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How low should be the energy required by a nearly Zero-Energy Building?
The load/generation energy balance of Mediterranean housing

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ABSTRACT

Directive 2010/31/EU adopted that by the end of 2020 all new buildings should be nearly Zero-Energy Buildings (nZEB) and Member States should achieve cost-optimal levels by ensuring minimum energy performance requirements for buildings. This paper discusses how low should be the energy required by a nZEB, in the context of housing energy consumption in a Mediterranean climate (Lisbon). For selected houses built after 1990, the calculated primary energy loads for regulated uses – heating, cooling and domestic hot water – are found to be below 90 kWh/(m^2 year). Applying the cost-optimal solutions of thermal insulation and glazing type and considering energy efficiency improved systems, this study concludes that housing energy loads are 'low' for the indicative range of 70 kWh/(m^2 year) for regulated uses or 100–110 kWh/(m^2 year) for total uses, taking primary energy indicators (PEI) from EN 15603. Assuming PEI from Passive House Planning Package or those to be assumed in Portugal for 2013, the threshold decreases to 60 kWh/(m^2 year) for regulated uses or 90–100 kWh/(m^2 year) for total uses. Only the first nZEB condition is explored by this paper. The second condition requires that the nZEB energy load is covered by a 'significant' part of renewable energy sources produced on-site or 'nearby'.

1. Introduction

Specific measures in the building sector are introduced by the European Commission [1] with Directive 2002/91/EC of the Energy Performance of Buildings (EPBD) with the purpose of adopting: (i) common methodologies for calculating the building energy consumption, (ii) thermal quality requirements for new, under major renovations and existing buildings, (iii) periodic inspection of boilers and central air conditioning systems and (iv) the buildings energy certification, introducing, for specific buildings, energy consumption thresholds based on calculations or measurements.

The potential for cost-effective energy savings in the building sector, with 40% of the final energy, was estimated to be higher than 20% [2], driving the European Commission [3] to adopt Directive 2010/31/EU (EPBD-Recast). The framework for cost-effectiveness evaluation is here the life-cycle approach, where initial investment costs (material, labor, applicable taxes, etc.) are compared with the operation (energy carrier tariffs) and maintenance costs during the period of building operation [e.g. 4]. Among other issues the EPBD-Recast introduced that building energy performance requirements and corresponding economic benefits should be analyzed together, in order to achieve cost-optimal levels. For the specific case of building energy analysis, the cost-optimal methodology consists in finding the local minimum of the cost as a function of primary energy. It is noteworthy, that the primary energy corresponding to the cost-optimal (the cost-optimal energy) is a cost minimum and not an energy minimum, thus other building solutions characterized by lower energy values could be obtained.

In order to set the cost-optimal energy, Member States should use the methodology established by the European Commission [5], which was previously explored by the Buildings Performance Institute Europe [6]. The methodology obeys to the following structure:

1. Define reference buildings (RB);
2. Define energy efficiency measures that apply to RB;
3. Determine the RB energy needs and primary energy;
4. Calculate the costs of the energy efficiency measures, during the RB expected economic life-cycle.

For instance, due to thermal losses, the thermal insulation thickness of the external envelope should be increased until a threshold

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