Energy and Buildings 98 (2015) 125–133

Contents lists available at ScienceDirect

Energy and Buildings

journal homepage: www.elsevier.com/locate/enbuild

On the impact of urban overheating and extreme climatic conditions on housing, energy, comfort and environmental quality of vulnerable population in Europe

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ARTICLE INFO

Article history:
Received 26 July 2014
Accepted 24 August 2014
Available online 6 October 2014

Keywords:
Low income population
Urban heat island
Extreme weather conditions
Low cost mitigation technologies

ABSTRACT

Extreme weather conditions in urban areas have a serious impact on the quality of life, energy consumption and health of urban citizens. In addition energy poverty has a serious impact on the quality of life of low income households. The aim of the present paper is review the actual housing status of low income population in Europe and discuss issues related to the impact of urban overheating and extreme weather phenomena on the specific energy consumption, indoor environmental conditions and health. Finally advanced low cost mitigation and adaptation technologies developed during the last years that offer a serious potential for energy and environmental improvements which can contribute to improve the quality of life of low income population are presented.

1. Introduction

Extreme weather conditions in urban areas have a serious impact on the quality of life, energy consumption and health of urban citizens. It is well accepted that climate change and local climatic phenomena like the urban heat island have a very significant impact on the low income and vulnerable population of cities [1]. Various studies are published quantifying the impact of extreme weather conditions on the energy consumption, the global environmental quality and health conditions of low income population [2–4]. Although the problem is a very serious one, very little is known about the specific penalties and the impact of extreme weather conditions in low income population in Europe. A few studies are published offering information on the specific energy consumption and the characteristics of the indoor environmental conditions [2,4],[6,7] in low income households.

Research on the topic focused for many years on the identification and the characteristics of the so-called energy or fuel poverty. The term energy poverty is used to describe a situation of a household not able to satisfy socially and materially the required levels of energy services in the house [5]. Fuel poverty is an equivalent term as energy poverty, however, historically was used to signify the inability to cover the heating needs of the houses. The exact definition of fuel poverty varies along the various countries in Europe. According to the European Commission fuel poverty risks depriving households not only from heating or cooling but also from hot water, lights and other essential domestic necessities [8]. In UK a fuel poor household is the "one that cannot afford to keep adequately warm at reasonable cost. The most widely accepted definition of fuel poor household is one which needs to spend more than 10% of its income on all fuel use and to heat its home to an adequate standard of warmth". In France, a citizen is considered as fuel poor "if he encounters particular difficulties in his accommodation in terms of energy supply related to the satisfaction of elementary needs, this being due to the inadequacy of financial resources or housing conditions" [9]. Finally, the Irish Government defines fuel poverty as "the inability to afford adequate warmth in a home, or the inability to achieve adequate warmth because of the energy efficiency of the homes". The use of the expenditure approach is used currently in UK however it is highly criticized as it does not provide information on the deprivation and social exclusion elements of fuel poverty, while households often do not cover their full energy needs and live under improper comfort conditions [10].

Actually apart from the data available for single countries, standardized European data on the real cost of fuel used in European households are not available. Thus, fuel and energy poverty in Europe may be estimated using consensual parameters. Based on specific consensual indicators, researchers have published the first estimates concerning fuel poverty in fourteen countries of the European Union using data collected during the period 1994–1997. Estimates were based on the six following indicators: Unable to afford to heat home adequately; Unable to pay utility bills on time;

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http://dx.doi.org/10.1016/j.enbuild.2014.08.050
0378-7788/

Lack of adequate heating facilities; Damp walls and/or floors; Rotten window frames; Lacking of central heating. According to the analysis performed fuel and energy poverty is much higher in the Southern European countries that in the European North. The levels of fuel poverty in Portugal ranges between 32.8 to 62.7% as a function of the scenario used, in Greece from 24.6 to 36%, while in Spain from 32.1 to 43.8%. On the contrary in Finland the corresponding numbers range between 4.4 and 5.4% and in Denmark from 3.2 to 5.5%. Countries like France and UK present a relative high percentage of fuel poverty with France being between 8.6% and 11.2% and UK between 7.9 and 12.5%.

Energy poverty has a serious impact on the quality of life of low income households. It reduces their capacity to live in houses with proper environmental protection and energy installations, decreases their potential to use energy and achieve the required indoor environmental conditions, it has a serious impact on health while it increases the excess winter and summer mortality. Existing statistics show that low income households in Europe lives in houses characterized by lower thermal and environmental standards [9]. In parallel, numerous studies have shown that low income population is unable to cover part or the whole of their specific energy needs and as result indoor environmental quality does not meet the required levels for comfort and health purposes [10]. Because of the inappropriate housing thermal standards low income population has to spend a much higher share of their income to satisfy the household needs compared to the average or high income population. In particular, while in the 27 countries of EU, the average running housing cost represents about 11% of the actual household's income, the corresponding figure for the low income population is close to 40%. Buzar [11] reported that the cost of heating for the low income population in Czech Republic was about 20% higher per square meter than the average. In Belgium, low income households spent on average 15% of their income for energy reasons while the high income population spent only 2.5%. In Greece, the heating and cooling load in low income houses is found to be almost the double than that of the high income group [4]. In parallel, numerous studies have shown that low income population is unable to cover part or the whole of their specific energy needs and as result indoor environmental quality does not meet the required levels for comfort and health purposes [10].

However, one of the most important problems associated to energy poverty is related to health. It is well accepted that exposure to substantially low or high temperatures may have an important impact on health [10]. Several studies have shown an important increase of hospital admissions under very low or very high ambient temperatures while a significant relation between cold houses and mental health is reported. In parallel, excess mortality rates for low income population under extreme weather conditions is much higher than for the average population [12].

It is undeniable that global climatic change and urban heat island have increased ambient temperatures in Europe while the frequency of extreme weather conditions is seriously increased [2,13,14]. Apart of the obvious energy impact [15], overheating and extreme climatic phenomena deteriorate the ambient thermal comfort conditions [16,17], increase pollution [18], and may be the source of important health problems. Projections on the future impact of climatic change and urban overheating on the energy consumption of buildings in Europe reveals that the problem will seriously aggravate if the necessary mitigation and adaptation measures are not undertaken [19]. In fact, recent research has offered important technological tools that allow the decrease of urban temperatures and improve the environmental quality of households [20–22].

The present paper aims to present a review of the actual housing status of low income population in Europe and discuss issues related to the impact of urban overheating and extreme weather phenomena on the specific energy consumption, indoor environmental conditions and health. The paper also aims to present some ideas on the possible technologies that are proposed to amortize the climatic problems and improve the environmental conditions in low income households.

2. Housing conditions of vulnerable population

According to the official European statistical data [23] the percentage of people in the various European countries living in low income households ranges between 10 to 25% (Fig. 1). In general, higher percentages are reported for the poorest countries like Bulgaria and Romania and lower for richest countries, while an almost clear decreasing trend exists between the percentage of people living in low income and high income households and in particular for the 60% of the median equivalized income in each country.

Vulnerable population in Europe is living in much less housing space than the average population or the higher income groups and there is a strong association between the income and the occupied housing space shows the number of rooms per person for the low and high income groups as well as for the whole population for selected European countries [24][36]. As shown, for the European Union countries, the average number of rooms per person is 1.9 and it drops to 1.6 for the low income group while it rises up to 2.3 for the higher income group. Lower occupied space per person may result to lower energy consumption for heating and cooling purposes.

Limited data are available on the thermal and energy related characteristics of low income households in Europe [37]. Information on the percentage of houses with different energy savings features per country is available but is not updated quite recently Intensive energy conservation measures undertaken the last years in Europe have increased dramatically the number of houses with energy conservation features like insulation, double glazing, etc. For example while in the previous mentioned statistics the percentage of houses in UK with a cavity wall insulation was 25%, recent reports increases the percentage to 34% [38][25]. Also the percentage of houses with double glazing for UK is reported close to 61%, while recent data increase the number close to 90% [40-41][25]. Also for Belgium the reported percentage of houses with roof insulation is 43% however recent data increases it to 58%. Based on data provided by various national reports in Europe, it can be estimated that the percentage of insulated houses in the European South is between 30 and 40%, in west Europe between 60 and 70% while in the European North it should be more than 90% [39][26]. In Eastern European countries a very high percentage of the housing stock is constructed during the Soviet period and presents very poor thermal characteristics while a high proportion of houses has important energy and environmental problems. An indication of the specific condition concerning the housing envelope in various European countries for low income population, is given by the study of the European Foundation for the Improvement of Living and Working Conditions [24]. Figs. 2 and 3 report the percentage of the low and high income groups as well as the average percentage of the population living in houses with leaking and rotting windows. As shown, about 20–55% of low income population in Southern and Eastern European countries lives in houses with leaking windows, while the corresponding percentages for all the population and the high income group is by 30–40% and 40–60% lower, respectively. In general, there is a relation between the percentages of people living in houses with leaking windows with the economic development of the countries. Low values are observed for the Western and Scandinavian countries except the UK mainly because of the intensive energy conservation measures applied in the specific zones. Almost similar conclusions may be drawn concerning the percentage of population living in houses with rotting windows, and those living in houses with leaking walls and rotting windows, although the