International Journal of Sustainable Built Environment (2012) 1, 217–226

Gulf Organisation for Research and Development

International Journal of Sustainable Built Environment

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Original Article

Net ZEB office in Sweden – A case study, testing the Swedish Net ZEB definition

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Received 23 November 2012; accepted 13 May 2013

Abstract

An important measure for climate change mitigation is reduction of energy use in buildings worldwide.

In 2010 Skanska Sverige AB began designing an office building in the southern parts of Sweden, aiming towards a Net zero energy building (Net ZEB) balance. The construction work started in the middle of 2011.

In the beginning of 2012 Sveriges Centrum för Nollenergihus/the Swedish Centre for Zero-energy buildings (SCNH) published a Swedish definition for a zero-energy building in the Swedish climate. In short; the Swedish definition of a zero-energy building demands fulfilment of the passive house criteria, and that a zero energy balance must be reached over a year based on import/exported balance.

This study summarises the overall design ideas, constructions, installations, energy balance of the office building and investigates whether the building reaches the zero energy-building definition according to SCNH. The simulations show that a Net ZEB balance may be reached. However, the passive house criterion is not reached. The study discusses pros and cons in the Swedish definition of "zero-energy building"/Net ZEB and suggests clarifications needed and possible amendment that may be implemented in an updated version of the definition.

Keywords: Net zero energy building; Zero energy building; Office building; Net ZEB definition

1. Introduction

Reduction of energy use constitutes an important measure for climate change mitigation. Buildings today account for 40% of the world's primary energy use and 24% of the greenhouse gas emissions (International Energy Agency (IEA), 2011). The population and need for residential and non-residential buildings increases worldwide. Therefore, reduction of energy consumption and increased use of energy from renewable sources in the buildings sector constitute important measures required to reduce energy dependency and greenhouse gas emissions.

Today, the concept of Net zero energy buildings (Net ZEBs) is no longer perceived as a concept that can only be reached in a very distant future. A growing number of projects in the world, in different climates, show that it is possible to reach Net ZEB balance with technologies avail-

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Peer review under responsibility of The Gulf Organisation for Research and Development.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.ijsbe.2013.05.002

able today on the market. Examples may be found in (Fachinformationszentrum, 2011; Lenoir et al., 2011; Musall et al., 2010; SHC Task40/ECBCS Annex52 IEA, 2011; Voss and Musall, 2011).

In contradiction to autonomous Zero energy buildings (ZEBs), the Net ZEBs interacts with the energy infrastructure. Renewable energy generation covers the annual energy load. At a first glance, the "zero energy concept" seems simple and intuitive. However, there may be significant differences between definitions that seem similar. Relevant studies that investigate differences and try, to clarify the definitions may be found in (BPIE, 2011; Kurnitski et al., 2011; Marszal et al., 2010, 2011; Sartori et al., 2010; Sartori et al., 2012). In the most recent of the studies (Sartori et al., 2012) a comprehensible framework is presented. The framework considers relevant aspects characterising Net ZEBs and may be used to define consistent (and comparable with others) Net ZEB definitions in accordance with country specific conditions. The presented framework was largely developed in the context of the joint IEA SHC Task40/ECBCS Annex52: Towards Net Zero Energy Solar Buildings (International Energy Agency (IEA) Solar Heating an Cooling programme (SHC) & (ECBCS), 2008).

In 2010, Skanska Sverige AB began designing an office building in the southern parts of Sweden, aiming towards Net ZEB balance, called "Väla Gård". The construction work started in the middle of 2011. The building was taken into use in the autumn of 2012. In the beginning of 2012 the Swedish Centre for Zero Energy Buildings (SCNH) published a revised definition of "mini energy house", passive house and zero-energy building (Sveriges Centrum för Nollenergihus, 2012) for the Swedish climate. In short; the Swedish definition of a zero-energy building demands the fulfilment of the Swedish passive house criteria, and that a weighted zero energy balance must be reached over a year based on import/export balance. Hence, it is a Net ZEB.

This study summarises the framework presented within the IEA SHC Task40/ECBCS Annex52 and the Swedish Net ZEB definition. Furthermore overall design ideas, constructions, installations and energy balance of the Net ZEB office are presented. The studied case investigates whether the building reaches the Net ZEB definition according to SCNH, discusses pros and cons in the Swedish definition of Net ZEB and proposes small clarifications and additions suggested for an updated version of the definition. The studied building is an office building. Hence, only the Swedish Net ZEB definition for non-residential buildings is addressed in this study.

1.1. Terminology and the balance concept of Net ZEB

In Fig. 1(left), the terminology used and the link between them are presented. The Net ZEB balance is reached when the weighted supply meets or exceeds the weighted demand. The general strategy to reach a Net ZEB balance may be described as a two-step procedure: first, apply energy efficiency measures to reduce energy demand (e.g., passive house design principle). Secondly, generate energy to achieve the balance, Fig. 1(right).The passive house design principle may be described as (Janson, 2010):

- Reducing thermal losses through the building and install/use a balanced ventilation system with a high system heat recovery efficiency.
- Minimise the need of electricity by installing energy efficient fans, pumps, appliances and lighting systems.
- Utilise solar energy, both for passive solar gains and as a source for domestic hot water production and local production of electricity.
- Measure and visualise the energy use in a user friendly and transparent way.

Different aspects, recommended to be addressed within the Net ZEB framework (Sartori et al., 2012) are summarised below:

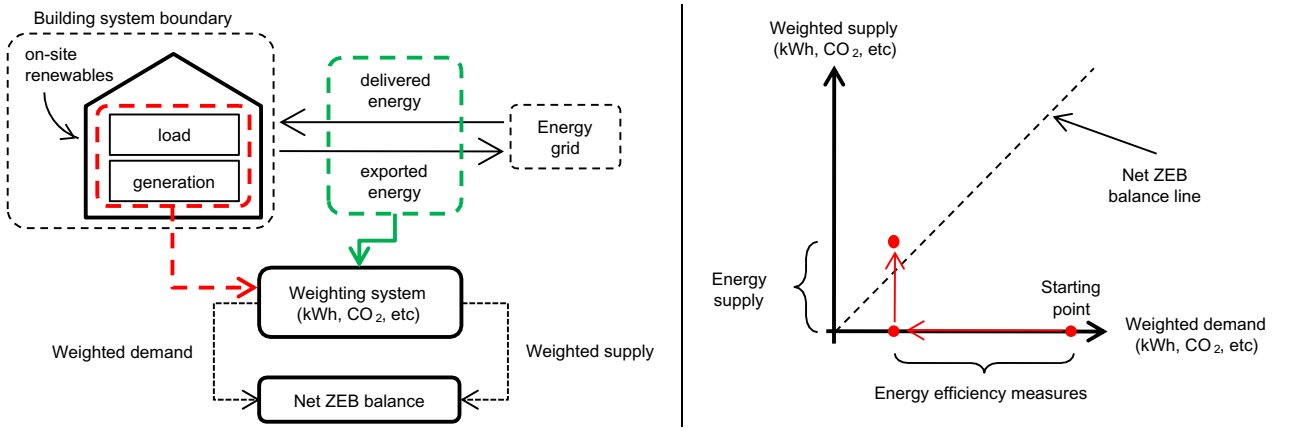

Figure 1. Based on (Sartori et al., 2012). Left; sketch of connection between buildings and energy grids showing relevant terminology. Right; graph representing the Net ZEB balance concept and strategy.