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1.

The big picture: buildings - a key determinant of health

Buildings: They shape our health and wellbeing on a daily basis regardless of whether we talk about homes, schools, workplaces, health care facilities, universities, shopping centers, or those used for religious or recreational purposes. With a majority of our time – about 20 hours a day - spent indoors, the buildings surrounding us, both residential and non-residential, are a crucial but often overlooked determinant of health.

The built environment impacts our health through a variety of factors including inadequate ventilation, poor indoor air quality, chemical contaminants from indoor or outdoor sources, by making us feel too cold or too hot, traffic noise or poor lighting.

The results are respiratory and cardiovascular diseases from indoor air pollution; illness and deaths from temperature extremes and inadequate energy access; anxiety and depression when buildings can't provide a sense of safety; as well as discomfort from less than optimal lighting conditions or irritability from noise levels.ⁱ

Unhealthy buildings even result in a distinct medical condition, known as Sick building syndrome (SBS)ⁱⁱ. With one in six Europeans living in homes that make them sick¹, unhealthy buildings are a widespread problem that need political and public attention.

In addition to those direct health consequences, there is also an environmental perspective. Buildings are an important sector to tackle if we are to protect health from the impacts of climate change since they are responsible for a third of the EU's greenhouse gas

emissions and consume 40% of total energy in the EU. The buildings sector has been rightly identified as one of the key sectors in need of transformation to achieve the 2020 climate targets of the European Unionⁱⁱⁱ as well as the Paris Climate Agreement to limit global warming well below two degrees.

Almost all existing buildings could benefit from an upgrade in order to reduce their energy demand and make them more energy efficient. Accelerated energy-efficiency measures and a shift away from fossil fuels - which still supply 82% of final energy consumption globally - are needed to achieve much needed zero-emissions buildings in the next decades.²

According to a 2016 report looking at the cost of addressing the shortcomings of the EU housing stock alone, €295 billion EUR (2011 prices) would be required, but would be recouped within 18 months by projected savings such as lower healthcare costs and better social outcomes. In other words, for every €3 invested, €2 would pay back in one year.³

Thus, the improvement of existing and new buildings are a priority in tackling climate change but equally a public health concern that requires respective social and equity priorities and that should therefore be of vital interest among policy-makers, the industry, and the public health community alike.

ⁱ Other risks such as home injuries from badly designed indoor environments or communicable diseases from overcrowding are prevalent in many parts of the world but won't be discussed in detail in this briefing.

ⁱⁱ The "Sick building syndrome", a medical condition where inhabitants suffer from symptoms of illness for no apparent reason, results in symptoms such as mucous membrane and eye irritation, cough, chest tightness, fatigue and headache.

ⁱⁱⁱ Reduction of EU GHG emissions by at least 20% below 1990 levels by 2020

- 20% of EU energy consumption to come from renewable resources by 2020
- 20% reduction in primary energy use compared with projected levels, by improving energy efficiency

2.

The facts: building-related factors that impact our health

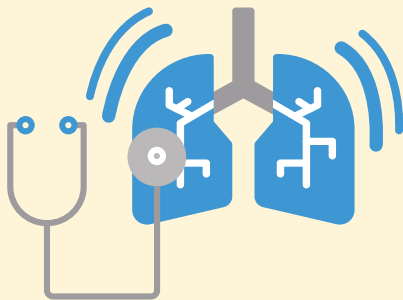
The scientific evidence on the many links between buildings and health has grown substantially in recent decades and covers a vast array of risks to health from flaws in the heating, ventilation, and air conditioning systems over contaminants produced by some building materials, volatile organic compounds (VOC) and moulds as well as the use of industrial chemicals, to only name a few.

The health impacts from living in energy-inefficient buildings and particularly in energy poverty have been studied extensively in some countries, for example the United Kingdom or New Zealand.

According to a 2011 World Health Organization (WHO) report, the environmental burden of disease attributable to inadequate housing alone (not counting non-residential buildings) in Europe amounted to 100,000 premature deaths annually.⁴

Unhealthy buildings impact our health in multiple ways:

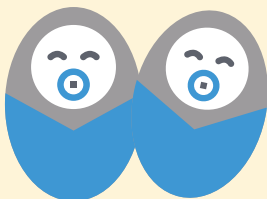
Unhealthy buildings harm our lungs and overall respiratory health



Several effects on the respiratory system have been associated with exposure to indoor air pollution, including acute and chronic changes in pulmonary function or an increased incidence and prevalence of respiratory symptoms. Studies for example found:

- **A consistent association between dampness and mould** in indoor environments and respiratory symptoms and asthma.
- People living in **unhealthy buildings** are **40% more likely to suffer from asthma**.⁵

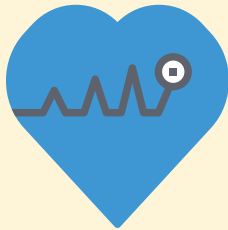
Unhealthy buildings are especially harmful to our children



- **Damp** living conditions are strongly linked to childhood illnesses.⁶
- Poor housing conditions increase the **risk of severe ill-health** or disability by up to 25 per cent during childhood and early adulthood.⁷
- Children who had lived in damp accommodation for the past 3-5 years, are **over twice as likely** to have problems with chest, breathing, asthma or bronchitis as children who were not exposed to bad housing⁸.

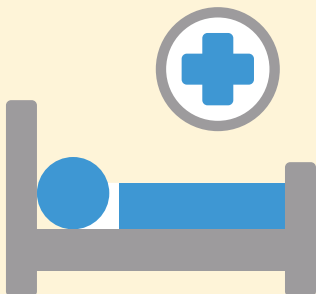
- Children living in damp, mouldy homes are **between one and a half and three times** more prone to coughing and wheezing – symptoms of asthma and other respiratory conditions – than children living in dry homes⁹.
- 25 per cent of children who persistently lived in poor conditions had a **long-standing illness** compared to 15 per cent who avoided poor conditions¹⁰.

Unhealthy buildings can increase our cancer risk and jeopardize our cardiovascular health



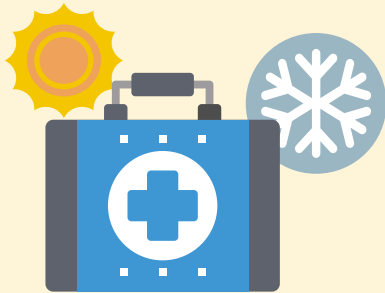
- **Radon**, a radioactive gas, that's emitted by some building materials, has been linked to an increase in the risk of developing lung cancers if present at elevated levels.
- A few other **indoor air pollutants**, notably environmental tobacco smoke but also asbestos when present have been associated with cancer.
- **Improving the thermal quality of cold housing** reduced blood pressure very significantly as well as the use of medication and hospital admissions.¹¹
- Increased **noise levels are associated with higher systolic and diastolic blood pressure**, changes in heart rate, and hypertension.
- In the European Union, about **56 million people** (54%) living in areas with more than 250,000 inhabitants are **exposed to road traffic noise** of more than average LDEN **55 dB per year**, which is thought to be risky to health.

Unhealthy buildings harm our mental health



- **Cold, draft, and condensation** are associated with anxiety, as is the cost of energy.¹⁴
- In low-income populations, **poor housing quality, residential instability, lack of affordability, and socially deprived** neighbourhood conditions represent significant sources of stress.¹⁵
- The strain of **unaffordable housing** has been associated with **hypertension** and poor self-rated **health**.¹⁶
- **Living in cold and damp housing** contributes to a variety of different mental health stressors, including persistent worry about debt and affordability, thermal discomfort, and worry about the consequences of cold and damp for health.¹⁷
- **1 in 5 English adults** (21%) said a **housing issue had negatively impacted** upon their mental health in the last 5 years.¹⁸

Unhealthy buildings result in premature deaths both in summer and winter



- **More people die in winter** than in summer but inadequate housing is responsible for ca. 40% of this excess winter mortality.¹⁹
- Countries with the **poorest housing conditions** demonstrate the highest excess winter mortality.²⁰
- There is supporting evidence of a **relationship between energy inefficient housing and winter respiratory disease** among older people and being classified as energy-poor is a predictor of excess winter morbidity.²¹
- **Summers can be dangerous too:** Between 2006 and 2012, the rate of Spanish households who self-reported they could no longer afford to keep comfortably cool in summer stood at 25%.²²

Unhealthy buildings make us less productive and decrease our overall wellbeing



- **Improved ventilation** in schools has increased the rate of students passing exams in reading and math by about 3%.²³
- There is a **link between productivity and the wellbeing of employees.** Poor indoor air quality can provoke a 6-9% productivity loss.²⁴
- Even in the absence of serious health effects and morbidity, **discomfort of building occupants** because of temperature can translate into lower productivity, reduced job satisfaction, increased employee turnover, and greater work loss due to illness.²⁵
- **Children in classrooms with high background noise performed lower in a phonological processing task,** reported a higher burden of indoor noise in the classrooms, and judged the relationships to their peers and teachers less positively than children from classrooms with good acoustics.²⁶
- **Poor indoor air quality** was responsible for the loss of 2 million healthy life years annually in the European Union (EU-26).²⁷

3.

Chemicals in building products - an overlooked harm

Building products require special attention as the selection of those is often beyond the control of those who occupy or use the building. Yet some building materials contain chemical toxicants that are harmful to human health, including at relatively low doses. They may be carcinogenic, or otherwise impact the health of the respiratory, neurological, endocrine or other systems of the human body. For example, paint on the wall may emit volatile organic compounds (VOCs) which can be associated with respiratory, allergic, or immune effects in infants or children; flooring may contain phthalates²⁸ which have

been shown to interact with our hormone system, increase the risk for asthma²⁹ or i.e. attention-deficit hyperactivity disorder; building materials as well as furniture is often coated in flame retardants, which recent toxicological studies demonstrate pose the greatest risk to the normal growth and development of fetuses, infants, and small children.³⁰ But even carpets contain up to 59 hazardous substances according to a recent study, including endocrine disruptors and carcinogens, linked to serious health conditions such as cancers, learning disabilities and fertility problems.³¹

Connecting the dots between energy efficiency, energy poverty and health

One in six Europeans lives in homes that make them sick. These are often damp, energy-inefficient homes that are either too hot in the summer or too cold in the winter because residents can't afford to pay their energy bills. This so-called **energy or fuel poverty** can have a negative impact on the occupants' physical and mental health³² and can exacerbate existing conditions, such as respiratory or cardiovascular problems.³³⁻³⁴ The body of evidence shows that low indoor temperatures are commonly associated with a wide range of negative health consequences, including an increased risk of strokes, heart attacks and respiratory illnesses, as well as with common mental disorders.³⁵⁻³⁶

In the UK for example, one quarter of all families are said to have to choose between eating or heating. Overall, at least 50 million Europeans can be classified as energy poor, usually due to a combination of low incomes, increasing energy prices in the EU, and highly energy- inefficient buildings. Therefore, **cold homes and fuel poverty have been identified as factors that could be alleviated through energy efficiency interventions.**

The results show that improving the energy efficiency of homes at risk of fuel poverty has a profound impact on wellbeing and quality of life, financial stress, thermal comfort, social interactions and indoor space use.³⁷

Energy efficiency is an important goal for health and reducing energy poverty



4.

Building renovations: opportunity for a win-win for health and climate

Whereas the health and climate impacts from building-related factors are not only significant but also oftentimes complex, the solutions are straightforward and can address both issues simultaneously, allowing policy-makers to fill two needs with one deed.

Increasing the rate of building renovations is one such solution that addresses mostly energy-inefficient buildings and that aims to reduce their energy needs by improving the buildings insulation. This does not only reduce energy bills for building occupants but is also an absolute must if the EU wants to achieve its climate targets.

Additionally, building renovations and retrofits have the potential to significantly improve the health and wellbeing of building occupants, if executed in a health-conscious way:

- **renovation of i.e. low-income housing using “green” and healthy principles result in significant improvements** in overall health, asthma, and non-asthma respiratory problems in adults and children³⁸
- **insulation improvement of existing buildings** led to drier and warmer indoor environments, improved self-rated health, decreased days off school or work, decreased visits to a general practitioner, and fewer hospital admissions for respiratory conditions³⁹, they also reduce incidences of asthma, hay fever, sinusitis and hypertension⁴⁰
- when **combined with improvements such as measures that promote more efficient and natural light**, mental health and productivity can benefit, too⁴¹
- **improving warmth and energy efficiency** of the building benefits users’ life quality through

increased use of the home for studying and leisure, inviting friends into the home, increased privacy and improved relationships between household members⁴²

Thus, renovating existing buildings and making sure new buildings are constructed in a climate-friendly and health-promoting way could not only decrease energy bills and consequently energy poverty and reduce CO₂ emissions, but also holds the potential to improve people’s physical and mental health through healthier indoor conditions. This would also be reflected in national health care costs: the total cost to the British National Health Service attributable to the health outcomes from unhealthy housing alone (residential buildings) to be approx. 717 million EUR per year.⁴³ The French Agency for Food, Environmental and Occupational Health & Safety conducted a scoping study of the socio-economic cost of indoor air pollution and estimates the cost to be 19 billion EUR per year from premature deaths, healthcare costs and production losses.⁴⁴

But despite clear scientific knowledge urging us to act, CO₂ emissions from buildings and construction worldwide rose by nearly 1 per cent per year between 2010 and 2016.

According to a recent UN Environment report, the entire existing global building stock would need to be retrofitted in order to have a chance of meeting the UN objective of limiting global warming to 2 degrees Celsius. Yet, over the next 40 years, the world is expected to build 230 billion square meters in new construction. This translates into adding the equivalent of the city of Paris to the planet every single week.

Do renovations always result in better health?



CLIMATE PERSPECTIVE

Whereas renovating the existing building stock and investing in health-promoting and sustainable new buildings is undoubtedly **beneficial from a climate perspective, its positive direct health impact is not guaranteed.**



MENTAL HEALTH

Whereas housing renovations can clearly improve residents' health, studies have shown they can also make people's health - in particular **mental health- worse if they result in rent increases.**⁴⁵



The drive to build highly energy efficient buildings

can result in sealed up buildings with unintended consequences:

- **stagnant air**
- **under-ventilated indoor environments**
- **resulting in air-quality related health problems mentioned earlier**



In the EU, many countries **recognise indoor air quality as an important aspect of its building code** for new residential buildings; however, this is often not the case for existing residential buildings in need of renovation.

Measures must be taken to assure the full health benefits can be achieved and will reach those in need.

- **A quest for more energy efficiency in buildings therefore must be supported by an equal quest for better health in indoor environments** social inequalities aren't increased.

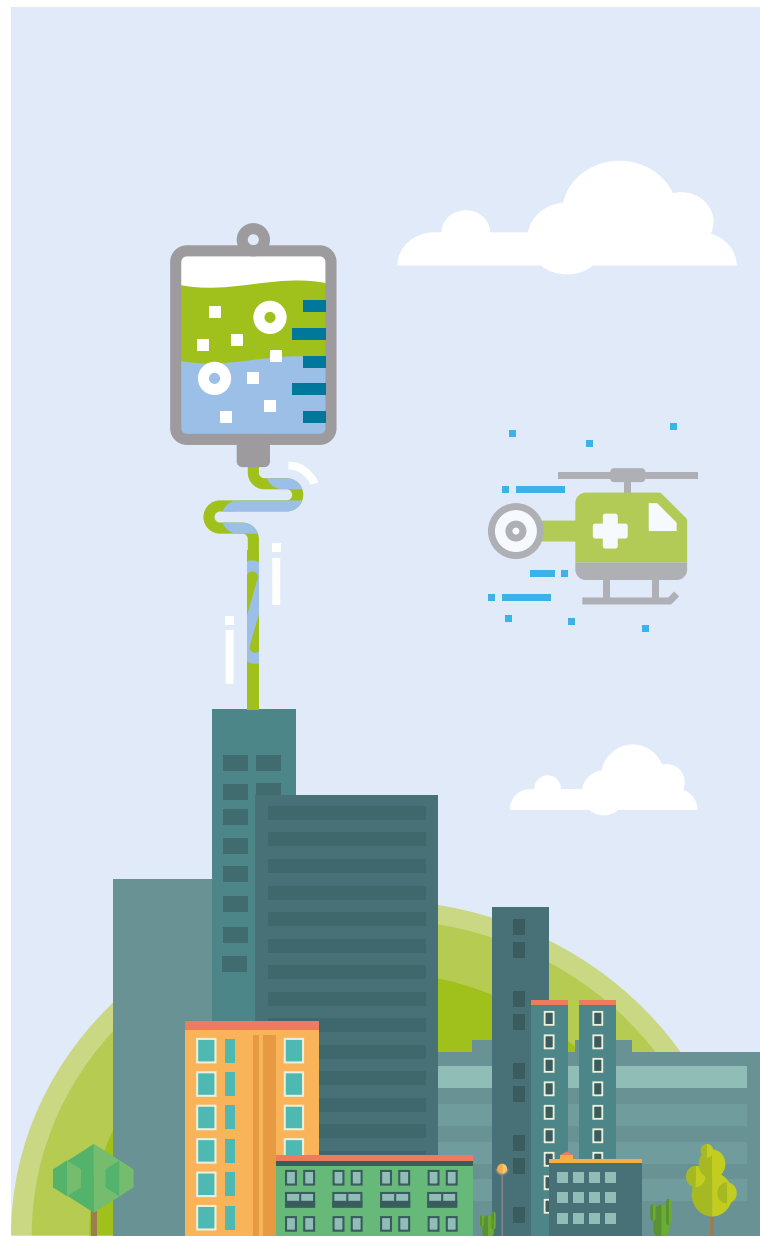
The public health sector is in a unique position to put forward this quest.

5.

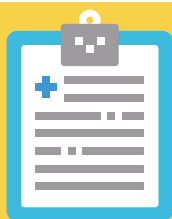
Sick buildings are contagious: a call for climate-friendly and health-promoting buildings

With only 1% of buildings in the EU currently being renovated annually, creating the zero emission buildings we need to prevent climate disaster is out of reach unless countries step up their game. Greater ambition would also help reduce health inequalities and contribute to pulling some 50 million Europeans out of energy poverty. What this briefing aims to highlight is that there is a cost to society from the health outcomes attributable to unhealthy buildings, particularly to the health sector. Knowing that we are spending 90% of our time in indoor environments, the current renovation cycle is a public health opportunity to develop a more human centric approach to buildings to the benefit of health and well-being. Cooperation across sectors is required in order to solve the problem, involving public health, but also housing, engineering and construction, environment, social welfare, urban planning, and building management, to strengthen the case for health-promoting and climate-friendly buildings.

Ultimately, housing is healthcare; and being surrounded by healthy buildings- whether that concerns our homes or work places- must be of interest to the public, public health professionals and medical practitioners alike. A 2017 UK survey found that only 9% of people agree with the following statement: "I am concerned about the health and wellbeing impact of the buildings where I spend my time". This low percentage indicates that there is a lack of public awareness on how buildings are connected to our health.



In order to achieve positive health results from building retrofits and renovations as well as from new building projects, the following needs to be considered:



Pointers for policy-makers on EU and national levels

- **Prioritise health** - promoting buildings on national and EU level so that existing laws and strategies are reviewed and updated accordingly (e.g. stringent inclusion of health criteria in the minimum energy performance requirements of the EU's Energy Performance of Buildings Directive; national building codes to reflect the latest health evidence).
- **Green renovation without gentrification:** Policy-makers must increase yearly (national) renovation rates to at least 3% while assuring those newly renovated buildings are operated with renewable energy and have a high energy efficiency potential (i.e. so-called A-class buildings). High rent increases must be minimised which could potentially force the relocation of current residents and businesses.
- **Provide incentives to swiftly move to 100% renewable energy** in building design and renovation and away from the use of health-harming fossil fuels.
- **Apply a life-cycle approach to the building sector:** polluter-pays principle from start until end of the life of a building.
- **Prioritise buildings used by vulnerable populations** such as children, elderly, energy poverty victims (kindergartens, schools, retirement homes, healthcare facilities...).
- **Prioritise cooperation with local authorities on low-income,** sub-standard residential buildings first as a way to ensuring greater social and health equities.
- **Regulate building materials** to the benefit of occupational health of the workers in the building sector and replace hazardous chemicals with safer alternatives.
- **Implement a green public procurement policy** based on highest health and sustainability standards.



Pointers for the building industry

- **Apply health criteria in i.e. ventilation improvements** (especially after insulation), efficient provision of heating, radon testing and mitigation, moisture management measures, integrated pest management and restrictions on the use of chemicals in construction materials in renovation projects.
- **Apply wellbeing criteria** including the potential benefits from improved lighting quality and increased use of daylight, noise reduction technologies and other non-energy-efficiency focused improvements.
- **Reduce the environmental and health impacts of materials and equipment in the buildings & construction value chain** by considering the sustainability of the products and materials used already in the planning stage and by taking a life-cycle approach to make choices for the longer term (i.e. eco-design and circular economy strategy).
- **Reduce climate-change** related health risks by improving resilience of buildings related to for example warmer temperatures, intense storms, greater precipitation or other.
- **Apply and regularly update occupational health criteria** in the choice of building materials.
- **Inform and involve building users about suggested ventilation guidelines** to assure long-term maintenance from the end-user perspective.



Pointers for the health sector and the public

- **Raise awareness on the importance of indoor environments on building user's health** and the potential role that especially primary care physicians hold in identifying the underlying root causes.
- **Engage around deliberations on the future of European buildings and renovations strategies** as part of climate efforts and highlight the centrality of health and the urgency to act.
- **Share and promote best practices** such as the Irish Warmth and Well-Being scheme which demands that renovations prioritise those residents that have a pressing medical need associated with low thermal efficiency housing, and request that progress on both efficiency outcomes and health status is reviewed afterwards.
- **Lead by example** with ensuring that buildings such as hospitals, clinics or public health offices are health- promoting buildings.



Pointers for local level officials

- **Apply environmental health criteria in urban planning** by ensuring sufficient exclusion zones between a polluting area (polluting industry, traffic, natural source of pollution, etc.) and buildings where people live/work.
- **Improving buildings by setting** i.e. city-focused health- based building policies and by knowing their city's building priorities including areas of greatest concern, while giving consideration to the threats associated with gentrification.
- **Ensure that public and private landlords provide safe and healthy accommodation to their tenants**, provide energy efficiency and remedy energy poverty to residents.

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