COMFORT AND ENERGY PERFORMANCE RECOMMENDATIONS FOR NET ZERO ENERGY BUILDINGS

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Synopsis

Conceptually, a Net Zero Energy Building (NZEB) is a building with greatly reduced energy needs that are balanced by an equivalent generation of electricity, or other energy carriers, from renewable sources. So far no common agreement exists on a clear and sound definition of NZEB, even though the subject is receiving significant attention in many countries. A major advantage of the NZEB approach is claimed to be the absence of energy performance indicators, hence avoiding the need to set internationally agreed limits. Nevertheless, if the *rationale* is to endorse the design of environmentally friendly buildings that promote sustainable development, then reasonably strict requirements on energy performance should be satisfied while providing high levels of indoor environmental quality and consequent users comfort. Otherwise, the risk is that poorly designed buildings could achieve the definition of NZEB simply by means of oversized photovoltaic systems, e.g. low rise commercial buildings with large roof area available. The *purpose* of this paper is to provide an overview of existing international standards and/or design best practices on both comfort levels and energy efficiency requirements that can be taken as general recommendations or guidelines for the design of NZEB.

1 Introduction

Energy performance of a building and the level of comfort provided are interrellated, and the two should always be evaluated together. Recommendations on ways of achieving comfort and energy performance objectives would differ with building categories, i.e. residential and commercial buildings, such as offices, schools, hospitals, etc., and with climates, i.e. cold, temperate, hot and humid, etc.

2 Climate classification

Different climate classifications exist, based on a set of climatic parameters and eventually codified in national standards. NZEBs designed for cold climates will have different solution sets than if designed for warm climates. However, a climate classification based on a simple degree-days method proved sufficient for the purposes of this paper. Description of degree-days method, advantages and disadvantages will follow.

3 Comfort criteria

Recent revisions of international standards have updated the definitions of comfort and ways to use them in designing and evaluating buildings. ASHRAE 55:2004 and EN15251:2007 have introduced the Adaptive model to be used in naturally ventilated buildings and ISO 7730 and EN15251 have introduced the concept of comfort categories based on different ranges of PMV or operative temperature around the neutral conditions. There are similarities but also differences in the approach taken by those standards which have relevant implications on the design of low energy buildings and will be analysed in the paper. The level of air changes to ensure indoor air quality are particularly relevant on the energy performance in well isolated, air tight buildings, and certain discrepancies between values in Standards and current practices in low energy buildings deserve discussion and possibly further research. Visual comfort will also be discussed.

4 Energy performance

There are mainly two ways of expressing recommendations on energy performance. One is the *prescriptive method* and consists in giving specific technical requirements for a set of envelope and technical system elements or characteristics. The other is the *performance method* and consists in giving limits on energy needs, i.e. for heating and cooling, and/or for total primary energy. There are advantages and disadvantages in both approaches, as will be discussed more in detail in the full paper. However, it is also possible to adopt a tandem approach, meaning that it is enough to comply with either the prescriptive method – mostly suitable for conventional building solutions and in the early design stage – or with the performance method – mostly suitable for particular building solutions, e.g with double skin façades where the concept of U-values loses its meaning and in more advanced design stages.

When standardized input are chosen as the basis for design and evaluation of performances, there are certain loads that are normally regarded as building load while others are regarded as user load. The border line between the two is somehow arbitrary, and this will be discussed. However, energy performance recommendations may be specified on both user and building loads.

4.1 User loads

Overview of reference values and/or guidelines for energy efficient systems on: Domestic Hot Water (DHW), Lighting, Appliances for different building categories.

4.2 Building loads

We will provide and discuss reference values and/or guidelines for high performance building components and systems which determine building loads for different building categories. As a preliminary result Table 1 shows a summary of the values found in existing standards and literature ([1],[2],[3],[4] and [5]) for the prescriptive method.

Table 1: Technical requirements – prescriptive method

Parameter		Heating DD	Cooling DD	Low Energy building		Passive House building	
Air tightness, n_{50} [ach]		≥ 2000	-	≤ 1.0		≤ 0.6	
		< 2000; ≥ 500	-	≤ 1.0		≤ 1.0	
U-values [W/m²K]				Envelope[a]	Windows[b]	Envelope[a]	Windows[b]
		≥ 3000	-	≤ 0.17	≤ 1.20	≤ 0.15	≤ 0.80
		2000	-	≤ 0.28	≤ 1.50	≤ 0.25	≤ 1.10
		1000	-	≤ 0.45	≤ 1.90	≤ 0.40	≤ 1.50
		500	-	≤ 0.60	≤ 1.90	≤ 0.55	≤ 1.50
Thermal bridges ψ [W/mK]		≥ 500	-	≤ 0.03		≤ 0.01	
Solar shading class[c]		-	≥ 1000	class 4		Class 4	
		-	1000	≥ class 3		Class 4	
		-	≤ 500	≥ class 3		≥ class 3	
Heat Recovery efficiency	air-air	-	-	≥ 70 %		≥ 80 %	
	air-water-air			≥ 60 %		≥ 60 %	
Specific Fan Power (bal. ventilation)		-	-	≤ 2.0 kW/(m³/s)		≤ 1.5 kW/(m³/s)	

[a]average of the opaque envelope, including external walls, roof and ground floor; [b]overall, including frame; [c]as defined in EN 14501

5 Acknowledgment

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6 References

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