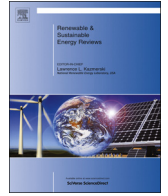




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Investigating greenhouse challenge from growing trends of electricity consumption through home appliances in buildings



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ABSTRACT

Energy use in buildings accounts for 38% of global total final energy consumption, 45% of which in OECD countries. According to the International Energy Agency the continuing demand for new large and small appliances, often with new functionality, is resulting in rapidly increasing electricity consumption in both the residential and service sectors. Appliances contribution to the residential electricity use is increasing. Also, appliances types are changing in our homes. This paper aims to find the trend of energy consumption of appliances in the building sector and describing the driver of this energy consumption. For doing so, a review of the literature available in the topic is summarized first. Trends show that appliances energy consumption is growing, but also that are disproportionately powered by electricity, mainly due to the proliferation of electronics and other small household devices, especially in OECD countries. This trend, which have already brought millions of households out of poverty in China and India and promises to continually improve standards of living throughout the developing world, will also have a major impact on appliance energy consumption as many more households will be able to afford basic equipment such as refrigerators and washing machines. Moreover, because appliances generally consume electricity instead of renewable fuels or direct combustion fuels, they carry a relatively large carbon footprint in countries where electricity production is carbon intensive. Finally, appliances present significant opportunities for efficiency improvement, since most of the appliances to be implemented in the near future still have to be produced.

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1. Introduction

According to the International Energy Agency [1,2] energy use in buildings accounts for 38% of global total final energy consumption. Of this, 45% is consumed in OECD countries and around 55% in non-OECD countries.

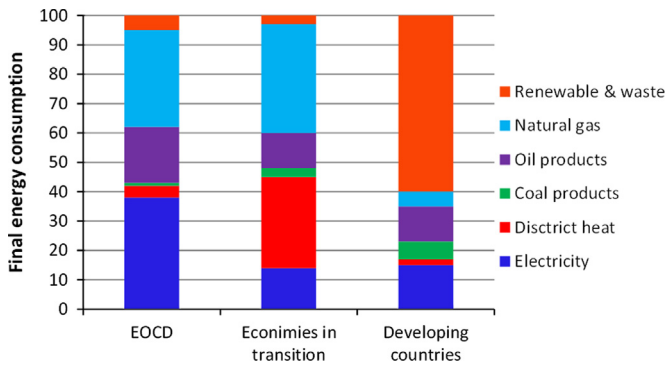


Fig. 1. Final energy consumption in buildings by region, 2005. Source: adapted from [1].

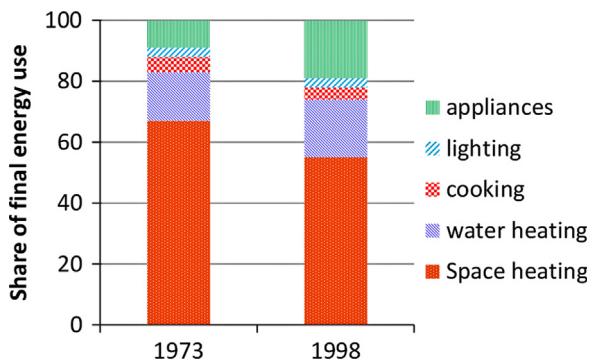


Fig. 2. Share of final energy use in buildings. Source: adapted from [6].

Fig. 1 shows that different world regions have different energy use patterns. In OECD countries, natural gas and oil products dominate energy consumption, primarily due to the importance of space heating. In transition economies, district heating plays an important role that, together with gas, accounts for heating and cooking accounts for 56% of total energy consumption. Electricity accounts for 15% and reflects low electrification rates in many developing countries. Economic development in non-OECD countries therefore portends a greater overall share of electricity in buildings worldwide, and a significant increase in non-renewable fuel usage.

According to the International Energy Agency [3] the continuing demand for new large and small appliances, often with new functionality, is resulting in rapidly increasing electricity consumption in both the residential and service sectors. Given the high CO₂ intensity of electricity generation in many developing countries, and their rapid economic growth, energy efficiency for lighting and appliances will be an important abatement area, as confirmed in recent studies [4,5]. Fig. 2 shows that from the final energy use of buildings, appliances grow from 9% in 1973 to 19% in 1998, including space cooling.

In 1973, appliances (including space cooling) accounted for roughly half of the residential electricity use in the group of eleven IEA countries (IEA-11). By 1998, this share had increased to 58%. On the other hand, and as comparison, the share of electricity for space heating grew only from 13 to 16% [6]. Roughly two-thirds of the doubling of IEA-11 electricity demand between 1973 and 1998 came from appliances. Traditional “big appliances” such as clothes washers and refrigerators dominated the growth in appliance electricity consumption through the early 1980s, while much of the recent growth is due to the use of “miscellaneous” appliances, such as home electronics and small kitchen gadgets.

Fouquet et al. [7] accounted the energy consumption taking into consideration the changes between energy consumption in 1800 and 2000. They state that, “The economic history of light

shows how focussing on developments in energy service provision rather than simply on energy use and prices can reveal the ‘true’ declines in costs, enhanced levels of consumption and welfare gains that have been achieved”

Firth et al. [8] presented a monitoring study of the electrical consumption in UK by a residential building due to appliances. They concluded that there is great variation in the annual electricity consumption of the dwellings, the annual electricity consumption of the dwellings increased from the first to the second year of monitoring the domestic buildings, and the users were responsible for the overall increase in electricity consumption in the monitored dwellings. These authors stated that the overall increase in electricity consumption is attributed to a 10.2% increase in the consumption of ‘standby’ appliances (such as televisions and consumer electronics) and a 4.7% increase in the consumption of ‘active’ appliance (such as lighting, kettles and electric showers).

Saidur et al. [9] stated that the trend of electricity consumption was rather escalating in 2006 and therefore did an estimation of the energy consumption for operating household appliances, saving of energy under policy intervention, and emission of poisonous gases in Malaysia between 1999 and 2015. The study found that refrigerator–freezer was the major energy-consuming appliance followed by air conditioner, washing machine, fan, rice cooker, and iron.

Murakami et al. [10] described the outlines in greenhouse gas emission trends in the residential and commercial building sectors in Japan. They stated that the increase in residential energy consumption in Japan was due to the widespread use of heating equipment, hot water supply apparatus, and other household electrical appliances. Moreover, the energy consumption increase in commercial energy use was mainly due to the increase of the floor area of buildings, particularly hotels, hospitals, and department stores.

Similarly, Rosas-Flores and Gálvez [11] highlighted important factors contributing to the increase include changes in the types of housing built, heating, cooling, water-heating equipment and other appliances. Trends in energy consumption between 1984–2006 by end use was reviewed over the same period. Energy use by appliances was estimated by assuming that the unit consumption was constant and penetration of appliances was the only variable. The refrigerators accounted for the highest residential electricity use in Mexican households, at 56% consumption among the main electrical appliances; air conditionings or coolers represented, on average, 17%; televisions accounted for 13%, on average; irons, 5%; and washing machines, 5% of consumption for the period of the essay.

In areas such as Europe, appliance energy standards have driven appliances consumption. In 2008 Waide et al. [12] summarized the appliance energy standards available in Europe then discussing the components of the residential electricity demand by end use and the role played by appliances in it. This authors claim that although the standards were set to ensure that the models sold after 1999 would use on average 15% less energy, this did not mean that saving energy was cost-efficient then.

Later on, in 2010, Atanasiu and Bertoldi [13] assessed the final energy consumption in the European Union residential buildings over the period 2004–2007. This paper summarized the result of an in-depth survey on the electricity consumption in the EU-27 residential buildings, the main findings of the first preparatory studies for implementing the Eco-design Directive as well as other related analysis and studies. One of the aims of this paper was to show the status of electricity consumption for the main appliances and equipments, the energy efficiency progress, and estimates of the electricity-saving potential in the EU-27 residential sector at the time of the publication.

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