Energy Policy 52 (2013) 181–189

Contents lists available at SciVerse ScienceDirect

Energy Policy

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

Economic effects of energy efficiency improvements in the Finnish building stock

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HIGHLIGHTS

► The possible cut in energy consumption: 3.8–5.3% by 2020 and 4.7–6.8% by 2050.
► Short term negative effects to GDP and long term positive effects are expected.
► A significant drop in harmful emissions and hence external costs is anticipated.

ARTICLE INFO

Article history:
Received 21 November 2011
Accepted 3 October 2012
Available online 23 October 2012

Keywords:
Energy efficiency
Economics
Buildings

ABSTRACT

This study estimates the economic effects of investing in energy efficiency in buildings on a national level. First conservation potentials in space heating for two different scenarios with different levels of investment in energy efficiency are quantified. This was done relying on statistical data and future projections of the development of the building stock. Then economic modeling was used to estimate the effects on energy sector and the economy at large. The results show that a rather modest increase resulting in a few percent rise in annual construction and renovation investments can decrease total primary energy consumption 3.8–5.3% by 2020 and 4.7–6.8% by 2050 compared to a baseline scenario. On the short term a slight decrease in the level of GDP and employment is expected. On the medium to long term, however, the effects on both would be positive. Furthermore, a significant drop in harmful emissions and hence external costs is anticipated. Overall, a clear net benefit is expected from improving energy efficiency.

1. Introduction

In this study an estimation of the economic effects of improving the energy efficiency of buildings in Finland was done in two phases: first an engineering estimate of energy conservation potentials was done for two scenarios, then economic modeling was used to assess the economic effects. The study provides insight to the potential effects of the new European Union directive on the energy efficiency of buildings that stipulates major efficiency improvements (European Parliament, 2010).

The consumption of energy can be attributed to a few major categories of consumers—among them buildings. One quarter of the global energy production is consumed in residential buildings, one tenth in commercial buildings. Commercial and residential buildings represent one of the largest energy use segments in the global economy. Major consumers of energy in buildings are lighting, electric appliances and devices and, above all, heating. As Fig. 1 illustrates, heating, together with traffic, is the most significant specific end use for energy in the world (IEA, 2008).

The average household in the US was estimated to consume 873 $ for heating each year in 2007 (Hagenbaugh, 2007). In Finland, heating is the largest component of expenses in housing companies (Marttila, 2005). The overall share of housing and energy expenses in Finnish household expenditure has increased over the past decades from 19.7% in 1985 to 28.7% in 2001 (Viinikainen et al., 2007). Thus the share of heating expenses in household expenditure is not inconsequential. It bars a considerable fraction of households' disposable incomes from other potential consumption. Furthermore, the importance of heating in the total consumption of energy means that a major portion of energy investments has been made to supply the needed heat.

Whereas most of heating needs are presently covered by the consumption of fossil fuels (Balaras et al., 1999), heating inevitably contributes to climate change. Moreover, the use of different fuels in heating, directly or indirectly, causes a variety of local and

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http://dx.doi.org/10.1016/j.enpol.2012.10.012

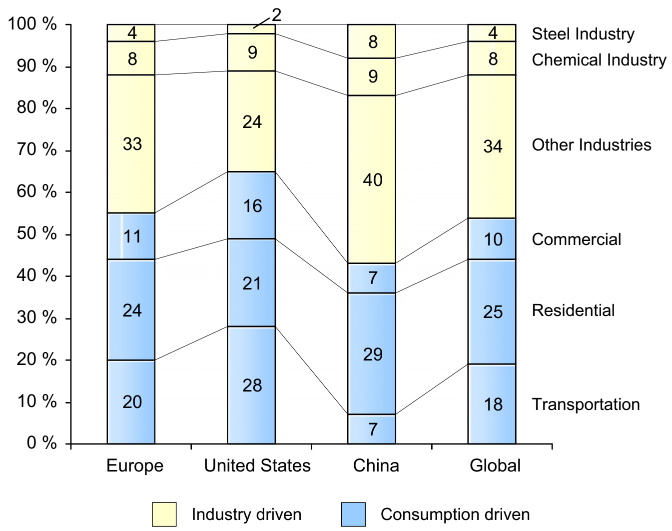

Fig. 1. Share of energy end use by sector in 2003. Adapted from Farrell et al. (2007).

regional environmental effects, such as sulphuric oxide, nitrous oxide and particulate emissions (Kara et al., 2004).

Improving energy efficiency in buildings is one possible way to limit the consumption of energy and mitigate negative environmental effects. From the policy measures under consideration, the measures that have the greatest effect with the smallest cost should be implemented first. Therefore, the economic study of the available policy measures is needed (Enkvist et al., 2007).

Energy efficiency has become a central theme in the energy policies in Finland, the European Union and around the world in the mitigation of climate change. If the recently announced legislative and regulatory programs (Ministry of the Environment, 2008; European Parliament, 2010) concerning energy efficiency in buildings are carried out, we are to expect drastic changes in energy consumption in the building sector. The effects will radiate, through the building and energy sectors, throughout the whole economy. Thus the question of economic effects of these measures is indeed an important one. This study aims to quantify those effects with economic modeling.

2. Methods

The estimation of the economic effects of improving the energy efficiency of buildings in Finland was done in two phases. First conservation potentials in space heating for two different scenarios with different levels of investment in energy efficiency were quantified. Then economic modeling was used to estimate the effects on energy sector and the economy at large.

2.1. Defining the scenarios

For estimating future levels of energy consumption, two efficiency levels for buildings had to be defined: low energy buildings and passive buildings. In Finland a *low energy building* is generally understood as a building that consumes less than half of the heating energy of a comparable ordinarily designed and constructed building, so this definition was used. At the time when this study was conducted, according to the Finnish Association of Civil Engineers (RIL, 2001), a norm residential building consumed 100 kW h/m^2 a year for heating, half of which is 50 kW h/m^2. For commercial buildings consumption was 75 kW h/m^2, half of which equals 37.5 kW h/m^2.

In a *passive building* a comfortable indoor climate is achieved with no or very little active heating and cooling. According to the classification employed by the Promotion of European Passive Houses project of the European Commission a passive house in the Nordic Countries, above 60° of latitude, has a consumption of 20 kW h/m^2 to 30 kW h/m^2 (Kaan et al., 2006). According to RIL 216–2001 a passive residential multi-storey building has a heating energy consumption of 15 kW h/m^2 and a passive commercial building 9 kW h/m^2 (RIL, 2001).

The future heating energy consumption in buildings was estimated based on the forecast development of the Finnish building stock in the coming decades, estimates of typical energy consumption for different kinds of buildings and the expected rate of renovations. Using this method, three scenarios for future development were created.

The baseline scenario is called Business as usual (BAU); it assumes that buildings continue to be built according to current practices. The results of the other two scenarios will be compared to this one to quantify the savings potential and the consequences of its realization. The BAU scenario is not meant to be in any way prognostic, in fact, considering recent developments in regulations, it is highly unlikely. Rather, it offers the possibility to compare the present level of efficiency to more likely future scenarios. The major assumptions in the two other scenarios, Delayed development (DD) and Rapid development (RD) are presented in Table 1.

Both DD and RD scenarios assume that energy efficiency improvements will be done in buildings that would undergo renovation in any case for other reasons. In DD these improvements will be relatively modest, whereas in RD major energy retrofits are assumed.

Both development scenarios, RD and DD, include the change in the construction regulation in 2010 with a 30% decrease in the maximum heating energy consumption of new buildings (Ministry of the Environment, 2008). This will be the minimum improvement compared to the BAU scenario that will affect even those new buildings that are not low energy or passive buildings. Due to a lag in the statistics available for input data, the starting point of the modeling was set at 2008.

The scenarios use the Rogers (1962) model for the diffusion of innovations for modeling the increase of low energy buildings in new construction. In the process of technology diffusion the market share of the new technology will gradually rise following the pattern of a Gaussian *S*-curve. Finally, the market will be saturated by the new product unless a new competing technology emerges.

The values used for adjusting the *S*-curves of the model are shown in Table 2. The values were chosen so that the results are in agreement with the current situation and with assumptions explained here.

2.2. Estimating heating energy consumption in buildings

The estimation of the heating energy consumption in buildings was done with MS Excel spreadsheets. It is based on the forecast

Table 1
Major assumptions concerning new buildings being built in the Delayed development (DD) and Rapid development (RD) scenarios.

Scenario	Low energy buildings, year of reaching majority in new buildings		Passive buildings, year of reaching majority in new buildings	
	Detached houses	Other buildings	Detached houses	Other buildings
DD	2030	2040	2070	2080
RD	2015	2020	2030	2040