Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 132 (2017) 69–74

Energy Procedia

www.elsevier.com/locate/procedia

11th Nordic Symposium on Building Physics, NSB2017, 11-14 June 2017, Trondheim, Norway

Possible explanations for the gap between calculated and measured energy consumption of new houses

Jesper Kragh[a,]*, Jørgen Rose[a] , Henrik N. Knudsen[a], Ole Michael Jensen[a]

[a]*Danish Building Research Institute, A.C. Meyers Vænge 15, København SV 2450, Denmark*

Abstract

The overall aim to reduce CO_2 emissions has brought the energy requirements for new houses into focus. The question is whether the stepwise tightening of the energy requirements for new houses has had the expected impact on the actual realized energy consumption. In the news media, headlines at regular intervals state that new houses do not perform as expected with regard to energy consumption based on a simple comparison to the building class (energy frame). The gap is sometimes explained by a higher indoor temperature than used in the standard calculation or more generally by resident's "careless" energy behavior. However, this may not be the full explanation and there may be other reasons for the difference. Or more specifically: Does the theoretical calculated energy demand, based on standard assumptions and without taking into account the effect of variations in e.g. hot water consumption, internal heat gains or construction faults, underestimate the actual energy consumption in general? As an example, the registered measured energy consumption for heating and hot water of approximately 800 new houses was compared to the calculated energy demand. The analyzed energy consumption data show that a significant share of the houses consumes more energy in a simple comparison with the theoretical energy frame based on standard assumptions. The objective of the study was to find and evaluate possible explanations/reasons for this gap between the theoretical calculated energy demand based on standard assumptions and the real-life registered measured energy consumption for new houses. It includes an evaluation of the possible impact on the energy demand caused by deviations from the standard assumptions for a series of parameters like indoor temperature, hot water consumption, internal heat gains, U-values, thermal bridges and ventilation rates.

Peer-review under responsibility of the organizing committee of the 11th Nordic Symposium on Building Physics.

Keywords: Energy consumption, heating consumption, energy frame, calculated heating demand

* Corresponding author. Tel.: +45 9940 2260
E-mail address: jkr@sbi.aau.dk

1876-6102
Peer-review under responsibility of the organizing committee of the 11th Nordic Symposium on Building Physics
10.1016/j.egypro.2017.09.638

1. Introduction

At regular intervals headlines in the news media state that new houses do not perform as expected with regard to energy consumption based on a simple comparison to the building class (energy performance rating) [1]. When it comes to new houses, the gap is usually explained by a higher indoor temperature than used in the standard calculation or more generally by resident's "careless" energy behavior. Such a comparison is shown in Figure 1, where an analysis of approx. 800 new single-family houses' registered measured heat consumption divided according to their building class; A2010, A2015 or A2020 as defined by the Danish Building Regulations [2]. The evaluation of the houses was established by using data stored in two main building registers in Denmark – the Building Stock Register [3] and the Energy Performance Certificate (EPC) Scheme Register [4]. The comparison shows that there is a tendency towards under-performance, particularly concerning the newest building classes (see right graph in Figure 1), however this is not a fair evaluation of the performance as the deviation in the assumed fixed boundary conditions has a significant effect on the theoretical calculated supply energy demand.

Usually the discussions in the media do not examine in depth the cause of these differences between measured and calculated consumption. The energy class calculation for new houses follows more or less the same standards and methods as used for energy ranking of buildings. This method however, must be both robust and simple to keep the price of certification reasonable. The primary reason for energy labelling of buildings is to make the energy performance of different buildings comparable for buyers and to suggest relevant energy-saving initiatives to the house owner. Behind the energy performance rating is a theoretical calculated energy demand for supply heating and electricity (for building operation only) under fixed standard conditions, used to rank the house on a scale (e.g. in Denmark: A2020, A2015, A2010, B, C, D, E, F, G).

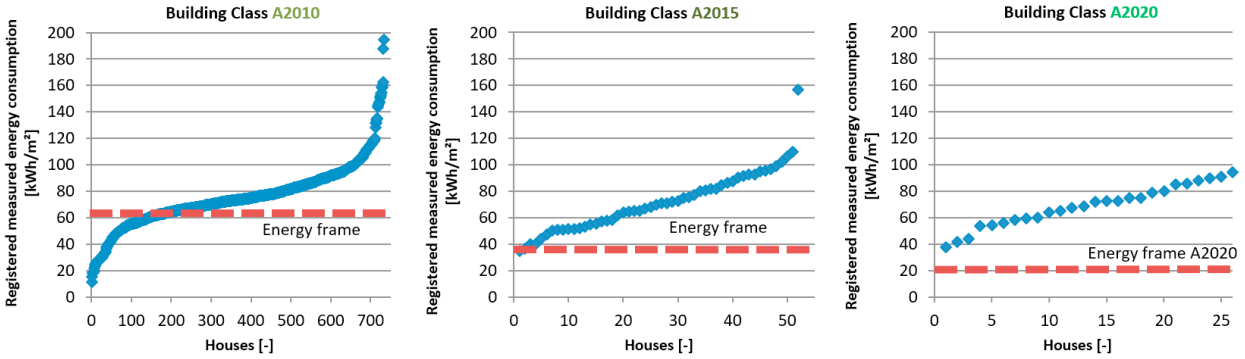

Fig. 1. Unfair comparison of the energy frame and registered measured energy consumption for room heating and hot water in 811 single-family houses erected between 2010 and 2013, heated by either district heating or natural gas. The heated area is between 75 and 300 m². The data have been adjusted for degree days and only realistic consumptions between 10 and 200 kWh/m², data span at least 300 days are shown (outliers 21). T

2. Method

The analysis of the possible impact on energy demand of deviations from the standard boundary assumptions of a series of parameters performed in this paper is based on the program, Be15 [5] and a simulation model of a typical single-family house attached with the program. The single-family house complies with Building Class A2015 and the main input data of the model are presented in Table 1.

Table 1. Main data of Be15 model.

Heat supply	District heating		Windows U-value	1.05	W/m²K
Heated area	180	m²	Glazing (double) g-value	0.62	-
Hot water consumption	250	l/m² per year	Ceiling U-value	0.09	W/m²K
Heat capacity	120	Wh/K m²	Wall U-value	0.16	W/m²K
Ventilation (air change)	0.32	1/s m²	Floor U-value	0.08	W/m²K
Heat recovery	88	%	Foundation ψ-value	0.09	W/m²K