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How to interpret the renewable share?

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ABSTRACT

Aiming at decarbonisation threshold of primary energy consumption is on the top of nearly Zero Energy Building requirements. Disputable instructions suggest that parallel a threshold of compulsory renewable share should be prescribed excluding utilised passive solar gains although the last covers a considerable fraction of heat losses. Elementary requirements such as thresholds of heat transfer coefficients encompass low peak load rather than low heating energy consumption. These features of directives and updated or planned national regulations do not motivate designers to take advantage of passive solar systems. Instead of reckoning the building itself as the most artless solar system utilisation of active systems are forced disregarding any life cycle aspects. Simulation of heating energy consumption of a set of sample buildings illustrates the considerable role of passive solar gain in existing and nearly Zero Energy buildings and the conflicting aspects of peak load versus consumption. The intention of authors is to initiate the reconsideration of formal rules.

1. Introduction

Low primary energy consumption, low emission, renewable energy are the key issues in the building sector, became subjects of European Directives and national regulations. Nevertheless without regulatory obligation the same objects were aimed at by responsibly thinking architects, moreover the examples of vernacular and historic architecture exhibit features of energy conscious design. The contemporary directives and regulations seem to forget the lessons of the past and simple solutions might be missing in the sophisticated contemporary system of requirements. The intention of the authors is to reveal some of the relevant problems which may be worth of analysis and reconsideration

Let us consider two buildings with the same low primary energy consumption. In the first this is due to the super thermal insulation (e.g. vacuum panels) and no renewable energy is used, in the second the thermal insulation is “normal” but renewable energy is used. From the point of view of environmental impact in the operational period the result is the same. Do both achieve the main goal? Which one is better? Is the designer free to ponder all aspects of the given brief and building site and to select the cost-optimal solution?

Let us consider two buildings with the same low primary energy consumption and with the same share of renewable energy use. In the first this is due to on-site utilisation of renewable energy, in the second it is due to district heating/cooling and national grid, based on, or supported by, renewable energy. Who is responsible for the fulfilment of requirements? – designers of individual buildings, local authorities running district systems or decision makers on regional or state level? Availability of any district heating network does not depend on the designers of individual buildings however they can do their best within the limits of on-site possibilities. Can we take seriously a requirement on the compulsory minimum renewable share if it can be fulfilled only if off-site renewable energy is available?

There are measures which decrease the energy consumption at the cost of higher peak load. Energy consumption or peak load should be encompassed?

Does utilised passive solar gain decrease the primary energy consumption?

Low operational energy consumption is accompanied by higher embodied energy. Are life cycle aspects considered in directives and national regulations?

These questions are intentionally provoking; some of them may seem to be stupid however brief analysis shows that the related rules and proposals are not free of contradictions. Maybe a discussion can resolve some of them.

2. Background

The concept of nearly zero energy building has been introduced in [5] – in the followings referred to as “recast”. According to logic

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a building can be considered evidently as nearly zero energy one if its specific yearly primary energy consumption does not exceed the threshold X.

The threshold X can be different for different building categories since some components: domestic hot water, internal heat gains, necessary air change rate depend on users' need and behaviour, and obviously depends on the climate, on the building traditions of MS. Obviously no numeral values of overall validity could have been prescribed for the EU stretching from arctic circle to the Mediterranean zone (not mentioning the overseas areas of some MS).

Nevertheless the recast needlessly attempts to define the nearly zero energy building although its text is a collection of instructions rather than a real definition.

According to the EPBD recast a nearly zero-energy building:

- has a very high energy performance,
- the amount of energy required should be nearly zero or very low,
- the energy required should be covered to a very significant extent by energy from renewable sources (including energy from renewable sources produced on-site or nearby).

Regarding *the first item*, in the typical interpretation the "very high energy performance of building" means thermal insulation and air tightness. Although these requirements are obvious other factors should be considered as well: the utilised passive solar gains, which depend on the thermal mass, orientation and solar access of the glazed elements. Certainly here the architectural concept is spoken of which cannot be regulated as easy as some numeral *U* value however introducing a

sub-threshold that relates to the building as a whole and that is based exclusively on data attributed to the building itself (geometry, U-values, g-values, orientation, solar access, thermal mass, etc) would motivate the designers and facilitate the formal acknowledgement of the buildings' energy performance.

The *second item* is difficult to interpret: even if the building has a very high energy performance, the energy need cannot be nearly zero, because this partly depends on the users' behaviour and expected comfort levels. The better the energy performance of the building shell and the efficiency of the service systems is, the more prevailing will be the net energy need of the hot water supply in the total energy balance of a residential building since it originates from demand in volume and temperature. Components of energy balance mostly depending on building should be separated from components which do not depend on the energy performance of building.

As far as the *third item* is considered certainly the main goal is not simply the consumption of renewable energy but to cover a rational part of the needs by renewable energy (pro forma wherever the source is: on-site, off -site, nearby). Nevertheless, the measure of "significant" as well as the reference value is not defined in the recast. When determining the renewable energy share, regulations must consider not only the possibilities but the constraints as well.

Although in permissive phrasing many details of [9] inspire the MS to support the use of renewable energy in buildings. "It *may be appropriate* for Member States, in order to facilitate and accelerate the setting of minimum levels for the use of energy from renewable sources in buildings, to provide that such levels are achieved by incorporating a factor for energy from renewable sources in meeting minimum energy performance requirements under Directive 2002/91/EC, *[now the nZEB level]* relating to a *cost-optimal reduction* of carbon emissions per building."

and "By 31 December 2014, Member States shall, in their building regulations and codes or by other means with equivalent effect, *where appropriate*, require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation."

Only the oblique phrases (marked by the authors) suggest (in implicit way) that the final aim is not the extortion of the use of renewable energy at any cost but the limitation of primary energy use and the related emission.

In accordance with the above quotation [2] emphasizes, that "a threshold for the minimum share of renewable energy demand should be defined".

Pushing the envelope of renewable share many deep analysis [4,2,3] propose very high renewable share from 50 up to 90%. The correctness of these studies is convincing however it is to be mentioned that the role of off-site renewable sources and biomass seems to be exaggerated: at least the sources of biomass in a given region are not arbitrary and the availability of district heating network is beyond the cognizance of the designers of individual buildings – this is why the proposed share does not seem to be realistic as obligatory requirement.

Decision makers responsible for national regulations are puzzling over the solution. In some MS simple philosophy is followed: the requirement (in the term of specific primary energy consumption) should be demanding, thus the use of renewable energy is hardly evitable – the designers are forced upon use renewable energy. This approach opens the door to select the best solution fitting the conditions of building site whilst the main goal in terms of emission will be achieved. Nevertheless some MS take seriously the instructions of the recast and [9] and intend to prescribe the numeral value of the renewable share. Attempting to find a demanding but realistic figure however further rules of the [9] must be considered which unambiguously states that

"(32) Passive energy systems use building design to harness energy. This is considered to be saved energy. To avoid double counting, energy harnessed in this way should not be taken into account for the purposes of this Directive." and again in Article 5. (4):

"Thermal energy generated by passive energy systems, under which lower energy consumption is achieved passively through building design or from heat generated by energy from non-renewable sources, shall not be taken into account for the purposes of paragraph 1(b)."

Obviously double counting must be excluded however if utilised passive solar gain remains hidden in the energy balance the designers are less motivated to make use of it and the fulfilment of renewable share requirement will be rendered more difficult.

Utilisation of passive solar gain has been the main concept of classic solar architecture and its usefulness has been proven by experience of centuries as well as fundamental and recent research [8,7]. There were radical changes in the building elements and service systems in the last few decades, therefore the question can be raised whether the utilised passive solar gain play an important part in the energy balance of a nZEB (for which many times the term "passive building" is used to complicate the terminology) and if yes, how to consider it formally in the energy balance.

3. Method

Comparing a passive solar building (in the classic sense – thereafter solar buildings) and a passive building (in the nZEB sense – thereafter nZEB) the main differences at the first sight are the followings:

- solar buildings exhibit large glazing ratio, concentrated on the Equator facing façade, nZEB often exhibit "defensive character" with modest glazing ratio (although it is not unalienable feature);
- the glazing of nZEB has lower *g* value;
- due to the good thermal insulation the gain/loss ratio in nZEB is higher than in solar buildings – as a consequence the utilisation