Nearly zero energy target integration in public design tenders

Giulia Paoletti
Junior Researcher
EURAC research
Italy
giulia.paoletti@eurac.edu

Annamaria Belleri, PhD, EURAC reserch, Italy. annamaria.belleri@eurac.edu
Roberto Lollini, Coordinator of research group Energy Management in Buildings, EURAC research, Italy. roberto.lollini@eurac.edu
Hannes Mahlknecht, Junior Researcher, EURAC Research, hannes.mahlknecht@eurac.edu

Short Summary

The paper in the beginning clarifies what the nearly Zero Energy Building (nZEB) means and what the advantages of an Integration Energy Design (IED) process are. Afterwards, it shows two local experiences about nearly zero energy target integration in two different public design tenders procedures. The first experience regards a restricted design competition which aims at finding the best design proposal within a restricted number of projects. While the second experience regards a negotiated design tender which just aims at selecting the design team will design the new public building. Results show how to integrate, require and evaluate the results of different tender procedures, advantages to use IED process.

Keywords: nZEB, IED, public design tender.

1. Introduction

The Directive 2010/31/EU [1] invited public authorities to develop plans to increase the number of nearly Zero Energy Buildings (nZEBs). This paper proposes a way to increase the number of nZEBs including the zero energy balance target within the public design tender for new buildings (or for building renovation) and to push the design teams to follow an Integrated Energy Design (IED) process. The goal was to define the most effective rules and points of attention that municipalities or public administrations must consider in the tender elaboration phase. The paper shows the approach applied to two real experiences with two different public administrations. In both cases close collaborations between EURAC team and municipalities were necessary to fix energy performance indicators, establish a method to calculate the energy balance, the award score criteria and the evaluation commission members.

2. Integrated Energy Design process (IED)

The project Affirmative Integrated Design Action (AIDA), supported by the Intelligent Energy Europe (IEE) programme, aims at setting up strategies to support local authorities in pursuing nZEB target for new buildings and building renovations. One of the key approaches suggested is to enhance the decision making process through an Integrated Energy Design. The IED is a multidisciplinary, collaborative process that analyses the whole building process and integrates different aspects and knowledge during all phases of development of the

building.
The ultimate goal is the achievement of the performance targets defined by the customer (e.g. null energy balance, high internal comfort, economy, functionality, aesthetic impact, etc.) through a collaborative process for determining the most advantageous solution [2]. The IED work team consists of individual figures (i.e. contractor, architect, engineer, constructor, sponsor and users), whose specific expertise, if effectively integrated allows to define, analyse and evaluate different design solutions and their possible interactions. The choices are taken from a work team through a participatory decision making process. Thanks to the IED process qualitative, economic, functional and aesthetical aspects of a wide range of design solutions can be taken into consideration to find the optimal solution [3]. Generally, IED is an iterative process with a feedback loops mechanism [4].

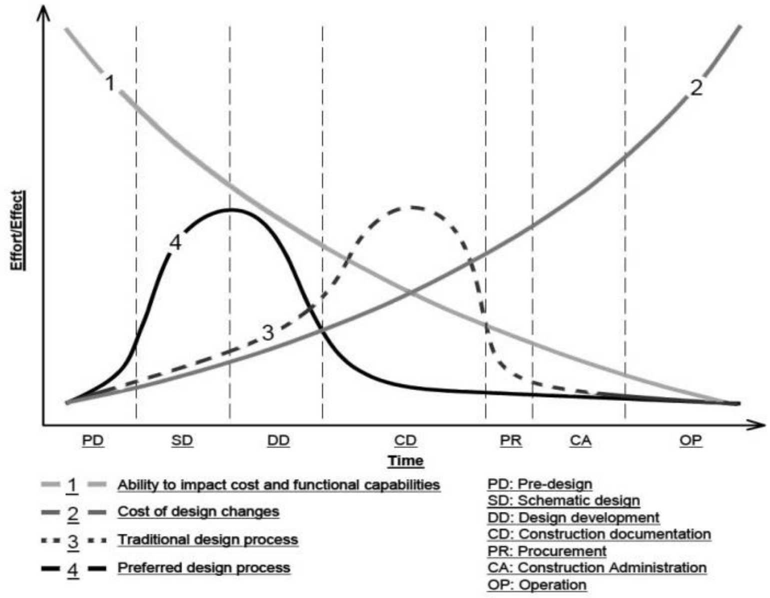


Figure 1: Difference between traditional design process and integrated design process. [14]

Figure 1 shows the difference between a traditional approach and an integrated design process. The main advantage of the IED is, that design decisions are taken at a time, when the cost does influence only design changes and not the overall construction cost. Therefore the design effort is higher during the early design phases than in the construction phase.
For this reason a close collaboration between public administrative figures, engaged to draw up public tenders and to untangle legislative procedures, and nZEB expert figures, is a key to success, which should be included into the rules of design competition procedures.

3. Nearly Zero Energy Buildings

The EPBD recast 2010 introduced the concept of nearly zero energy buildings stating that "*nearly zero energy building means a building that has a very high energy performance*" and that "*the nearly zero or very low amount of energy required should to a very significant extent be covered by energy from renewable sources, including renewable energy produced on-site or nearby*". Member States should ensure that by December 2018 all new buildings owned or occupied by public authorities are nearly ZEBs; public authorities are in charge of promoting and setting up strategies to pursue the nearly ZEB target.
The lack of a precise definition of nZEB [5], has led several member countries of the International Energy Agency to launch the research project "IEA SHC Task 40 – ECBCS Annex 52: Towards Net Zero Energy Solar Buildings". The project aims at clarifying the precise meaning of Net ZEB, translating it in calculation methodologies, and showing the implications of the latter on design solution sets. EURAC is participating in the project and is collaborating, with the Province of Bolzano to transfer the gained knowledge at local level.
The nZEB requirements part included in design tenders are the results of Task 40 project, and consists of energy performance indicators (energy balance, heating/cooling/electric demand, IEQ level, etc.), energy calculation methods (tools and methods) and evaluation

methods (ranking procedures through assignment of points and weighted sum).
In addition to this guide lines, in the tenders should be reported the national/local laws that fixes the energy performance indexes. In the Province of Bolzano, CasaClima Agency is the public authority in charge of establishing the energy performance requirements, and verifying them, for new and existing buildings through an energy certification performance (ECP) procedure. The CasaClima certification defines energy performance classes based on envelope performance during the heating season.
The new legislative decree DP 362/2013, in force from the 4th March 2013, introduces other energy performance requirements such as CO_2 emission, heating load and minimum energy production by renewable energy (see Table 1).

Table 1: Energy requirements for new buildings. Source: DP 362 of 4th March 2013.

Measures	Energy efficiency	RES
New buildings	CasaClima B (Heating Load<50kWh/(m²year))	40% of the total primary energy produced by RES
	CO_2 emission < 20kg/(m²year) (for non residential buildings CO_2<100kg/(m2year))	60% of the DHW load covered by RES
	minimum periodic thermal transmittance (Y_{ie}) for summer season	minimum of 20W (of for each square meter covered) of electric production system from RES

The following sections describe the nZEB definition applied to the two case studies in terms of metrics and calculation boundaries.

4. Alpine huts design competition

In November 2011 the Bolzano Provincial Committee has announced a design tender restricted to 8 selected design teams. The tender concerns the design of three alpine huts located at an altitude of 2000 - 3000 m [6].
The new alpine huts would serve two important purposes: to provide alpinists and hikers protection from the elements and a comfortable place to rest, to be an arrival point for families. The activity period is from July to September, except for a small part of the huts used as winter bivouacs. The huts are not connected to the public power and water supply grids and cannot be reached by vehicles. Actually victuals and supplies are delivered by helicopter or by walk. The construction process cannot be accomplished with traditional methods. So the designers had to contend with the challenge of building the new huts in isolated sites.
The Provincial Committee challenged further the designers by requiring the nZEB target and involved EURAC as energy consultant to support the energy concept design. The first version of the tender just mentioned some general requirements as energy production from renewable energy and sustainable construction mode. EURAC worked with the Provincial Committee to include energy guidelines in the second version of the tender and provided two simplified tools to estimate the energy performance indicators.
As this tender is a first attempt of IED introduction in the common procedures, the Provincial Committee did not include the energy concept in the ranking list and the nZEB target was not mandatory.
EURAC, according to the Provincial Committee and the hut manager's needs, established the following energy targets:

- energy efficiency of the building envelope with heating load ≤ 50 kWh/m²y (CasaClima B);
- 50% of domestic hot water consumption and 20% of the sum of heating and domestic hot water consumption have to be produced by thermal systems driven by renewable energy sources;
- 20% of electric energy demand has to be covered by electric energy produced by renewable supply systems.

The energy autarchy would require a wide area of solar collectors and PV panels with

resulting big storage volumes. Besides the lack of space, we also considered the plant transportation costs both in economic and environmental terms and the fuel transportation which would occur if we do not rely exclusively on renewable plants. We also considered that helicopter flights needed to deliver victuals could also be exploited for fuel transportation.
Another important requirement fixed by the huts manager is the low maintenance need of the systems. High reliability has the priority on high efficiency.

4.1 Simplified tools to assess energy performance

EURAC provided two simplified tools to prove the accomplishment of the fixed target. We modified the existing energy performance calculation tool (CasaClima version 2.3) adding weather data measured by local weather station, adjusting the load profiles according to huts manager descriptions and changing the heating period from winter to summer.
The resulting heating load is needed to calculate the share of energy consumption covered by renewable energy production. We developed an excel tool that enables designers to verify these energy targets accomplishments (Figure 2).

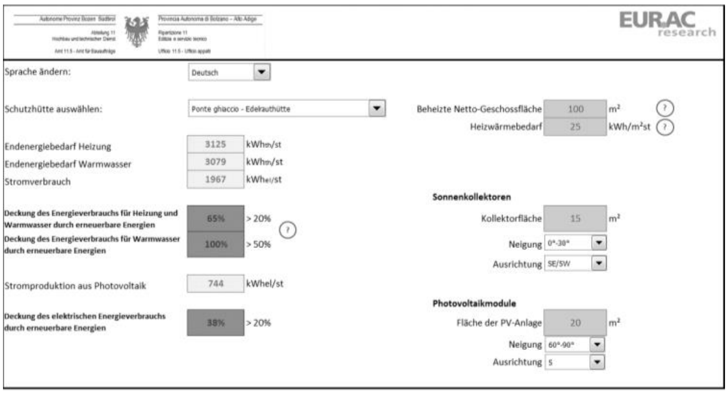


Figure 2: Excel tool to verify target accomplishment.

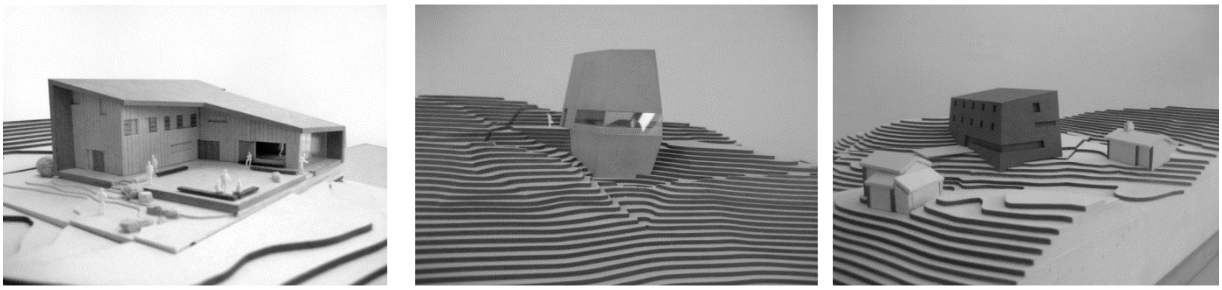
The tool requires as input the following data: net conditioned area, heating load during the activity period, total area, tilt angle and orientation of solar thermal collectors and PV panels.
We estimated Domestic Hot Water (DHW) consumption on the base of the total overnights during the hut opening season and by referring to the standard UNI TS 11300-2. Hut managers gave us indication about the kitchen electric energy consumption. Regarding lighting, we considered a power of 8 W/m² per 5 hours per day. We estimated the auxiliaries' consumption as 2% of the final energy demand of heating and DHW system.
We calculated the solar fraction of the solar thermal system by the f-chart method [7]. Solar thermal collector efficiency and losses are referred to a standard flat plate collector. We advised against evacuated tube solar collector application at high altitudes because they are more frail and need more maintenance compared to the flat plate ones.
We assessed the electric energy production of a standard mono-crystalline PV panel with 14% efficiency in the three location by means of the software PVsol [8] and using the global radiation on surfaces with different inclination and orientation calculated by Meteonorm [9]. We advise against thin film technology at high altitude applications because it is more subject to wear compared to the crystalline technology.
The energy concept guidelines recommend a combination of the following thermal system: gas micro-turbine for cogeneration, wooden boiler or solar thermal collectors with storage.
Gas micro-turbine are recommended for a decentralized use because of their almost constant efficiency in a wide range of load. Considering that the system requires fuel transportation by helicopter and produces exhaust gas emission, the turbine has to be activated only as backup.
For the electric energy production the guidelines recommend a combination of the following electric system: photovoltaic system, wind turbine, hydro turbine or cogeneration.
Due to the lack of wind data collected on site, the wind turbine feasibility and production cannot be assessed at this stage of the project.
The tender also suggests the area needed for storage tanks and batteries.

4.2 Evaluation criteria

Besides the accomplishment of the tender requirements, the evaluation criteria consists of architectural quality and landscape integration (50 points), functional quality and general standard and law accomplishment (35 points), construction, maintenance and operating costs (15 points).
Even though the ranking list does not include criteria to assign points to the energy concept, EURAC evaluated each project from the energy point of view and presented the results to the Provincial Committee.
Besides the accomplishment of energy target, we evaluated the building shape and the facade layout. Big roof surfaces and solar optimized orientation are preferred. Due to the low outdoor temperature even during the summer season, compact volumes can reduce heat losses.
The position of technical services should be advantageous in order to have a good energy savings potential. The restaurant zone has the higher internal loads due to large window surfaces, the presence of visitors and the kitchen. This zone could be exploited to heat passively the night zones, if the heat losses are limited.

4.3 Results

Since the design concept phase the design teams have considered energy efficiency issues. Most of the projects had a compact building shape to reduce heat losses. The design teams defined the thermal and electric energy generation systems and size the technical rooms properly in order to contain storage, batteries and system equipment.
As the huts are located at high altitudes, the landscape integration plays an essential role. Solar optimized orientation of envelope surfaces and high integration of solar systems are important design characteristics to be evaluated. Figure 3 reports the winner project models.



Ponte ghiaccio / Edelrauthütte
Arch. M.Scagnol, Arch. S, Attia

Vittorio Veneto/Schwarzensteinhütte
Arch. H. Stifter, Arch. A. Bachmann

Pio XI / Weisskugelhütte
Arch. Höller & Klotzner

Figure 3: Winner project models.

Main mistakes found from the energy point of view concern the building orientation and the compact shape. Some designers separated into two or more volumes the building isolating the restaurant zone from the rest of the spaces.
The energy concept development was no mandatory and there were no award criteria for energy requirements achieved. Therefore some design proposals had no energy concept description.
In some cases the energy requirements seemed to influence the architectural project in a not advantageous way. In some projects the restaurant zone is oriented towards the afternoon sun to have high solar loads, neglecting that a panoramic view is a high priority requirement too.

5. Negotiated tender to design a new elementary school

The municipality of Merano accepted to join the AIDA project and EURAC supported them in setting up the public design tender for a new elementary school. When the collaboration started, the public administration had already determined which kind of administrative

procedure to adopt for the design tender. The municipality decided to select the design team through a public tender for design service, also called “Negotiated tender”.
This kind of tendering process was chosen to reduce tender time and costs.
The negotiated tender rules the relation between public authorities and private companies as regard design and/or construction services and supply costs. The winner is determined by the most economically advantageous offer and by its experience (curriculum). Design teams participate at the tender without any design proposals. The winning team will deal with the preliminary, definitive and executive project and will direct the construction phase too.
Despite the tender does not demand for a design proposal, the development of an energy strategy was set as obligatory requirement. To support the design teams in this task, energy guidelines were included into the tender documents.
Therefore, the public tender is based on:

- a ‘Preliminary document for design phases’, including national and local laws (fire, acoustic, energy and structural regulation laws...), functional and dimensional requirements, energy performance targets (fixed to nZEB), budget and technical rules (for design teams) to participate in the design competition;
- energy concept guidelines to support design teams in developing energy strategies;
- evaluation criteria.

5.1 Energy concept guidelines

The energy concept guidelines consist of two parts.
The first part fixes the energy design targets and the energy performance requirements. This part explains what nZEB is meant to be, by defining the energy balance calculation method, the balance metric and weighting factors and the physical boundaries of building system [10].
The second part of the guidelines defines the rules of participation and gives instructions about the implementation mode of the required energy strategy. The tender requires an IED process and introduces the design team to this design approach.
The target, for the new elementary school of Sinigo, is the nearly zero energy one. The tender constrains the design team to follow an IED process during the design development.
The Municipality of Merano requires more restrictive energy performance requirements than the local law DP 362/2013 (see Table 1), which adopts the EPBD recast:

- energy efficiency of the building envelope with heating load lower than 30kWh/m²y (CasaClima A);
- nearly zero energy balance, using the calculation method developed within IEA SHC Task 40 project, and described in the energy guidelines of the tender.

The CasaClima certification protocol requires the proof of building envelope air tightness through a Blower Door Test and the on-site inspection of the building site by a CasaClima Agent to prove the correct realization of the execution, the absence of thermal bridges and the thickness of insulation layers. For these reasons, these actions are not mentioned in the energy section of the public design tender.
We define the nearly Zero Energy Building as a building, fulfilling CasaClima A requirements of the local EPC system and any national (DPR59/09 e s.m.i., DLgs 28/2011 e s.m.i.)/local (DP 362/2013) energy efficiency requirements, which offsets the yearly balance between generation and load (Equation 1), weighted in terms of equivalent carbon emissions. [10]
The balance has to be checked in the design phase by means of dynamic simulations.
All the energy uses of the building are considered as negative balance items: heating, domestic hot water, cooling, lighting, auxiliaries, ventilation and every kind of plug loads.
As positive balance item, only the on-site generation from on- or off-site sources can be considered, as long as the generation systems are architecturally and/or urban integrated inside the physical boundary. The physical boundary identifies so called ‘on-site’ generation systems and energy use. If a system is within the boundary it is considered ‘on-site’, otherwise it is ‘off-site’. If an energy use is within the boundary, it is included in the balance, otherwise it is not considered. The physical boundary in this case is defined as the perimeter of the urban lot, also delimited by the point of connection to the energy grid.

In order to guarantee a high aesthetic building value, the integration of energy generation systems is an important aspect which has to be taken into account from the beginning of the project. These systems can be integrated into the architectural elements of the building or in others elements located within the boundary system limits (e.g. integrated into the bus shelter of the parking area).
Weighting factors to translate final energy in equivalent carbon emissions are defined by DP 362 of 4th March 2013.

$$\sum_i g_i * w_{e,i} - \sum_i l_i * w_{d,i} = G - L \geq 0 \qquad (1)$$

where:
i = energy carrier
g_i = generation of the i-th energy carrier
l_i = load of the i-th energy carrier
$w_{e,i}$ = weighting factor for exported i-th energy carrier
$w_{d,i}$ = weighting factor for delivered i-th energy carrier
G = weighted generation
L = weighted load

The design team is also committed to follow an integrated energy design (IED) process.
Thanks to the AIDA project EURAC team will support the design team during the preliminary and definitive design phases. Specific meetings and workshops will be organized to actively support the evaluation of energy performance and indoor comfort through energy simulations.
Design teams have to present the energy concept in a report, their experiences and abilities in applying energy efficient solutions through a list of references. The school contains spaces with different functions, use patterns and comfort requirements: classrooms, gym and library. Therefore the energy concept can consider more than one conditioning system typology and/or different management systems. For this reason the tender requires the presence of an Energy Adviser/Certifier in the design team, with experience in energy efficient planning..

5.2 Evaluation criteria

The evaluation criteria consist of design architectural proposal, dimension, cost, urban integration, innovation, quality, functional aspects and daylight of connections areas (30 points), and law accomplishment construction, maintenance and operating costs, criteria to achieve nZEB target, experience of the Energy Adviser/Certifier and design team curriculums (30 points). The design team has to deliver a description of the energy strategy (passive and active solution), planned to reach the fixed energy targets through a technical report (6 points).
The tender deadline is the 22nd of May 2013. Thanks to AIDA project, we will join the jury to evaluate the energy strategy reports.

6. Conclusions

The paper shows two local experiences about energy performance requirements integration into public tenders. The legislative procedures of the tenders are totally different. The first experience (mountain huts) regards a restricted design tender which aims at finding the best design proposal within a restricted number of projects. While the second experience regards a negotiated tender (elementary school) which only aims at selecting the design team. This difference has influenced the way energy performance requirements are included into the tender. In the first case (mountain huts) energy guidelines and supporting tools are integrated in the tender and the design team has to demonstrate that the fixed targets are

reached. In the second case the energy guidelines are part of the tender to define the method that the winning design team has to use to reach the fixed targets.
In both cases the IED process is considered a necessary approach to increase the quality of the design proposal, from aesthetic, functional, energy efficiency and economic point of view. The IED main advantage is the achievement of the performance targets defined in the tender (e.g. nearly zero or zero energy balance, high level of indoor comfort, economy, functionality, aesthetic impact, etc.). The management of an IED is not always easy, because it involves different professionals that have to communicate with each other. For this reason it is necessary to identify a figure able to manage the design process and facilitate the design team meetings.
Results of the mountain huts case, show how the buildings have been shaped to allow the climate potential exploitation and to optimise renewable energy production. The design support activities and the collaboration with municipalities are still ongoing to follow the whole Integrated Energy Design Process.

7. Acknowledgements

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