# Design of Net Zero Energy Buildings: Feedback from International Projects

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# Design of Net Zero Energy Buildings: Feedback from international projects

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**Abstract**

The International Energy Agency (IEA), through the Solar Heating and Cooling programme (SHC) Task 40 and the Energy Conservation in Buildings and Community Systems programme (ECBCS, now named EBC) Annex 52, works towards developing a common understanding and setting up the basis for an international definition framework for Net Zero Energy Buildings (Net ZEBs). One of the subtasks of this programme –SubTaskC focuses benchmarking the Net ZEBs around the world to identify the innovative solutions sets that makes up this new type of building. This paper presents an overview of the work conducted by the participants of Subtask C and of Zero Energy Building projects that have been identified.


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## 1. Introduction

By 2005 the number of Net Zero Energy Buildings (Net ZEBs) had started to reach significant numbers and the number of projects and publications about this kind of building has grown constantly since. In 2002, the EU adopted the Energy Performance of Buildings Directive [1], which set minimum efficiency standards for both residential and commercial buildings. The Commission then proposed a recast of the directive as part of its Second Strategic Energy Review in November 2008. The second article of the

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directive of the 14th of April 2010 [1] gives a definition of a “nearly zero-energy building”. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources produced on-site or nearby. According to article 9, “by 2020, all new buildings are nearly zero-energy buildings”.

## 2. What is an Net Zero Energy Building?

In 2005/2006, the Net-ZEB concept was still generic and in 2006 there was no harmonized understanding about what was really a Net Zero Energy Building [2]. This was one of the principal motivations for an international collaborative research project that started in 2008 within the framework of the International Energy Agency “Towards Net Zero Solar Energy Buildings” [3]. The objective of this work is to study current net-zero, near net-zero and very low energy buildings and to develop a common understanding, a harmonized international definitions framework, new design tools, innovative solutions sets and industry guidelines. Since then, the Task participants have produced a range of deliverables including journal papers and books providing clarification about definitions [4] and presenting interesting case studies from around the world [5].

## 3. The Net-ZEB challenge

In simple terms, a Net ZEB is a very low energy building that balances its low annual energy consumption by the use of renewable energy on site.

To reach the Net-ZEB goal, two important analyses must be conducted at the design stage :

- to reduce building energy demand using passive solutions and energy efficient systems;
- to generate sufficient electricity by renewable energy systems to achieve the desired energy balance.

Passive approaches play a crucial role in the design of Net ZEBs as they directly affect the heating, cooling, ventilation and lighting loads put on the building’s mechanical and electrical systems, and indirectly reduce the sizing of the renewable energy systems that balance the consumption.

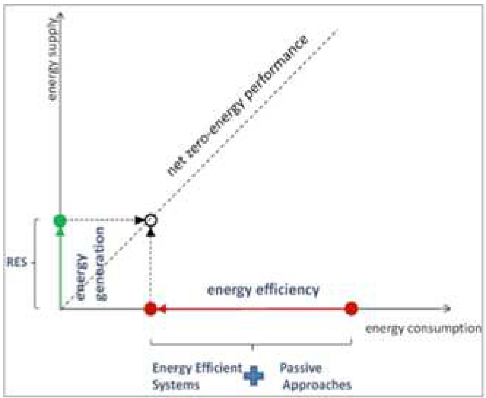


Fig. 1. : The Net Zero Energy Building Challenge

## 4. The STC Net-ZEBs data base

One of the subtasks of IEA Task40/Annex52 – SubTask C (STC) – focuses on a benchmark set of NZEBs from around the world in order to identify the innovative solutions sets that make up this new type of building. A list of 30 zero energy buildings and projects was established matching a set of mandatory criteria intended to ensure high quality data about the buildings and their measured performance. The locations of those 30 Net-ZEBs are plotted on a world map in Figure 2. The colour coding describes the principal thermal environment design challenge faced by each design team and the size of icon the type of building.


Fig. 2. : World map of the 30 Net ZEBs by climate challenge and by building type. The three pictures are the Net ZEBs in tropical climates : Enerpos (left) and Ilet du Centre (middle) in Reunion island and BCA Academy in Singapore (Right)

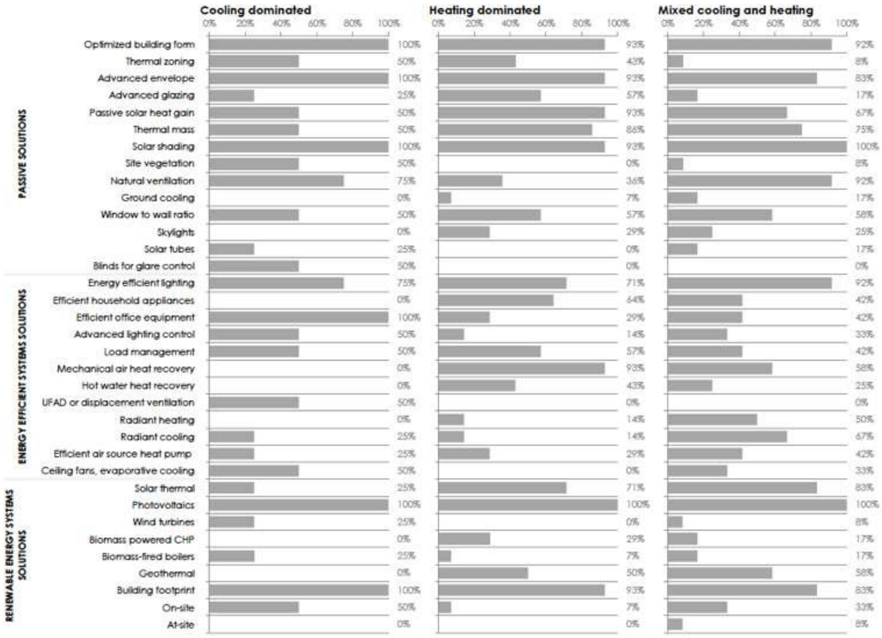


Fig. 3. : An example of analysis of solution sets by type of climate. One can see for instance that 100% of the buildings use PV as electricity generation or that 100% of Net-ZEBs in cooling dominated climate use solar shading systems

## 5. What are the solution sets ? (see Fig. 2)

In every new building the various challenges faced by the design team are met in a unique response, which combines particular building design approaches and strategies to lower the energy impact of the space conditioning and building loads. A solution set is a set of passive design solutions, energy efficiency solutions and/or renewable energy solutions that are used in a building to mitigate or lessen the various building challenges and achieve a building design goal. The STC database has been analysed in terms of these solution sets. Two kinds of solution set are reported: Whole Building Solution Set – The set of solutions used to lower the energy consumption of the whole building; Building Challenge Solution Set – the set of solutions used to lower the energy needed by a particular building challenge (e.g. heating, cooling, lighting, plug loads etc...).

## 6. Conclusion and recommendations about how to design Net-ZEBs

The overview of the Net ZEBs carried out in the framework of Subtask C of the IEA Task 40/Annex 52 has led to the identification of new ways of design for this innovative type of building. The building of the future must be bioclimatic with a passive design approach [6]; its width is shorter (12m max) compared to conventional buildings in order to improve cross natural ventilation and daylighting. Its envelope should be not only dedicated to thermal insulation but becoming multi-functional to protect from the outside environment while drawing from free sources of energy such as wind, sun, etc. Summer comfort conditions must be studied carefully to take into account the effect of global warming on the climate for the upcoming decades. The systems used should be more energy efficient. Ceiling fans play a crucial role and can be used whatever the climate in non-residential buildings for ensuring summer thermal comfort conditions up to temperature around 30°C.

Users' behaviour is also important in this new type of building to ensure they understand the specific operating processes of the building. The best-designed building in the world can consume more than a conventional building if users are not informed and supported in the use of the building. The aim is to design passive buildings with active occupants rather than active buildings and passive occupants.

The comparison of the energy consumption during the design phase and during occupancy demonstrates that it is always complicated to forecast the consumption of a building. One of the major problem is the definition of a timetable to evaluate the occupancy of the future building. This occupancy and use of equipment scenario must be considered as a primary input to energy consumption calculations to attain the optimum Energy Use Index (EUI – a measure of energy use per square metre) objective.

Finally, the design stage cannot neglect the importance of the brief and of the Integrated Design Process. At the brief stage it is important to document the expectations of the building owner in terms of EUI, energy efficient systems, and performance of the building envelope. The brief provides the objectives for the design team and must be as accurate as possible. In all cases where the design team was interviewed, an Integrated Design Process (IDP) structure for the collaboration of the various design disciplines was viewed as a key element in the successful delivery of a high performance building.

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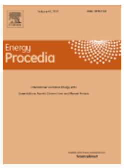


### Biography

François Garde is a Professor in the Faculty of Engineering ESIROI, Department of Sustainable Construction, University of La Reunion. He is also one of the Sub-Task leaders of the International Energy Agency SHC Task40/ECBCS Annex 52 "Towards net zero energy solar buildings" that ended in October 2013.