



Review

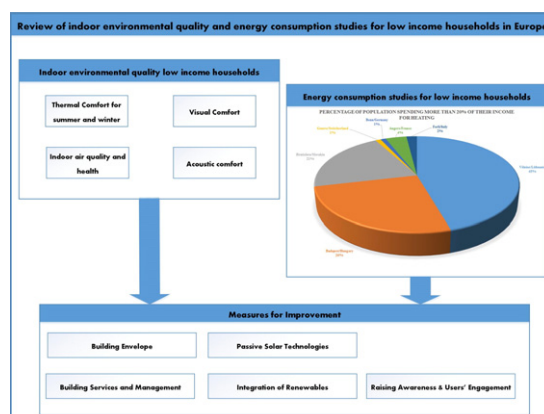
Review of the indoor environmental quality and energy consumption studies for low income households in Europe

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HIGHLIGHTS

- The energy and indoor environmental problems for low-income population are analysed.
- Low cost heating equipment creates a critical environmental burden during winter.
- Discomfort and heat stress is recorded during summer.
- Common indices and criteria should be adopted at European level.

GRAPHICAL ABSTRACT



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ABSTRACT

The term energy poverty is used to describe a situation of a household not able to satisfy socially and materially the required levels of its energy services. Energy and fuel poverty is an increasing problem in the European Union. Although the specific conditions vary from country to country the drivers defining fuel and energy poverty are similar in all Europe. This paper aims to present the state of the art regarding the energy demand and indoor environmental quality of low income households in Europe. The characteristics of this specific population group are presented including details on the specific energy consumption, the indoor comfort and finally the impact of the specific living conditions on the occupants' health.

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1. Introduction

Provision of proper indoor environmental conditions is a requirement for comfort and health of human beings. The impact of poor indoor environmental conditions like high indoor pollution, very low or high indoor temperatures, lack of daylight, excess noise, etc. can be particularly negative. It is expected that by 2030 inappropriate indoor conditions may cause more premature deaths than malaria or AIDS (Lavelle, 2010).

Furthermore Europe's low income population is increasing. According to the official definitions, low income households are considered those with net income less than 60% of the median equivalised national net income. Official statistics show that almost 80 million people in the European Union or 16.4% of the total population lived below the poverty line in 2010 (Anon., 2012a). In parallel, around 23% of the population is considered to be at risk of poverty or social exclusion. Additionally people are considered low income if at least satisfy one of the following three criteria: a) to be below the previously defined poverty line, b) be in a situation of severe material deprivation and c) living in a household with a very low working intensity (Anon., 2012a).

Moreover 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 (Bouzarovski, 2011). Energy poverty is mainly created by the combination of low income people living in inappropriate and inefficient housing, while other demographic parameters may play a significant role (Lampietti and Meyer, 2002). Energy poverty has a significant impact on the quality of life of citizens, affects seriously indoor comfort levels in energy poor houses, influences social attainment, has a very negative effect on health and results in a significant increase of the seasonal mortality and morbidity (Bouzarovski, 2011).

Fuel poverty, although has similar meaning with energy poverty, historically was used to signify the inability of households to cover their heating needs. Energy and fuel poverty are an increasing problem in the European Union. Although the specific conditions vary from country to country, the drivers defining fuel and energy poverty are similar in all Europe. The specific levels of fuel and energy poverty in the various European countries differ as a function of the indicator used to identify and define the problem. In general, two approaches are used: a) the expenditure approach where fuel poverty is calculated as a function of the actual or required energy spent and b) the consensual approach using subjective indicators as defined by (Gordon et al., 2000). Subjective indicators may be the possession of a central heating system, the existence of insulation or double glazing in the house, etc. 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 studies concerning fuel poverty in fourteen countries of the European Union using data collected during the period 1994–1997 (Healy and Clinch, 2002). Estimates were based on the six following indicators:

- affordability to heat home adequately;
- ability to pay utility bills on time;
- lack of adequate heating facilities;
- damp walls and/or floors;
- rotten window frames; and
- lack of central heating.

To this end the present paper aims to analyse the current energy and environmental status of low income households in Europe. The low income indoor comfort, specific energy consumption, and finally the impact of adverse living conditions on health are reviewed. Existing technologies to improve the energy and environmental quality of low income houses are discussed.

The overall analysis of both the energy poverty and indoor environmental quality of low income households has specific limitations related to: a) Different number of buildings is analysed in different countries, resulting to a non-uniform sample. b) Different monitoring protocols are used to measure the indoor environmental conditions as well as to evaluate the energy consumption. c) Different construction practices are utilized in the various EU countries by the construction industry. d) There are different priorities related to the outdoor climatic conditions. Nevertheless the specific paper, by reviewing in detail all the available studies concerning the low income households' energy and indoor environmental quality, contributes to the creation of a common basis for comparison.

The paper is structured in four more sections. Section 2 analyses the indoor environmental quality of European low income households while Section 3 focuses on their energy consumption. Section 4 discusses the most appropriate measures for improvement of indoor environmental quality while simultaneously decrease the energy consumption of low income households. Finally Section 5 provides the conclusions and future research aspects in the specific field.

2. Indoor environmental quality of low income households

2.1. Indoor pollution and health

Non appropriate levels of indoor air quality in houses are associated with important health problems, (Wargocki, 2013). Low income

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