# Nearly Zero Energy hotels

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The focus of the European project neZEH on hotels raised the question of how to define requirements for nearly Zero Energy Buildings when complex buildings are concerned. This paper presents the first steps made to enter this topic, including a review of the existing hotel buildings stock energy performances.

## Introduction

According to the UNWTO-UNEP study (2008) [1] tourism contributes around 5% to global $CO_2$ emissions, out of which hotels and other types of accommodation account for 1%.

This comparatively small footprint is nevertheless important in the EU strategies to achieve the 2020 goals, as proved by the projects dealing with the hospitality sector promoted by the IEE in the last years, such as HES[1] and RELACS[2], and neZEH project which started in spring 2013.

The most recent goal to be achieved within the hotel sector goes beyond the generic increase in the energy efficiency and use of renewables: the neZEH project aims at retrofitting existing hotels to achieve the nearly zero energy level.

Among the several building uses, focusing on the existing building stock of the hotel sector could be an asset for leveraging the nearly Zero Energy Building (nZEB) 2020 goal because:

- hotels' guests may replicate at home the architectural solutions they experienced in the hotel;
- energy consumption in hotels is usually higher than in residential buildings, providing more opportunities for consistent energy savings;
- as the hotel sector is highly competitive, it is very likely that the advantages gained by some hotels toward the nZEB goal will push other to imitation.

1 The **Hotel Energy Solutions** is an UNWTO-initiated project in collaboration with a team of United Nations and EU leading agencies in Tourism and Energy. The project delivers information, technical support & training to help Small and Medium Enterprises (SMEs) in the tourism and accommodation sector across the EU 27 to increase their energy efficiency and renewable energy usage. http://hotelenergysolutions.net/en

2 The **RELACS (REnewabLe energy for tourist ACcomodation buildingS)** is a IEE project - launched at the end of May 2010 in Modena - involving partners from 10 countries. It aims to involve and motivate a significant number of accommodations throughout Europe (at least 60) in implementing renewable energy technologies as well as energy efficiency measures on their buildings. http://www.relacs.eu/home.php

## The neZEH project

Nearly Zero Energy Hotels (neZEH) is a 3-years long project supported by the Intelligent Energy Europe (IEE) program, started in April 2013. It involves a consortium of 7 European Countries (Croatia, France, Greece, Italy, Romania, Spain, Sweden) and 10 partners, among whom REHVA provides the technical expertise in the field of buildings energy performances.

The project aims at accelerating the refurbishment rate of existing buildings into nZEB in the hospitality sector and promoting the front runners. Particularly, neZEH focuses on the SME hotels, which represent the 90% of the European hospitality sector and are usually the most reluctant to commit to energy saving measures and to the use of renewable energies. In order to convince hotel owners to invest significantly in refitting their buildings, successful examples of existing neZEH will be showcased (**Figure 1**). The interested hoteliers will be supported in designing feasible and sustainable renovation projects: 14 pilot projects will be implemented in 7 Countries to prove the profitability of deep refurbishments achieving NZE hotels.

To achieve these goals, neZEH works within the legal framework of the nZEB implementation in each partner Country, tackling the main market barriers that prevent SME hotel owners from investing in major refurbishment projects.

Originally the project was supposed to use existing national legal requirements, but the delay in the transposition of the EU nZEB definition in most of the involved Countries, lead REHVA to face a new task: the definition of Country specific reference values using available benchmarks.

The outcomes of this preliminary study are shown in the following paragraphs.

## Actual energy use of existing hotels

To understand the relevance of the energy costs on the operational costs of a tourist accommodation building at the present stage, an overview of the available data on energy use of existing hotels is provided.

### *BPIE data hub*

After its major study *Europe's Buildings under the Microscope* (2011) [2], BPIE created a data hub for the energy performance of buildings. Refining the search for energy use of hotel buildings, relevant available data are listed for some European Member States by building age group. For this article the information extracted is per country as a maximum to minimum range of delivered energy use level set by the age groups values (**Table 1**).

### *Hotel Energy Solutions*

The Hotel Energy Solutions (HES) project reported significant variations of energy use in facility types

**Figure 1.** One of neZEH project showcases: the zero energy Stadthalle Hotel in Vienna.

within the hotel sector. However, it concluded that regarding climatic conditions, overall energy use levels can be relatively constant (energy needs for cooling and heating balance out), but with significant differences in the necessary technologies to reduce energy use in different climate zones.

In addition, HES provided:

- average energy use levels according to available certification schemes for the energy performance of hotels (e.g. Accor, Nordic Swan, LowE, WWF/IBLF, Thermie) i.e.delivered energy use range **200–400 kWh/(m²·a)** with average energy use **305–330 kWh/(m²·a)**;
- definition of five energy performance ratings, shown in **Table 2**.

Comparing the values inferred from BPIE data hub and from HES, a similar range of energy use in hotels is highlighted.

### *ENTRANZE*

To determine Country specific values, data from ENTRANZE[3] project were used. The project delivered an EU online data mapping tool including buildings' energy uses updated at 2008 (the last year with available data not affected by the economic crisis). Data about the current situation of energy use in buildings in the European Countries involved in the project were given with an energy breakdown by energy source. In the context of neZEH, data for residential buildings (**Table 3**) were used.

Consistently with the conclusions drawn by HES, which affirms that energy use levels can be relatively constant among hotels as far as energy needs for climatization are concerned, these were the functions considered to define the average energy use of hotels. These functions, here

**Table 1.** Max … min range of energy use for hotel buildings in some European Member States, extracted from the BPIE data hub.

| N° | Country | Years | Hotels and restaurants [kWh/(m²·a)] |
|---|---|---|---|
| 1 | Bulgaria | 1946 … 2004 | 350 … 217 |
| 2 | Czech Republic | 1900 … 2002 | 430 … 290 |
| 3 | France | 1975 … 2005 | 397 … 292 |
| 4 | Latvia | 1940 … 2010 | 185 … 140 |
| 5 | Norway | 1983 … 2011 | 296 … 220 |
| 6 | Slovakia | 1951 … 2006 | 545 … 190 |

**Table 2.** Hotels' energy performance rating defined in the HES project.

| N° | Energy performance rating | Range [kWh/(m²·a)] |
|---|---|---|
| 1 | Excellent | < 195 |
| 2 | Good | 195 … 280 |
| 3 | Average | 280 … 355 |
| 4 | Poor | 355 … 450 |
| 5 | Very poor | > 450 |

**Table 3.** Energy use in residential buildings with energy breakdown by energy source for the Countries involved in the ENTRANZE project.

| Country | Residential Buildings Energy Consumption 2008 level | Residential Buildings Energy Breakdown by Energy Source | | | | | |
|---|---|---|---|---|---|---|---|
| | | District Heating | Oil | Coal | Gas | Biomass | Electricity |
| | [kWh/(m²·a)] | [%] | [%] | [%] | [%] | [%] | [%] |
| **Croatia** | 195 | 8 | 14 | 0 | 31 | 15 | 32 |
| **France** | 202 | 4 | 19 | 0 | 33 | 14 | 30 |
| **Greece** | 205 | 1 | 49 | 0 | 4 | 16 | 30 |
| **Italy** | 124 | 0 | 16 | 0 | 54 | 7 | 23 |
| **Romania** | 248 | 15 | 4 | 1 | 27 | 42 | 11 |
| **Spain** | 115 | 0 | 31 | 0 | 22 | 13 | 33 |
| **Sweden** | 240 | 33 | 3 | 0 | 0 | 14 | 49 |

3 The objective of the **ENTRANZE** project is to assist policy makers in developing integrated, effective and efficient policy packages achieving a fast and strong penetration of NZEB and RES-H/C focusing on the refurbishment of existing buildings in line with the EPBD and the RED. http://www.entranze.eu/

**Table 4.** Energy use in hotels with details of the increased contribution for ventilation and cooling with respect to values for residential buildings.

| Country | Hotels Added Ventilation Delivered Energy [kWh/(m²·a)] | Hotels Added Cooling Delivered Energy [kWh/(m²·a)] | Hotels Added Ventilation Primary Energy [kWh/(m²·a)] | Hotels Added Cooling primary energy [kWh/(m²·a)] | Hotels Hosting Function Primary Energy 2008 level [kWh/(m²·a)] |
|---|---|---|---|---|---|
| **Croatia** | 19,3 | 10,0 | 57,9 | 30,0 | 397,8 |
| **France** | 19,3 | 6,3 | 49,8 | 16,1 | 352,4 |
| **Greece** | 19,3 | 10,0 | 56,0 | 29,0 | 417,5 |
| **Italy** | 19,3 | 10,0 | 42,1 | 21,8 | 221,5 |
| **Romania** | 19,3 | 6,3 | 54,0 | 17,5 | 394,7 |
| **Spain** | 19,3 | 10,0 | 45,4 | 23,5 | 240,0 |
| **Sweden** | 19,3 | 3,8 | 52,1 | 10,1 | 519,8 |

named "hosting function", will be further specified in the paragraph *The typical energy use of a hotel*.

To use the data provided by ENTRANZE in the specific context of hotels, the energy needs for the hosting functions were considered similar to the residential buildings' ones, with an additional contribution of energy for cooling and ventilation. While the extra ventilation-related energy use was constant, the relevance of the additional cooling load depended on the climate zone. With national primary energy factors, the primary energy use of existing hotels at 2008 level was calculated, as shown in **Table 4**.

## Definition of benchmarks for neZEH

One of the main expected outputs of the neZEH project is the setting up of hotels renovation projects in line with the definition of nZEB. Moreover, it is important to demonstrate to hoteliers that achieving the nZEB target is cost-effective by providing existing examples of neZEH. Both these tasks entail a practical definition of neZEH.

### *The typical energy use of a hotel*

The first issue to be faced is how to define in a hotel the "typical use of the building", upon which the energy performance of the building is based (EPBD, Article 2) [3].

Different hotels may offer different facilities, which entails a wide gap in the energy needs even among buildings with the same general use classification. Hotels can have similar energy consumption related to the their hosting function, typically related to energy use in guestrooms, but diverse energy needs when the offered facilities are concerned.

The approach to the problem chosen by the authors was to compare the reference values for primary energy dealing only with the hotels' energy use for the hosting functions.

The selection criteria for specifying the hosting functions was suggested by the EPBD (2002) [4], affirming that the energy performance of a building derives from the climatic indoor environmental quality targets set for it. The energy performance of a building for its standard use (heating, cooling, ventilation, hot water, lighting) must refer to the standard indoor environmental conditions, which in a hotel are the comfort conditions required for guests and workers, as recommended in EN15251 [5]. With these premises, the standard zones of a hotel to be considered among the hosting functions were selected: guests' rooms; reception hall; offices; bar and restaurant; meeting rooms.

### *Reference values for the definition of a neZEH*

The second key aspect was the definition of proper reference values for Primary Energy and integration of Renewable Energy Sources.

To define neZEH, available definitions of nZEB were grouped according to the geographical division proposed by the Ecofys report 2013 [6], in order to consider regional disparities regarding, among others, climatic and economic differences. The selected Countries representing Zones 1 (Mediterranean Europe), 2 (Eastern Central Europe), 3 (Western Central Europe) and 4 (Northern Europe) were respectively Italy, Slovakia, France and Estonia.

The final reference values are presented in **Table 5**.

It is worth noting that, at this stage, the available definitions exploited are not referred to the achievement of the cost-optimal level, despite its fundamental role for obtaining a concrete reduction on buildings' energy consumptions – especially in retrofit actions.

From primary energy values of existing hotels (**Table 4**) and neZEH values of **Table 5**, the Country specific reduction percentages were calculated. For a coherent comparison between the current and the nearly-zero energy consumption, the benchmarks set for neZEH were increased by the contribution of appliances (final values are shown in **Table 6**). The appliances impact was quantified as an extra energy use of 7 kWh/m² weighted by the national primary energy factors. With these adjustments, the reduction percentages, displayed in **Table 6**, ranged between 67 to 81% of the primary energy of existing hotels, with an average decrease of 74.5%, meaning that primary energy use of existing building stock need to be reduced by factor of 4 in average (varied between 3–5).

## Conclusions

The first steps within the neZEH project allowed the authors to have an overview of the current situation of the European hotels' energy consumptions and of how ambitious are the targets set for reaching the nearly zero energy level.

Some available national consistent nZEB definitions allowed to determine benchmark values for nearly zero hotels in four climate zones. Comparison with existing buildings showed that the primary energy use of existing hotels is in average by factor 4 higher relative to determine neZEH benchmark values.

**Table 5.** Summary of the requirements for nearly zero energy hotels in Europe.

| Zone | EP [kWh/m²·a] | Energy uses | RES [%] |
|---|---|---|---|
| **Zone 1** | 55 | Heating, cooling, domestic hot water, HVAC aux, lighting | 50 |
| **Zone 2** | 60 | | 35 |
| **Zone 3** | 95 | | 35 |
| **Zone 4** | 115 | | 25 |

Being the national implementation of the nZEB definition late at the national level, the neZEH project had to face the hard task of defining its own benchmarks, by exploiting the information available so far. Therefore, despite the rigorous methodology followed to define the neZEH benchmarks, some critical considerations are needed:

- the existing definitions exploited refer to new buildings;
- the figures are now settled as fixed figures, which do not take into account the cost-optimality approach.

Considering the cost-optimal level of energy performance for refurbished buildings will necessarily lead to an increase of these benchmarks. While new buildings can nowadays be easily designed as zero energy buildings, refurbishment actions have to face many technical constraints which may not allow to reach the target. ■

**References:** See the complete list of references of the article in the html-version at **www.rehva.eu** -> REHVA Journal

**Table 6.** Reduction percentages of primary energy for existing buildings to calculate national benchmarks for hotels.

| Country | Hotels hosting function Primary Energy 2008 level [kWh/(m²·a)] | Hotels hosting function Primary Energy neZEH benchmark (with appliances added) [kWh/(m²·a)] | Percentage reduction [%] |
|---|---|---|---|
| **Croatia** | 398 | 76 | 81 |
| **France** | 352 | 117 | 67 |
| **Greece** | 418 | 76 | 82 |
| **Italy** | 222 | 71 | 68 |
| **Romania** | 395 | 79 | 80 |
| **Spain** | 240 | 72 | 70 |
| **Sweden** | 520 | 136 | 74 |