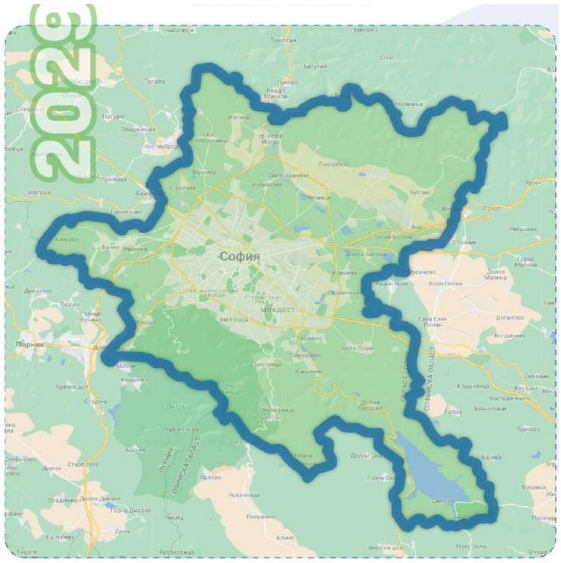


Figure 5: Sofia municipality where the ban on solid fuel heating will start from January 2029. From (Sofia Municipality, n.d.)

As a result, a LEZ for domestic heating entered into force in nine metropolitan districts on 1 January 2025, complementing the traffic LEZ introduced in December 2023 (see Fig. 4). The measure prohibits the burning of solid fuels in areas where a district heating system or a gas distribution network is available (Metropolitan Municipal Council, 2022). The LEZ is scheduled to be expanded to the entire

7 Sofia's topography influences its meteorological features, resulting in low-speed wind and temperature inversion (Shuleva, 2023). Such a phenomenon is predominant in winter, especially in January and February, when anticyclonic conditions persist and suppress atmospheric vertical mixing. Therefore, cold air is trapped in lower altitudes and contributes to poor air quality with the accumulation of pollutants in the Valley (Bacer, S et al., 2024), resulting in pollution episodes that can last one to two weeks (Burov, 2026).

8 https://legalacts.justice.bg/Search/GetActContentByActId?actId=TsmKsL1O7fU%3D

municipality (24 districts) from 1 January, 2029 (see Fig 5) (ibid). To support households affected by the obligation to phase out low-efficiency heating systems at no cost, the Municipality has introduced financial support, such as the Life Programme and the Operational Programme Environment 2021-2027[9] (Sofia Municipality, 2024). As of December 2025, over 15,000 solid-fuel heating systems have been replaced in 11,127 households, resulting in 219 tons of PM avoided annually. (Sofia Municipality, 2025). About one-third of the replacement was covered under the Life Programme, and two-thirds benefited from the Operational Environment Programme (Interviewee 2, 2026).

Social Aspects – Investigations and Stakeholder Consultations

To gain a better understanding of the process leading up to the introduction of Sofia's LEZ for residential heating and the associated social impacts, this brief incorporates the feedback gathered in dedicated stakeholder interviews in early 2026. A wide range of expertise from local authorities, NGOs and researchers provided key insights which enriched this section[10].

Social consideration during LEZ design

Interviewees reported differing views on the consideration of social impacts when the LEZ for residential heating was initially designed. **Affordability** is a core topic, with particular emphasis on the need to support households in replacing their old appliances with clean heating systems through subsidies (Interviewee 3, 2026); (Popov, 2026). All interviewees highlighted the importance of the replacement programmes accompanying the LEZ, noting that such a combined policy approach can help reduce the risk of the ban being viewed as punitive (Interviewee 1, 2026). However, the replacement programmes operate within a fixed annual budget and do not include specific criteria to prioritise vulnerable households. A few interviewees mentioned affordability concerns related to the level of monthly energy bills, with clean heating systems being costly (Popov, 2026) compared to lower-cost fuels such as wood and coal. Novakova (2026) also highlighted that concerns about future energy costs, as well as additional factors such as administrative complexity, uncertainty on timelines and lack of trust, can be barriers in accessing support.

During the development of the LEZ, vulnerable groups were identified through social service data, information on household heating methods, and NGO expertise (Interviewee 4, 2026); (Novakova, 2026). The health impacts of heating fuels, particularly affecting vulnerable populations, such as children and the elderly, were also recognised and cited as part of the rationale for the measure. However, they were not translated into a specific aspect of the policy design (Interviewee 3, 2026). While a source noted that energy poverty and housing constraints were discussed, another observed that energy poverty received somewhat narrower attention, in particular regarding the integration of housing exclusion and the tenure-

[9]More information: Annex 4 - Financial supports accompanying the LEZ for residential heating

[10] Among them are Dr Angel Burov, Chief Assistant Professor at the University of Architecture, Civil Engineering and Geodesy in Sofia (Burov, 2026), Ivaylo Popov, air quality member of the NGO Za Zemiata (Popov, 2026), Antoniya Novakova, project manager at the Centre for Energy Efficiency EnEffect (Novakova, 2026) . Other sources were anonymous, being associated with sequential numbers from 1 to 4.

related impacts. According to Burov (2026), social impacts were not systematically assessed during the LEZ design, partly due to reliance on aggregated data, with limited use of disaggregated socioeconomic data. However, the initial design is described as a pragmatic first stage, focusing on central districts with comparatively better infrastructure for district heating, gas and electricity, while more complex interventions in peripheral areas have been postponed to later stages. Therefore, in the early stage of implementation, some highly polluted low-socio-economic status (SES) areas have been excluded from the first phase of the ban, which started in 2025 (Figures 6 and 7)[11].

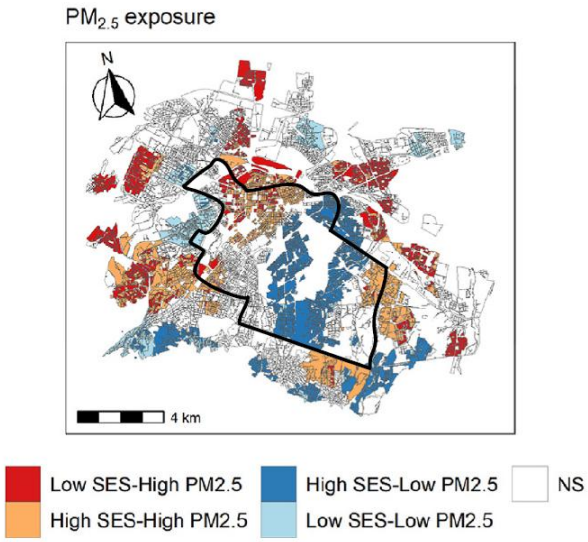


Figure 6: Spatial correlation analysis (local bivariate Moran's I) for SES and PM 2.5 exposure levels in Sofia, Bulgaria (adapted from Khomenko et al. 2025) and stage 1 LEZ residential heating in Sofia, approximation based on (Mission: Sofia without emissions)

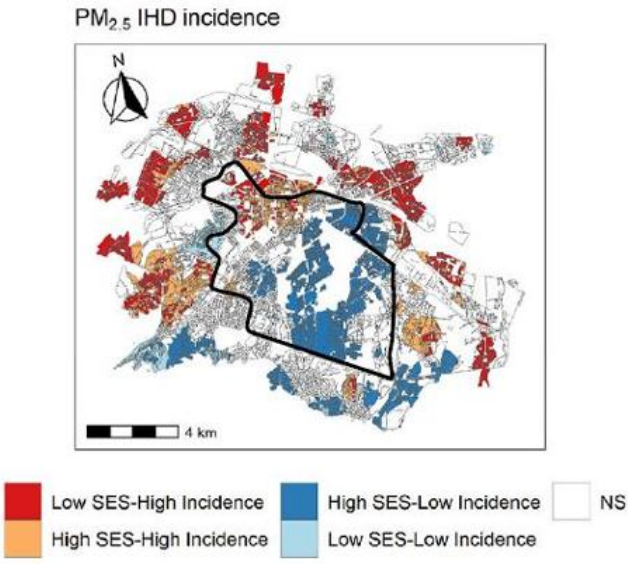


Figure 7: Spatial correlation analysis (local bivariate Moran's I) for SES and attributable morbidity incidence rates (considering baseline incidence rates adjustment by SES group) in Sofia, Bulgaria (adapted from Khomenko et al. 2025) and stage 1 LEZ residential heating in Sofia, approximation based on (Mission: Sofia without emissions)

Stakeholders' engagement

The LEZ design involved mainly institutional and technical stakeholders. Among them are municipal authorities (i.e. district administrations, departments responsible for environment, air quality, etc.) and air quality experts.[12]. Public health authorities, utilities and technical actors were also consulted, while civil society organisations participated selectively with some proactive outreach from the Municipality.

11 NB: PM 2.5 levels used in the study do not distinguish the sources of pollution. Therefore, it can come from residential heating as well as other sources, including transport. Exposure data for PM 2.5 comes from the Exposome-powered tools for healthy living in urban settings (EXPANSE) for 2019, while SES groups were based on socioeconomic data including annual household income at district level, education level and employment status..

12 National Institute of Meteorology and Hydrology, Scientific Council on Ambient Air Quality

Whilst not being specifically part of the design process, numerous NGOs took action to support the process. Several of them conducted their own studies and brought the subject to the attention of the public, due to the LEZ being perceived as a sensitive subject for the municipality at that time (Popov, 2026). According to Burov (2026), NGOs played a central role, while academia and research institutes provided technical inputs, bridging possible institutional gaps[13].

"They [NGOs] […] are working in one of the most harsh (sic) environments in Europe in terms of political environment and social communication environment, with a lot of propaganda and all kinds of theories, conspiracy theories. So, they're usually well prepared and dedicate a lot of resources to following what's going on in the municipalities and in the state authorities, being adequate in terms of short-term response. Big documents with not very good transparency and not that much availability of data, but they even perform their own analysis and research and collaborate with research institutes." (Burov, 2026)

However, engagement with non-experts in the population appears to have been limited throughout the process, as well as with social services, especially at the early stages (Interviewee 3, 2026). During the process, meetings with the Scientific Councils occurred. After the policy was first designed, Sofia Municipality launched a public consultation, which resulted in an updated version of the draft ordinance and a summary report on the proposals received, published three days after its end (Sofia Municipality, 2022) [14]Several comments were reflected in the revised draft. These included a reference to Ecodesign requirements for local space heaters using solid fuels[15], as well as bringing forward the municipality-wide application of the ban by one year, from January 2030 to January 2029. At first sight, the feedback appeared to have limited influence on the design of the first stage zoning of the LEZ (Popov, 2026). However, Novakova (2026) from EnEffect argues that even though stakeholders did not influence the design of the ban, they nevertheless played an important role in its gradual implementation and had an impact on the design of accompanying measures, the communication strategies, and the emphasis on technical assistance.

While the public consultation attracted citizens with higher levels of education (Burov, 2026), vulnerable households expressed their concerns through more informal channels, namely, social workers, community mediators and NGOs (Interviewee 3, 2026). The main concerns raised were the costs of cleaner heating systems and affordability; the lack of realistic alternatives looking at surrounding infrastructures; the fairness and unequal burden of such a measure, as middle-high income households might have already changed their heating devices; and distrust in the authorities, including fears that financial support would be delayed (Interviewee 3, 2026). Affordability concerns are shared not only by vulnerable communities, but more broadly and appear to constitute the main source of resistance to the measure. In particular, stakeholders expressed concern that the liberalisation of the electricity market could increase electricity

13 For instance, after the adoption of the ordinance, the NGO EnEffect carried out sociological surveys, focused interviews, indoor air quality monitoring and energy analysis of typical dwellings within the Breathe Cities-funded project "Phase-out of solid fuels for domestic heating in Sofia " (Novakova, 2026) . The results of the analyses, conclusions, and policy recommendations directly informed municipal decision-making, contributing to key updates of the Sustainable Energy and Climate Action Plan of Sofia Municipality 2021-2030.

14 For more information on the public consultation, look at Annex 5 – Public consultation comments

15 As required in accordance with Commission Regulation 2015/1185 implementing Directive 2009/125/EC

prices, while the required replacement of heating systems would impose additional costs on households (Interviewee 1, 2026).

Public acceptance, resistance and perceptions

Despite some citizen feedback, most interviewees noted limited organized public opposition to the LEZ, either at the initial voting stage or today. Several factors may help explain this response:

1. Air quality measures are welcomed as the issue is well known to society, and people are engaged in this topic (Popov, 2026);
2. The ban only affects several districts; part of the population might not feel concerned, presently.
3. Limited awareness of the LEZ introduction among the population may have contributed to less public debate[16];

Sofia's culture of civic engagement often leans toward individual responses rather than large-scale collective mobilisation (Burov, 2026). While no major public opposition emerged, the policy measure was challenged legally by various NGOs and citizens' groups, including Za Zemiata, in January 2023. (Za Zemiata, 2023). The primary reasons for such opposition mainly revolved around the geographical scope and timeline of the measure. The first stage of the ban covers nine districts that are not among the most polluting, potentially implying limited emission reductions and, therefore, any significant improvement in public health. (Za Zemiata , 2022). After a first decision rejecting the challenge made by the plaintiffs (Decision No 2591/2024), in February 2025, the supreme administrative court up-held the decision, confirming the enforcement of the Ordinance (Decision No 1031/2025).

Impacts of the LEZ

Health effects. While health benefits have been effectively communicated at a general level, evidence of observed, population-specific improvements from the LEZ are still emerging, as the first stage of the ban began only in January 2025, and targeted research is underway (Interviewee 3, 2026); (Popov, 2026). Currently, the evaluation is planned to be scenario-based, not real-time based (Burov, 2026). Assessing social impacts also presents opportunities for refinement, as publicly available data is evolving. Municipal reports provide valuable aggregate enforcement figures, and tracking by socioeconomic groups is an area of growing focus (Burov, 2026). While the overall air quality is expected to improve with the ban, this may conceal ongoing pollution in specific areas due to the absence of detailed air pollution data categorised by socioeconomic group and location.

[16] According to the survey led by Alpha Research in October 2024 on 300 households, 55% of the respondents were not aware of the upcoming ban on the use of solid fuels for domestic heating and the deadlines for this ban, three months before the implementation of the measure. Similarly, only 23% of the respondents knew about the free replacement program under the OPE 2021-2027. Additionally, the uninformed were more likely to be representatives of lower-educated groups, pensioners and people with incomes below average. (Alpha Research, 2024).

Vulnerable communities. A potential issue is the impact of the LEZ on vulnerable communities, especially those living in informal or semi-formal housing, including the Roma community. The lack of ownership status makes them ineligible for the replacement programmes led by the municipality. As a result, in addition to being more exposed to air pollution by their heating systems, some vulnerable households are unable to switch their appliances. Many such communities are in areas exempt from the current ban, helping to mitigate immediate social impacts. Looking ahead, the ban will expand municipality-wide from January 2029, presenting an opportunity to address potential disparities. Targeted support could enable these households to adapt without facing fines, ensuring equitable air quality benefits for all residents.

City challenges

Implementing the LEZ for residential heating effectively, together with fuel appliance replacement programs, offers opportunities for the city to strengthen its approach in several areas. On the administrative side, interviewees highlighted potential to expand dedicated staff, enhance coordination across services (social, energy, housing, air quality), streamline processes, and build technical expertise. Regarding the latter, developing an in-house data-collection system could enable more efficient impact analysis, reducing reliance on external experts and supporting budget integration (Popov, 2026). Concerns about the infrastructure readiness and the housing stock quality have been raised. Indeed, cleaner heating devices, which are mostly powered with electricity, the grid infrastructure and network have to be accessible and ready for households. Financially, while funding is currently project-based and time-limited, opportunities exist to pursue more sustained, integrated support for long-term household transitions (Interviewee 3, 2026)

Transferable lessons and recommendations

Sofia is the first city in Europe to implement a LEZ for residential heating, which marked a significant step forward towards cleaner air. Consultation respondents and interviewees highlighted that the current LEZ design for residential heating offers room for improvement in cleaner air ambition, communication, and monitoring. The successful implementation of a LEZ for residential heating requires careful consideration of contextual conditions and specific prerequisites by any national, regional and/or local authority willing to adopt it. Thus, the pioneering Sofia case study offers valuable insights that can be tailored to other cities. Concerning the social considerations of the LEZ, key lessons can be summarised as follows.

1. **Conducting research and being transparent should be prioritised.** Local authorities should collect reliable data from different sources to understand the level of air pollution in the city and should strive to gather disaggregated data to better assess the impact of air pollution on the population by socio-economic groups and areas. Different scenarios should be investigated based on this data and discussed with impacted stakeholders, fostering extended and transparent exchanges.

2. **Involving all stakeholders from the early stages is essential**. Early engagement of the stakeholders will help to better understand the needs of the affected citizens. Even though consensus is hard to reach, a wide engagement will enable local authorities and decision-makers to have a better picture of the situation without the underrepresentation of citizen groups. Minorities and vulnerable communities can play a key role, and yet techniques to adequately target them can be systematically different from standard ones. It is therefore important to integrate these groups into consultation processes, especially with local representatives of those communities or NGOs.

3. **Proactive and targeted communication should be cultivated.** Communication should not focus solely on the ban itself, but rather convey clear, evidence-based messages that resonate with the population, such as the health benefits gained with the measure, financial and non-financial support. Attention should be given to vulnerable communities and low-income households. In Sofia, the sociological surveys indicate that such groups lacked knowledge of the ban and of the replacement support programs.

4. **Adopting a holistic approach is recommended**. A coherent policy mix works better than isolated measures. In addition to changing appliances, the importance of building renovation and the interconnection between energy, housing, and social policies should be considered in order to create sustainable solutions for households. In Sofia, the municipality implemented the LEZ for transport alongside the LEZ for residential heating to better address different sources of pollution. When the budget is limited, prioritise what is most important regarding your local context.

5. **Decision-makers should adopt a** "**Carrot before the stick**" **approach**. Restrictive measures are more effective and socially acceptable when affordable alternatives are set up in advance to support behavioural change. The high level of public satisfaction with the replacement programs in Sofia demonstrates the importance of adopting such a measure before introducing a ban. However, targeted funding is crucial: where the demand for financial support exceeds available resources, there is a risk that households with greater financial capacity may benefit from the support, while vulnerable ones might face fewer alternatives.

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Annex 1 Socio-demographic data in Sofia

Socio-demographic data of Sofia	
Area coverage	472 km^2 (A)[17]
Population density	2,600 habitants/km^2 (B)
GDP per capita of Sofia	EUR 31,600 (C)
GDP per capita of Bulgaria	EUR 14,700 (D)
Sofia's average annual wage	EUR 19,801 (E)
Bulgaria's average annual wage	EUR 14,257 (F)
EU average annual wage	EUR 39,800 (G)

[17] A (Mayors of Europe, n.d); B (World Population Review, 2025). Additionally, 19.7% of the population is between 0-19 years old, 61.1% between 20-64, and 19.2% is 65 or older (Republic of Bulgaria Statistical National Institute, 2024), C (Republic of Bulgaria National Statistical Institute, 2025); D (Republic of Bulgaria National Statistical Institute, 2025); E (Republic of Bulgaria National Statistical Institute, 2025); F (Republic of Bulgaria National Statistical Institute , 2025); G (Eurostat, 2025)

Annex 2 National air quality and trends

Bulgaria has experienced improvements in air quality in recent decades, with a pronounced reduction in certain air pollutants. For instance, PM10 levels between 2013 and 2024 have decreased by approximately 38% (see Fig 1) (EEA, 2024) .Nevertheless, Bulgaria ranks among the most air-polluted countries in the EU, resulting in a high number of premature deaths, especially related to particulate matter (PM). In 2021, over 13,000 premature deaths were registered due to low air quality (Statista, 2023). The main sources of air pollution in Bulgaria include domestic heating of coal and wood, combustion of coal for electricity production, industrial activities, and road transport (IQAir, 2024).

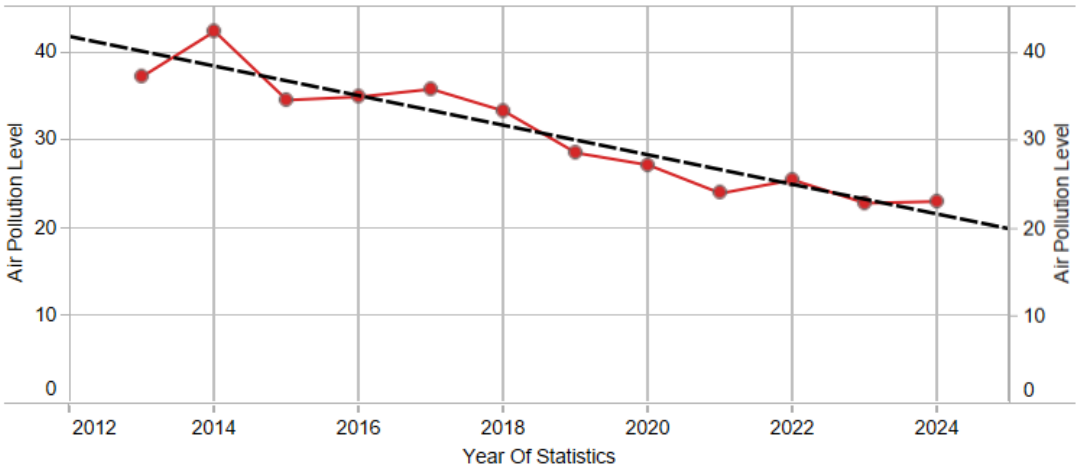

Figure 1: Annual mean of PM 10 levels in Bulgaria from 2012 to 2024. From (EEA, 2024)

In Bulgaria, in 2022, domestic heating with solid fuels was the main source of PM 2.5 (69%) and PM 10 (47%) (Andersen, et al., 2025). The country faces diverse challenges caused by this source of pollution, including cardiovascular and respiratory diseases that can lead to deaths in the worst cases (Helath Effects Institute , 2022). Another issue is the limited spatial coverage of air quality monitoring around the country. For instance, about 10 monitoring stations measure the level of PM 2.5, and their location does not necessarily register relevant high-emission areas, such as smaller towns or neighbourhoods with a high concentration of households using domestic stoves for heating. (Andersen, et al., 2025). Some municipalities, including Sofia, install a network of lower-class monitoring stations, but some concerns have been raised about the validity of those data (Andersen, et al., 2025). Additionally, many households rely on wood and coal for heating because of the affordability of this option.

Annex 3 EU legal and policy contexts

Repeated breaches of EU air quality legislation by Bulgaria have led to numerous legal proceedings. In 2017, the Court of Justice of the EU (CJEU) urged Bulgaria to take adequate measures for systematically violating the daily and annual PM limit values of the Ambient Air Quality Directive (AAQD) (Directive 2008/50/EC and failing to make and implement air quality plans (Commission v Bulgaria, C-488/15).

In 2019, the European Commission referred Bulgaria to the CJEU for not complying with the hourly and/or daily limit values for sulphur dioxide ($S0_2$) in the South-East (European Commission, 2019). In 2020, the country was brought before the court by the European Commission for failing to adhere to the ruling of 2017, with exceedances of the daily limits 2.5 times more than permitted under the AADQ (European Commission, 2020). More recently, in November 2025, Bulgaria was referred to the CJUE by the European Commission for failing to respect its emission reduction commitments required by the Directive on the reduction of national emissions of certain atmospheric pollutants (Directive (EU) 2016/2284). Such Directive targets five air pollutants, including $S0_2$ and PM2.5 (European Commission, 2025).

To address air pollution at national level and comply with EU legislations, Bulgaria has adopted several interconnected strategic documents, such as the National Program for Restricting Overall Annual National Emissions of Sulphur Dioxide, Nitrous Oxide, Volatile Organic Compounds and Ammonia in 2007, the National Program for the Improvement of Ambient Air Quality 2018-2024 – the last implementation report has been adopted in October 2025 -, and the National Air Pollution Control Program 2020-2030, which has been updated in July 2025. (Ministry of Environment and Water, 2026). Furthermore, in 2015, Bulgaria's Clean Air Law was revised through amendments, including the suggestion (but not requirement) for municipalities to create LEZs in case of increased health risks due to air pollution (Food and Agriculture Organization of the United Nations, 2023).

Annex 4 Financial supports accompanying the LEZ for residential heating

Two support programmes mainly financed the switch to clean appliances in Sofia:

1) Life Programme: financed by the EU, the measure allows specific neighbourhoods[1] to replace solid fuel stoves with pellet appliances, natural gas appliances, or air conditioners. The applications ended on the 31st of May 2025.

2) Operational Programme Environment (OPE) 2021-2027 [програма „Околна среда" 2021-2027]: the remaining neighbourhoods in Sofia can apply for a free replacement of old solid fuel stoves with a free pellet stove, heat pump or air conditioner. The application process runs until 31 December 2029. The programme aims at replacing solid fuel heating devices in 10,815 homes, which is supposed to save 222.8 tons of PM10 emissions per year (Sofia Municipality, nd). OPE is co-financed by the EU, through the Cohesion Fund, and by the Bulgarian national budget. This replacement campaign already started in 2020 under the OPE 2014-2020.

Alpha research evaluated the impacts of the replacement programmes, reporting that, among a hundred households interviewed, 97% were satisfied with the change of their heating appliances, with a slightly higher level of satisfaction for those who switched to air conditioners instead of pellets (Alpha Research, 2024). Additionally, a quarter of the respondents shared that the heating capacity increased since the switch to appliances, highlighting an increase in comfort for households. However, a few interviewees reported recent complaints from households about changing their fireplaces to air conditioners, as they perceived less thermal comfort in very cold weather conditions (Interviewee 2, 2026).

Annex 5 Public consultation comments

Sofia Municipality launched a public consultation by publishing the draft regulation for the LEZ together with the draft decision, a report, and a "partial ex-ante impact assessment" on its website. The consultation, opened between mid-June and mid-July 2022, received twelve written responses via email and post, with only three related to LEZ for residential heating (Sofia Municipality, 2022). While these responses were positive towards the introduction of a LEZ in general, the consultation respondents highlighted some weaknesses in the design, related, for instance, to the geographical scope and timeline of the measure, the control mechanism to ensure compliance and the target setting and measurability to evaluate the impact of the LEZ.

The following list gathers comments from the public consultation conducted between June and July 2022 (not comprehensive):

- Insufficient analysis and justification of the selected areas for stage 1 of the LEZ;
- Insufficient ambition for the geographical and temporal scopes of the LEZ to generate a significant and lasting impact;
- Lack of clarity on alternatives for residential heating, especially for buildings without built-in connection with district heating or gas supply networks;
- Insufficient development of scenarios for impact with different choices for the design of the LEZ;
- Insufficient scope of the ban – solid fuels only do not include heavy fuel oil, gas oil etc;
- Insufficient consideration of EU standards: banning completely firewood and allowing biomass briquettes and pellets without specific standards;
- Insufficient information on standards and requirements for heating appliances;
- Insufficient control mechanism to ensure compliance;
- Insufficient control mechanism to ensure compliance; Insufficient consideration of the LEZ's impact outside the zone;
- Insufficient target setting and measurability to evaluate impact;
- Insufficient consultation process and consideration of respondents' previous comments

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