



POSITION PAPER* ON INDOOR AIR QUALITY

***Excluding Radon and Environmental Tobacco Smoke. The main focus of this paper is on the air pollutants associated with domestic use of Solid Fuels**

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MAY 13, 2022

HSE

Abbreviations

AQIH	Air Quality Index for Health
CAFE	Ambient Air Quality and Cleaner Air for Europe Directive (2008/50/EC)
CO	Carbon monoxide
CO ₂	Carbon dioxide
COVID-19	Coronavirus disease
DCCAE	Department of Communications, Climate Action and Environment
EPA	Environmental Protection Agency
ETS	Environmental tobacco smoke
EU	European Union
HiAP	Health in All Policies
HPSC	Health Protection Surveillance Centre
HVAC	Heating, ventilation, and air conditioning
IAQ	Indoor air quality
NO ₂	Nitrogen dioxide
PM	Particulate matter
PM _{2.5}	Fine particulate matter that is 2.5 microns or smaller in size.
PAHs	Polycyclic aromatic hydrocarbons
PHMEHG	Public Health Medicine Environment and Health Group
SARS-Co-V-2	Severe acute respiratory syndrome coronavirus 2
VOCs	Volatile organic compounds
WHO	World Health Organization

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Summary

Poor air quality is estimated to cause 1, 400 premature deaths in Ireland annually, with air pollution resulting from the production of particulate matter (PM) and other pollutants from solid fuel burning contributing to 1,300 of these deaths¹. New research has found increased evidence of adverse health effects at much lower levels of air pollution than had previously thought, particularly cardiovascular and respiratory conditions. Population most vulnerable to the impacts of poor air quality include children, pregnant women, older people, and people with underlying chronic health conditions, low-income and minority and ethnic groups.

Irish research has found that in winter, over 60% of ambient air pollution is caused by burning peat, and 10% due to burning wood². This has resulted in frequent exceedances of the older 2005 World Health Organization (WHO) air quality guidelines for PM and polycyclic aromatic hydrocarbons (PAHs) especially in smaller towns and villages where the burning of solid fuel is often more common or where there are less-alternatives for home-heating. The ban on burning smoky coal was extended nationwide in January 2022 and new solid fuel regulations covering other smoky fuels will be introduced in September 2022³. This should result in improvements in air quality measurements. However, it does not cover the burning of turf which is used by many households in the midlands and northwest.

The updated 2021 WHO Air Quality Guidelines have set pollution levels that are significantly lower than previously⁴. The CAFE Directive European Union (EU) air quality standards which are legally binding are currently being reviewed and may be brought in line with the updated stricter WHO guidelines. Whilst measurements of concentrations of PM_{2.5} and PAHs are currently below the CAFE Directive air quality standards, any revision may mean that Ireland consistently fails to meet the new legally binding levels.

Strategies to improve indoor air quality include:

1. Source Control, transitioning to cleaner fuels and policies to reduce the emissions from solid fuels and stoves
2. Justice in transition to enable the above, in terms of:
 - i. Implementing an energy poverty strategy ensuring that cleaner fuels are affordable for all households
 - ii. Addressing loss of income for turf-harvesters
3. Increasing energy efficiencies, with building regulations for new builds and increasing retrofitting of older housing stock
4. Improved ventilation through building regulations
5. Improving air quality standards and extended air monitoring networks
6. Communication and raising awareness amongst households
7. An integrated, interdisciplinary Health in All Policies (HiAP) approach

Background

Indoor Air Quality (IAQ) refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants⁵.

Indoor air pollution is increasingly recognised as a public health problem^{6, 7, 8, 9, 10}. Most people, especially in urban areas spend around 90% of their time indoors, whether at home, at work, in schools or other locations^{11, 12, 13}. Factors affecting indoor air quality include ventilation, cleaning conditions, building characteristics, products used in households, cultural habits, climate and outdoor environment¹⁴. Concentrations of air pollutants can be higher indoors than outdoors^{15, 16, 17}. While the source of some air pollutants is from outside, the origin of most air pollutants is from inside the building itself, e.g. burning fuel or cleaning products^{18, 19}. Because of this personal exposures to these contaminants are not adequately captured by outdoor / ambient air monitoring²⁰. Management of indoor air quality may therefore require a different approach than management of outdoor air quality²¹.

Pollutants

There are over 900 indoor air pollutants²². Amongst the more important indoor air pollutants associated with health effects are^{23, 24, 25, 26, 27, 28, 29, 30, 31} :

- particulate matter (PM), especially PM_{2.5},
- carbon monoxide (CO),
- nitrogen dioxide (NO₂),
- environmental tobacco smoke (ETS)
- radon
- volatile organic compounds (VOCs) including benzene
- polycyclic aromatic hydrocarbons (PAHs)
- biological air pollutants – bacteria, fungi, viruses – including SARS Co-V-2, and pollen

Whilst environmental tobacco smoke and radon are both important indoor air pollutants they are not covered in this paper. The main focus is on air pollutants associated with domestic use of solid fuels.

Health Effects

Poor air quality is estimated to cause 1, 400 premature deaths in Ireland annually, with air pollution resulting from the production of particulate matter (PM) and other pollutants from solid fuel burning contributing to 1,300 of these deaths³². PM is also associated with significant morbidity³³.

Health effects of Pollutants associated with domestic use of solid fuels

Particulate Matter

Both PM_{2.5} and PM₁₀ are capable of penetrating deep into the lungs but PM_{2.5} and ultrafine PM can enter the bloodstream, resulting in cardiovascular and respiratory impacts, and also

affecting other organs. PM_{2.5} are particulate matter with a diameter of 2.5 µm or less and ultrafine PM are <0.1 µm. The degree of toxicity is greater for smaller particles³⁴.

The range of health effects that PM_{2.5} can cause includes^{35, 36, 37, 38, 39, 40}:

- Asthmatic attacks
- Bronchitis
- Bronchiolitis
- Pneumonia
- Chronic obstructive pulmonary disease
- Lung cancer
- Eye, nose, and throat irritation
- Coughing
- Sneezing
- Runny nose
- Shortness of breath
- Cardiovascular disease
- Stroke

New epidemiological studies have found increased evidence of adverse health effects at much lower levels of air pollution than had previously been studied^{41, 42}. In fact there is growing evidence that the adverse health effects of air pollution can be observed all the way down to very low concentration levels, with no observable thresholds below which exposure can be considered safe⁴³. The Air Quality Index for Health which was developed by the [EPA](#) and the [HSE](#) provides health advice for the general public based on the air quality measurements at their nearest air monitoring station.

Carbon Monoxide

Carbon Monoxide (CO) is a colourless, odourless, poisonous gas. Important indoor sources are incomplete combustion of domestic fuels from badly-installed, faulty, damaged or blocked appliances, chimney or flue in association with poor ventilation. Particulate matter emission dominates at the start of combustion but CO dominates at the end⁴⁴.

Common short-term symptoms of CO poisoning include poor concentration, memory and vision problems at low levels. Higher levels can cause vomiting, nausea, weakness, dizziness, fatigue, headache, increased symptoms of ischaemic heart disease and loss of consciousness^{45, 46}. At very high levels CO can kill within a matter of hours. On average six people die annually from accidental CO poisoning. However, one study examining HIPE data estimated that CO poisoning is responsible for over 40 deaths per year in Ireland, when house fires are included⁴⁷. Long term exposure to low levels of CO may produce heart disease and damage to the nervous system, and it is a category 1 reproductive toxin⁴⁸.

Nitrogen Dioxide

The most important indoor sources of NO₂ include ETS, and as with PM and CO incomplete combustion of domestic fuels⁴⁹. The threshold levels for indoor NO₂ the same as the ambient air guideline. Exposure to levels above the threshold levels result in adverse respiratory

health effects such as increased inflammation of the lungs, cough and wheezing and increased asthmatic attacks and reduced lung function⁵⁰.

Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) are emitted from the combustion of solid fuels, such as peat, wood and coal. Domestic heating is the dominant source. PAHs and in particular benzo (a) pyrene (BaP), which is used as a marker for PAHs, are known carcinogens⁵¹. Ireland was above the EU reference levels at 4 of the 5 monitoring stations for PAHs in 2020⁵².

Volatile Organic Carbons / Benzene / Formaldehyde

Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. They can have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors⁵³. VOCs are emitted by a very wide range of products, including the following common products and indoor furnishings, e.g.:

- Petrol, other fuels, and solvents.
- Paints, stains, strippers, and finishes.
- Pesticides.
- Personal care products.
- Aerosol sprays.
- Cleaners, disinfectants and room deodorisers.
- New furniture.
- New carpets, rugs, and wood floors
- Office equipment such as copiers and printers

Health effects of VOCs include:

- Eye, nose and throat irritation,
- epistaxis,
- allergic skin reactions,
- headaches,
- loss of coordination,
- nausea,
- Shortness of breath,
- liver, kidney and central nervous system damage.

Benzene can also cause cancer and no safe level of exposure is recommended⁵⁴. The WHO threshold limit value is 100 mg/m³.

Indoor exposures to formaldehyde through inhalation is the dominant contributor to personal exposure and indoor concentrations may be high enough to cause adverse health effects⁵⁵. However, formaldehyde can be smelled at levels below those which cause short-

term sensory irritation effects. The use of the short-term (30-minute) guideline of 0.1 mg/m³ will also prevent long-term health effects, including cancer.

General mitigating measures for VOCs include reducing use of these products, increasing ventilation when using these products, or to use outdoors only. Products should be used according to the manufacturer's instructions^{56, 57}.

As VOC emissions reduce over time, use, reuse and repair of older furniture and products has value here.

Biological air pollutants

Exposure to microbial contaminants is associated with respiratory symptoms, allergies and asthma, and can affect the immunological system^{58, 59}. Sick-building syndrome is a non-specific group of symptoms that can affect multiple occupants of a building⁶⁰. Symptoms include flu-like symptoms, headaches, nausea, and irritation of the eyes, nose, and throat^{61, 62}. Poor indoor air quality can reduce the performance of office workers by 6–9%⁶³.

We have become very aware of the risk of COVID-19 which results from exposure of vulnerable people to SARS Co-V-2, especially in poorly ventilated crowded indoor spaces.

Vulnerable populations

Population most vulnerable to the impacts of poor air quality include but are not limited to:^{64, 65, 66, 67, 68, 69}

- Children
- Pregnant women
- Older people
- People with underlying chronic health conditions, e.g. cardiovascular or respiratory conditions
- Low-income
- Minority and ethnic groups

Guidelines / Standards

Air Quality Guidelines

The World Health Organization (WHO) has developed guidelines for indoor air quality on different topics⁷⁰:

- biological indoor air pollutants (dampness and mould)⁷¹
- pollutant-specific guidelines (chemical pollution)⁷²
- pollutants from indoor combustion of fuels⁷³
- as well as updated ambient air quality guidelines⁷⁴.

WHO indoor air quality guidelines for household fuel combustion recommendations include⁷⁵: setting emission rate targets for household stoves for PM_{2.5} and CO; encouraging governments to increase access to clean fuels and encouraging the maintenance and replacement of stoves over time; and preventing use of unprocessed coal as a household fuel.

The updated WHO Air Quality Guidelines set pollution levels that are significantly lower than previously, especially for the six air pollutants with the largest health impact where evidence has advanced the most⁷⁶. WHO guidelines are advisory only, however, the European Union (EU) air quality standards are legally binding.

Air Quality Standards

Within the EU a series of Directives set the ambient air quality standards to provide protection from excessive pollution concentrations:

- the Ambient Air Quality and Cleaner Air for Europe (CAFE) Directive (2008/50/EC),
- and the fourth daughter Directive 2004/107/EC.

The CAFE Directive was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011). The 4th Daughter Directive was transposed by the Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations 2009 (S.I. No. 58 of 2009).

A comparison of the current EU standards with the 2005 and the updated 2021 ACQ are given in the following table.

<i>Pollutant</i>	<i>Averaging period</i>	<i>EU standard</i>	<i>WHO 2005 AQG</i>	<i>WHO 2021 ACQ</i>
Fine particles (PM _{2.5})	24 hours		25 µg/m ³	15 µg/m ³
	1 year	20 µg/m ³	10 µg/m ³	5 µg/m ³
Sulphur dioxide (SO ₂)	24 hours	125 µg/m ³	20 µg/m ³	40 µg/m ³
Nitrogen dioxide (NO ₂)	1 year	40 µg/m ³	40 µg/m ³	10 µg/m ³
PM ₁₀	24 hours	50 µg/m ³	50 µg/m ³	45 µg/m ³
	1 year	40 µg/m ³	20 µg/m ³	15 µg/m ³
Carbon monoxide (CO)	Maximum daily 8 hour mean	10 mg/m ³	*10mg/m ³ in 8 hours 7mg/m ³ in 24 hours	4 mg/m ³ in 24 hours

*2010 guideline⁷⁷

As part of the European Green Deal (zero pollution ambition), the EU is revising these standards, to align them more closely with the 2021 updated recommendations of the World Health Organization.

Recommendations

The PHMEHG has made a submission to Consultation on the Development of a New Solid Fuel Regulation for Ireland, 2021⁷⁸. The recommendations included:

- Timely updating and strengthening of current Irish air quality standards. And that the requirement for regular updating should be embedded in legislation
- Standards should be set according to health benefits, not associated costs
- The extension of ambient air quality network to include more residential settings, to allow for more granular identification of ‘hot spots’ of air pollution

Air Pollution from Solid Fuel Burning in Ireland

Residential heating with solid fuel is an important source of ambient (outdoor) air pollution; but it can also cause substantial indoor air pollution through either direct exposure or infiltration from outside^{79, 80}.

The following table from the census quarterly household behaviours surveys for Quarter 3 2021 shows the main heating fuel used by region⁸¹.

	% of weighted households				
	Natural gas	Heating oil ¹	Electricity	Solid fuel ²	Other
Border	4%	66%	7%	20%	2%
Dublin	69%	8%	18%	2%	1%
Mid-East	45%	36%	8%	6%	2%
Mid-West	27%	43%	13%	13%	3%
Midland	16%	44%	6%	31%	2%
South-East	20%	52%	11%	14%	1%
South-West	33%	44%	11%	8%	2%
West	6%	58%	13%	17%	3%
State	37%	37%	12%	11%	2%

¹Kerosene, diesel/gas oil and LPG; ²Wood logs, coal, peat and wood pellets

In addition, solid fuel is used as a supplementary heating source so the incidence of solid fuel use is higher⁸².

In 2015, the average Irish dwelling emitted 60% more energy related carbon dioxide (CO₂) than any other EU country⁸³. 15% of energy used in Irish households is from direct use of coal and peat. These are the two most carbon intensive fuels, and Ireland uses more of them per dwelling than any other EU member state, apart from Poland⁸⁴.

There have been little measurement of indoor air pollutant levels in Ireland. Research carried out on behalf of the EPA in Irish and Scottish homes in 2013 found that peat-burning homes had PM_{2.5} concentrations approximately twice that of ambient air with the average 24-hour PM_{2.5} concentrations being almost six times the WHO 2005 air quality standard

value of $25 \mu\text{g}/\text{m}^3$ ⁸⁵. Modern wood burning stoves can also result in emissions which contribute to ambient air pollution exceeding guideline levels⁸⁶.

Irish research of ambient air quality has found that whilst measurements of concentrations of $\text{PM}_{2.5}$ and PAHs are below the CAFE Directive air quality standards, the WHO 2005 air quality guideline levels were exceeded at many of the air monitoring sites especially in winter time^{87, 88}. A study published in 2021 found that the 2005 WHO AQ guidelines were exceeded on 1 in 5 days in winter in Ireland during 2021. The authors found that 62% of air pollution during winter was caused by peat, with wood being responsible for 10%, coal 3% and oil / traffic 13%. 70% of the high pollution levels during these events was attributed to peat and wood burning, despite only a small percentage of residential homes using peat or wood as a primary fuel type⁸⁹.

The figure below shows that elevated $\text{PM}_{2.5}$ is more prevalent in smaller towns and villages (zones C and D) where the burning of solid fuel is often more common or where there are less-alternatives for home-heating.

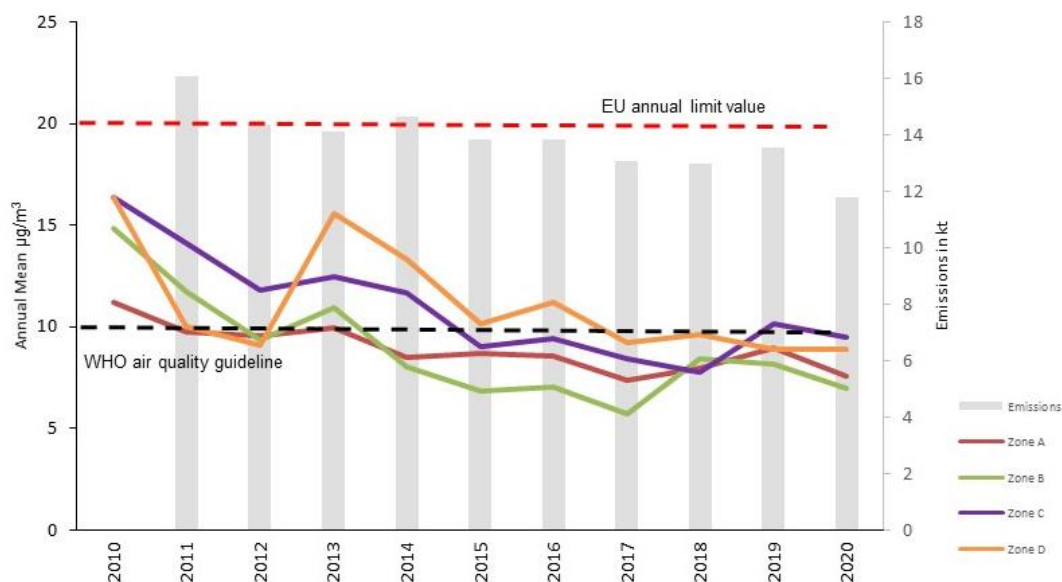


Figure: Long-term trends in ambient $\text{PM}_{2.5}$ concentrations for Zones (using selected stations) in Ireland (with national emissions figures presented in bar chart)⁹⁰ (Environmental Protection Agency, 2021).

Ennis, Enniscorthy and Letterkenny regularly exceed the 2005 WHO air quality guideline values especially on cold winter days with thermal inversion⁹¹. The PHMEHG has in their submission on the development of a new solid fuel regulation recommended the extension of the smoky fuel ban nationwide⁹². The smoky coal ban was extended nationwide in January 2022 and new solid fuel regulations covering other smoky fuels will be introduced in September 2022⁹³. The findings from ambient air quality measurements during 2022/2023 will inform the effectiveness of this ban. Turf which is widely used in rural areas is not covered by this legislation so we may not see the expected improvement in air quality. It is highly likely that Ireland will fail to meet the updated WHO air quality guidelines nationally.

Prevention of Air Pollution from Solid Fuel Burning

Strategies to improve indoor air quality include^{94, 95, 96}:

1. Source Control and policies to reduce the emissions from solid fuels and stoves used for domestic heating^{97, 98, 99}
2. Implementing a just transition and an energy poverty strategy¹⁰⁰
3. Increasing energy efficiencies
4. Improved Ventilation^{101, 102}
5. Use of air cleaners¹⁰³
6. Improving air quality standards and extended air monitoring networks¹⁰⁴
7. Communication and raising awareness¹⁰⁵
8. Integrated, interdisciplinary approach¹⁰⁶

Source Control

Usually the most effective way to improve indoor air quality is to eliminate individual sources of pollution or to reduce their emissions¹⁰⁷.

Switching to cleaner fuels

Residential solid fuel heating is the largest source of PM_{2.5} and PAHs (responsible for over 50% and 90% respectively) in Ireland so tackling this source should have a significant impact on both PM and PAHs, in addition to CO and NO₂¹⁰⁸. A 2021 EPA report estimates show that specifically targeting 100% reduction of emissions of wood and peat would reduce PM concentrations by 52–70%¹⁰⁹. However, the use of wood as a heating fuel may be increasing in part as a response to higher fossil fuel prices¹¹⁰. And threats of black outs will lead to increased reliance on sold fuels¹¹¹.

In Ireland the prohibition of the sale and marketing of smoky coal was first introduced in Dublin in 1990 and then by 2020 was extended to all cities and towns with populations above 10,000. Research on the effects of the smoky coal bans in Ireland has found an improvement in both air quality and health, especially for respiratory outcomes^{112, 113}. The successive Irish coal bans resulted in immediate and sustained decreases in PM concentrations in each city or town where the bans were introduced; with the largest decreases in winter and during the heating season. The bans were associated with reductions in respiratory mortality and hospitalisations. There was a smaller reduction in hospital admissions for cardiovascular disease but no detectable improvement in cardiovascular mortality.

Since the beginning of 2022 the smoky coal ban has been extended nationwide and regulations will be introduced in September 2022 to cover other smoky fuels¹¹⁴. These regulations will cover coal, peat briquettes and wood, but turf is not expected to be included. Coal, coal-based products, any manufactured solid fuel or peat briquettes sold in the State are now required to have a smoke emission rate of less than 10grams/hour, reducing to 5g/hr by 2025. Sulphur content permitted for all fuels will be reduced from 2% to 1% over time. Wood sold in single units under 2 cubic metres in size will be required to have a moisture content of 25% or less moving to 20% within four years. Wet wood sold

over these volumes will be required to come with instructions for the purchaser on how to dry this wood.

In its submission on the new solid fuel regulation, the PHMEHG note that a lack of uniformity of standards across Ireland pertaining to solid fuel regulation creates health inequities and that a more standard approach across Ireland would highlight problems and aid abatement measures in the most polluted parts of the country¹¹⁵.

Recommendations

- The PHMEHG supports the extension of the smoky fuel ban across Ireland.

Justice in transition to cleaner energy sources

The transition from smoky carbon based fuel sources to cleaner energy sources can result in increased inequity between those that can afford the transition and those that cannot if supportive measures are not put in place to ease the transition.

Measures to reduce energy poverty

Three factors can cause Energy Poverty:

- Income.
- Energy costs.
- The energy efficiency of their home.

A household is considered energy poor if it spends more than 10% of their disposable income on energy costs. The WHO 2019 country profile for environmental inequalities found that the energy poverty rate in Ireland increased 1.9 times between 2008 and 2016. The proportion of the population reporting problems paying energy bills increased from 9% to > 17% during this time period¹¹⁶. Energy costs have soared since the start of the recent war in Ukraine in February 2022. This will result in a large increase in the population of Ireland at risk from energy poverty.

Reliance on traditional solid fuels is closely linked to poverty¹¹⁷. There is an association between energy poverty levels and areas of deprivation with residential pollution hot spots where solid fuel is used as the primary heating source¹¹⁸. Households at risk of energy poverty may buy solid fuels because of the heating system available to them and the fact that solid fuels can be purchased on demand in smaller amounts. While more research is required, almost all of the identified residential pollution hot spots in Ireland are in deprived or very deprived areas. These areas predominantly use coals or peat for heating with little use of oil or gas and thus the potential exists for negative impacts on air quality to elevate mortality and add to deprivation in these areas¹¹⁹.

Economic measures to promote the uptake of low emission fuels should be implemented alongside measures to reduce emissions from domestic fuel use and policies on energy efficiency^{120, 121}. Care needs to be given to ensure that, where possible, fuel poverty does not arise as a consequence of this policy. Securing a rapid transition to clean, efficient and

modern household energy systems for cooking, heating, lighting and other household uses will present challenges, especially for lower-income households¹²². There is a need for much more emphasis on accelerating access to clean household fuels.

Recommendations

The following two recommendations are from the PHMEHG submission on solid fuel regulation¹²³:

- The PHMEHG recommends implementation of significant and sustainable incentives for all using solid fuels to switch to less polluting production alternatives/techniques.
- The PHMEHG recommends that less polluting fuels are made more affordable and easily available for households that suffer from fuel poverty.
- In addition the PHMEHG strongly recommends the implementation of the Energy Efficiency and Energy Poverty a Strategy to Combat Energy Poverty 2016-2019 which sets out the national strategy to address energy poverty.

The PHMEHG commends the government for the recent review of the National Home Energy Upgrade Scheme. This now provides for increased grant levels of up to 50% of the cost of a typical retrofit to a B2 BER standard (up from the current 30 - 35% grants), in addition to increasing the number of free energy upgrades for those at risk of energy poverty to 400 per month.

Recommendation

- The PHMEHG recommends that the revised National Home Energy Upgrade Scheme be implemented as quickly as possible.

Addressing loss of income and way of life for turf-harvesters

Cutting and harvesting turf in the summer months has been a way of life for many people living in rural areas, especially in the midlands. Many families have an area of bog which generation after generation have harvested to provide them with enough fuel to warm their houses during the winter months. It is also sold on to neighbours to help them likewise to heat their homes. These turf-harvesters face an uncertain future. There has also been a dramatic reduction in commercial peat production with resultant loss of employment. Other countries have shown that a just transition is possible by engaging with stakeholders and offering a significant financial support and other social safety nets to those disproportionately affected by the transition¹²⁴.

Recommendation

- PHMEHG recommends that all stakeholders should work together to consider how to encourage reduced use of turf without resulting in negative financial impact on households affected.
- PHMEHG commends the Irish government for funding a Just Transition programme for the Midlands. This will include retraining, funding for new enterprises including in renewable energy and investment in the tourism,

heritage and leisure sectors. This initiative if successful should be extended to other parts of the country where turf is harvested.

Increased energy efficiency

More efficient heating methods can reduce emissions from solid fuel heating devices^{125, 126}. Policies on energy efficiency should be implemented alongside measures to reduce emissions from domestic fuel use^{127, 128}. The EU Energy Performance of Buildings Directive as amended by Directive (EU) 2018/844 was transposed into Irish law through Part L of the Second Schedule to the Building Regulations (Energy Performance of Buildings) Regulations (S.I. No. 292 of 2019 and S.I. No. 393 of 2021)¹²⁹. Part L deals with improving energy efficiency, reducing CO₂ emissions and limiting heat loss from buildings¹³⁰. These regulations have led to an improvement in energy efficiency of housing stock^{131, 132}. New houses or those renovated require a Building Energy Rating (BER) of B2 or equivalent. A BER certificate shows a building's energy performance. Most existing dwellings (houses or apartments) are energy inefficient. Seventy-eight per cent of dwellings have a C2 BER or worse¹³³.

The Eco Design Directive 2009/125/EC covers all energy-related products sold in the domestic, commercial and industrial sectors. The Directive was transcribed into Irish law by S.I. No. 96/2021 - European Union (Ecodesign Requirements for Certain Energy-related Products) (Amendment) Regulations 2021. 'Ecodesign' means that there is a greater focus on lifetime energy use and other environmental aspects during the conception and design phases, before it is manufactured and brought to market. Its primary aim is to reduce energy use, however it is also aimed at reducing polluting emissions. The Directive came into effect in January 2022 for eco-design requirements for solid fuel local space heaters. This will impact the specification and certification of new solid fuel burners coming into the market. The Energy Labelling regulation 2017/1369 complements the Ecodesign Directive by providing the information about the performance of the appliances.

Recommendations

- The PHMEHG recommends that the Eco Design Directive and Energy Labelling Directive be considered as a means to improve air quality and reduce the emissions from solid fuel appliances for sale on the market in Ireland.
- The PHMEHG recommends that the resources required to enforce the requirements under these directives are put in place.

Communication

Policies to reduce the use of smoky fuels and the transition to cleaner fuels, together with measures to increase energy efficiencies and reduce energy poverty need to be supplemented by raising the information and communication profile of the issue to householders¹³⁴.

The 'ABC for Cleaner Air' campaign, launched by the Department of Communications, Climate Action and Environment (DCCA) in 2021, highlights some simple steps that can be

taken to help reduce pollution from solid fuels including switching to cleaner fuels and maintenance of chimneys and stoves¹³⁵.

The Environmental Protection Agency - EPA's [infographic](#) highlights how households can reduce air pollution through better fuel and appliance choice.

Recommendations

- The PHMEHG recommends that educational campaigns are used as tools to reduce emissions from residential solid fuel heaters, supported by clear communications to ensure public engagement and the best outcome for air quality and health^{136, 137}.
- The PHMEHG also recommends that research be conducted on how to change the traditional Irish cultural perception that an open fireplace represents the hearth of a home and is a welcoming sign to all visitors.

Ventilation

Usually the most effective way to deal with indoor pollutants is to either remove the source or reduce emissions from it^{138, 139}. If these are not possible, the pollutant can be diluted by ventilation to reduce exposure. Inadequate ventilation is one of the most important factors leading to poor indoor air quality^{140, 141, 142}. Inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the area. Carbon dioxide (CO₂) monitors can be useful to identify areas that need improved ventilation¹⁴³. Outdoor pollutants can also enter through windows or gaps in the structure and are a significant contributor to indoor air quality, particularly in deprived areas¹⁴⁴.

Buildings are ventilated by natural systems such as vents, windows and chimneys, or by mechanical systems such as extractor fans or heating, ventilation, and air conditioning (HVAC), or a combination of both^{145, 146, 147}. Opening windows and doors at home is the simplest way of improving ventilation for most people. Local bathroom or kitchen fans that exhaust outdoors remove contaminants directly from the room where the fan is located and also increase the outdoor air ventilation rate. Another natural process called infiltration allows air to enter buildings through openings, joints and cracks in walls, floors and ceilings, and around windows and doors. Unless buildings are built with special mechanical means of ventilation, those designed and constructed to minimise the amount of outdoor air that can "leak" in and out may have higher indoor pollutant levels¹⁴⁸.

There are legislative requirements¹⁴⁹ and other government^{150, 151, 152} and HPSC guidance¹⁵³ regarding the use of ventilation. Ventilation of enclosed places of work is a requirement under the Safety, Health and Welfare at Work Act (General Application) Regulations, 2007. Part F of the Building Regulations aims to improve ventilation of occupied spaces to minimise the risk of condensation, mould growth and/or other indoor air quality problems. The means of ventilation used can have a significant effect on building energy use, and therefore can affect compliance with the requirements of Part L of the Building Regulations which helps to ensure that new buildings are more airtight¹⁵⁴. Where buildings are more

airtight and make use of advanced insulation materials that help to reduce the loss of energy can result in a reduction in the circulation of fresh air¹⁵⁵.

Improvements in the standards of living have led to reduced reliance on smoky fuel products with resultant improved indoor air quality. However, it has also resulted in increased use of using indoor heating and cooling systems instead of natural ventilation system especially in offices. SBS symptom prevalence is significantly higher in buildings with simple mechanical ventilation than in buildings with natural ventilation¹⁵⁶.

Recommendation

- The PHMEHG recommends that measures are taken to ensure that the implementation of the Building Regulations does not have a negative impact on indoor air quality.

Additional actions

HEPA filters

HEPA Filters (in-home high efficiency particulate air) may reduce health effects from indoor air pollution. The effectiveness of an air cleaner depends on how well it collects pollutants from indoor air (expressed as a percentage efficiency rate) and how much air it draws through the cleaning or filtering element (expressed in cubic feet per minute). The long-term performance of any air cleaner depends on maintaining it according to the manufacturer's directions¹⁵⁷.

CO Monitors

European law requires a carbon monoxide standard to protect against immediate injury or death where carbon monoxide accumulates in the indoor environment. CO alarms can alert occupants of indoor air pace of high levels. These alarms should carry the CE mark and comply with the European Standard EN 50291 and be installed in accordance with the manufacturer's instructions¹⁵⁸.

Recommendation

- The PHMEHG recommends that every household in Ireland that uses solid or fossil fuel for heating or cooking should have a certified CO monitor inserted. Economic assistance should be available for those at risk of energy poverty to allow them to purchase CO monitors.

Integrated approach

An integrated package of measures is likely to be more effective in improving public health by reducing air pollution from solid fuel use for home heating¹⁵⁹. These include reduction of solid fuel use and emissions, education and communication but most important is that justice in transition and energy poverty are addressed. Adequate support mechanisms need to be provided for their effective implementation.

It is important that an integrated policy approach is taken to avoid perverse effects, e.g. to ensure that coal is replaced by cleaner, more efficient low carbon alternatives¹⁶⁰. The findings that over 70% of ambient air pollution in winter is due to burning of peat and wood highlights the potential negative health impact of encouraging use of biomass fuels. We need to move away from domestic burning to improving homes / renovations¹⁶¹. However, the use of solid fuels for heating is expected to persist and probably even expand within the EU in the coming decades as a result of climate policies that favour wood burning¹⁶². Replacing coal with biomass, as an alternative to fossil fuels as a policy measure to reduce greenhouse gas emissions, will in itself not necessarily have a major health improvement impact due to increases in air pollution. However, measures to reduce reliance on open fires nationally by promoting cleaner, more efficient low carbon alternatives would deliver both clean air and climate benefits, likely in a cost effective manner^{163, 164, 165, 166}. Health in All Policies (HiAP) is an approach to public policies across sectors that systematically takes into account the health implications of decisions, seeks synergies, and avoids harmful health impacts in order to improve population health and health equity¹⁶⁷. This is the approach that should be taken in Ireland to mitigate air pollution.

Recommendations

- The PHMEHG recommends the development and adoption of intersectoral policies that aim to reduce air pollution from all sources, as there is potential to generate important health co-benefits without negative effects¹⁶⁸. PHMEHG strongly recommends that a HiAP approach is taken¹⁶⁹.
- The PHMEHG recommends that the Department of Communications, Climate Action and Environment (DCCA) national Clean Air Strategy is published as soon as possible¹⁷⁰.

Conclusions

Poor air quality is estimated to cause 1, 400 premature deaths in Ireland annually, mainly due to air pollution and production of PM and other pollutants from solid fuel burning. Irish research has found that in winter, the main cause of air pollution and exceedances of air standards is burning peat and wood especially in small towns and villages. Cardiovascular, respiratory conditions and stroke are the main health effects. Vulnerable populations include children, pregnant women, older people, and people with underlying chronic health conditions, low-income and minority and ethnic groups.

The CAFE Directive European Union (EU) air quality standards which are legally binding are currently being reviewed and may be brought in line with the updated stricter WHO guidelines. Whilst measurements of concentrations of PM_{2.5} and PAHs are currently below the CAFE Directive air quality standards, any revision may mean that Ireland consistently fails to meet the new legally binding levels. The ban on smoky fuel has been extended nationwide since January 2022 which should improve air quality. However, it does not cover the burning of turf which is used by many households in the midlands and northwest.

Strategies to improve indoor air quality include:

1. Source Control, transitioning to cleaner fuels and policies to reduce the emissions from solid fuels and stoves
2. Justice in transition to enable the above, in terms of:
 - i. Implementing an energy poverty strategy ensuring that cleaner fuels are affordable for all households
 - ii. Addressing loss of income for turf-harvesters
3. Increasing energy efficiencies, with building regulations for new builds and increasing retrofitting of older housing stock
4. Implementing an energy poverty strategy ensuring that cleaner fuels are affordable for all households
5. Improved ventilation through building regulations
6. Improving air quality standards and extended air monitoring networks
7. Communication and raising awareness amongst households
8. An integrated, interdisciplinary HiAP approach

PHMEHG recommendations

- Implementation of significant and sustainable incentives for all using solid fuels to switch to less polluting production alternatives / techniques¹⁷¹.
- Less polluting fuels should be made more affordable and easily available for households that suffer from fuel poverty.
- Additional measures should be put in place to assist households that rely on turf as a heating fuel. All stakeholders should work together to consider how to encourage reduced use of turf without resulting in negative financial impact on households affected.
- The Irish Government's Just Transition programme for the Midlands initiative if successful should be extended to other parts of the country where turf is harvested.
- Implementation of the Energy Efficiency and Energy Poverty a Strategy to Combat Energy Poverty 2016-2019 which sets out the national strategy to address energy poverty.
- The Eco Design Directive and Energy Labelling Directive be considered as a means to improve air quality and reduce the emissions from solid fuel appliances for sale on the market in Ireland.
- The resources required to enforce the requirements under the above directives be put in place.
- The revised National Home Energy Upgrade Scheme be implemented as quickly as possible.
- Timely updating and strengthening of current Irish air quality standards. And that the requirement for regular updating should be embedded in legislation¹⁷².
- Standards should be set according to health benefits, not associated costs.
- The extension of ambient air quality network to include more residential settings, to allow for more granular identification of 'hot spots' of air pollution.
- Educational campaigns be used as tools to raise awareness of the impacts of poor air quality to reduce emissions from domestic use of solid fuels, supported by clear

communications to ensure public engagement and the best outcome for air quality and health.

- Research be conducted on how to change the Irish cultural perception that an open fireplace represents the hearth of a home and is a welcoming sign.
- Measures should be taken to ensure that the implementation of the Building Regulations does not have a negative impact on indoor air quality.
- Every household in Ireland that uses solid or fossil fuel for heating or cooking should have a certified CO monitor inserted. Economic assistance should be available for those at risk of energy poverty to allow them to purchase CO monitors.
- HiAP approach is taken for the development and adoption of intersectoral policies that aim to reduce air pollution from all sources. Consultants in Public Health Medicine (specialising in/working in health protection) are key stakeholders and should be involved in the development of policies from public health perspective.
- The Department of Communications, Climate Action and Environment (DCCAE) national Clean Air Strategy is published as soon as possible¹⁷³.
- Awareness raising be conducted on reducing use of products containing VOCs, and on the importance of increasing ventilation or outdoor use of these products.

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