Nearly Zero Energy Buildings in reality, not just theory

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The EU requires new buildings to be 'nearly zero energy' by 2020. A citizen might expect this to mean what is says. However, the current requirement is for predicted energy, not actual performance in use. The difference is often a factor of 2 or 3. How can the performance gaps be eliminated?

Keywords: Design for performance, Base building, Commitment agreement, Nearly Zero Energy.

What should NZE mean

All new buildings in Europe must be nearly zero energy (NZE) by the end of 2020, if Member States are complying with Article 9.1(a) of the EPBD recast (1). This paper reflects on the expectations that European citizens might have of this 'nearly zero' concept, particularly those in the real estate industry, when they need to report to internal and external stakeholders.

At first sight, the NZE ambition might be expected to apply to all the energy used in a building. This would be laudable, but the EPBD recast is focused on the energy needed for heating, ventilation and cooling (HVAC) to provide a comfortable working environment, together with domestic hot water[1]. Of course, the energy needs for lighting, lifts and the business energy uses of the occupiers, e.g. small power and ICT, can and should be subject to a complementary NZE protocol to arrive eventually at NZE whole buildings. Stakeholders have to recognise for now that the EPBD's NZE remit for 2020 is to concentrate on reducing to nearly zero the energy used for HVAC and hot water.

1 See the first paragraph of Annex 1 of the EPBD recast which defines how the energy performance of a building is to be determined for a building energy certificate

Government officials charged with transposing Article 9.1(a) appear to believe compliance with the NZE requirement can be fulfilled by theoretical calculations at the design stage of new buildings. We think most stakeholders would disagree, given the performance gaps between design and reality, and assuming the EPBD intends new buildings to play their proper part in achieving the EU's energy security and climate goals - by reducing their energy use in practice, not just in theory. We, therefore, suggest that the NZE requirement should be verified by measurements over a year of operation with normal occupancy. This is not a fantasy: the scope of the EPBD's NZE ambition is similar to what is called **base building** energy use in Australia, where large new commercial offices have been designed for better in-use performance with increasing success since, at least, 2002. The EU needs to adopt a similar approach.

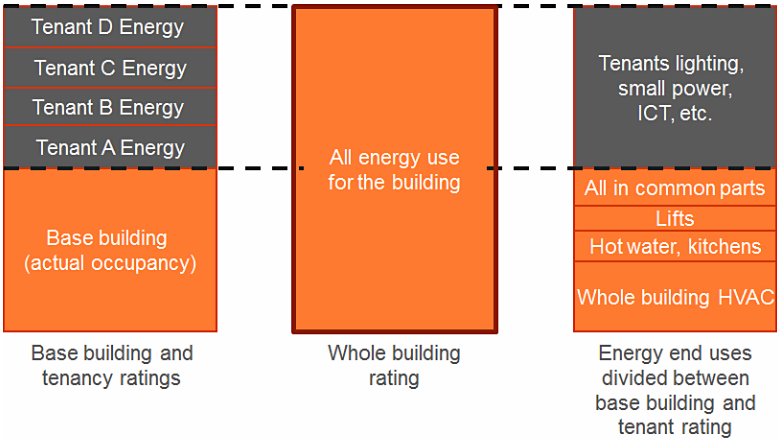

Figure 1. Alignment of energy metering and ratings with landlord and tenant responsibilities.

The other uncertainty in the 2020 NZE ambition is: how 'nearly' close to zero means. Stakeholders might expect NZE buildings to be approaching zero energy use on a scale that covers the full range of performance for the applicable building type. Again Australia offers a template: the NABERS[2] scale for rating office energy performance has eleven points from 1 to 6 stars, with 1/2 stars between the whole stars. The scale was calibrated in 1999, when 15% of buildings performed poorer than 1 star, average base building performance was 2.5 stars and 4 stars was best practice. Today, the stock average rating is 4.2 stars, while nearly all new offices achieve at least 4.5 stars, most reach 5 stars or better, and a few are beginning to achieve 5.5 or 6 stars. 6 stars is a credible contender for the NZE target, being half-way from 5 stars to net zero energy.

Market transformation

Australia has focused its energy efficiency efforts on base building energy performance in use because this metric gained the most traction in the market. Measured base building energy ratings and their disclosure in sale or let transactions are now fundamental to the way commercial offices are managed in Australia: they influence investment decisions for existing and new buildings and impact the management of major investment property portfolios, including sales and purchases (2). Research indicates that better base building ratings enhance property values, reduce vacancy rates and increase yields (3).

One reason why base building ratings have worked so well in Australia is the routine provision of landlord's utility meters, facilitating measurement and benchmarking of base building energy use (see **Figure 1**). Separate utility meters measure energy used by each tenant, giving each party the energy data they need to support management of the energy use they can control.

Commitment Agreements

The impact of the base building in-use rating on asset value and a reluctance of some tenants to occupy space unless they knew its rating created a need for developers and investors to be able to promise how well a new building would perform once occupied. This triggered the concept of the NABERS "Commitment Agreement" in which a developer could enter into a firm commitment to deliver a specified level of in-use performance. This was considered feasible because base building performance is determined by the building's design, its construction, HVAC services, controls, commissioning and management - all things for which the developers, designers, procurement and delivery teams and operations and maintenance people can be responsible. It has been demonstrated that, provided occupancy hours are taken into account, other aspects

[2] NABERS (the National Australian Built Environment Rating System) covers energy, water, indoor environment and waste. The NABERS Energy rating scheme has enjoyed particular success in driving improvement in energy performance of larger prime office base buildings in Australia, for which it is now mandated (on sale or let) by the Building Energy Efficiency Disclosure Act 2010. NABERS is also available, but less widely used, for office tenant ratings, whole office buildings, and for shopping centres, hotels and data centres. NABERS Energy is based on measuring and benchmarking the CO_2 emissions arising from the energy use of buildings. (www.nabers.gov.au/public/WebPages/Home.aspx).

of tenant activity have a relatively small effect on measured base building performance.

Since its inception in 2002, experience of 'design for performance' has accumulated to the point that Australian teams are now capable of designing, building, commissioning, fine-tuning and operating office buildings that routinely achieve measured performance in line with predictions made at the design stage. Overall, there have been a total of 147 Commitment Agreements for base buildings. **Figure 2** shows that 30% have been achieved, 40% are pending, 25% are overdue and just 5% have failed. It also shows nearly all have targeted 4.5 or 5 stars, whilst one has achieved 5.5 stars. This is significant in that 5.5 star performance represents almost four times less energy than 2.5 stars, the average performance of Australian office buildings in 1998. In other words, a 5.5 star building is now achieving the "Factor 4" efficiency improvement hypothesised by Lovins et al in 1998 (4).

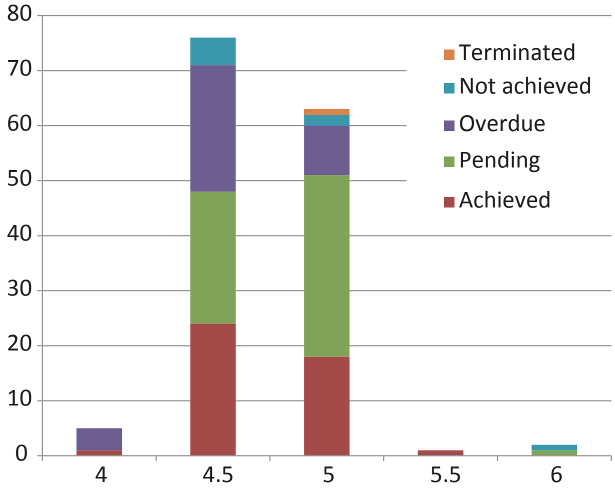

Figure 2. Number of office base building Commitment Agreements by target.

Offices in London and Melbourne compared

There are no intrinsic physical reasons why the base building energy performance of new European offices cannot be as good as it is in Australia. However, the absence of both a disclosure culture and feedback from real-world measurements into new office design and management has contributed to Europe falling behind (5).

In **Figure 3** we compare the base building energy performance of offices in London and Melbourne. London is typically cooler, both in summer and winter, so buildings require more heating and less cooling. The line in **Figure 3** shows the relationship between base building energy intensity in kWhe/m²NLA/yr and the NABERS star level for the State of Victoria (for such international

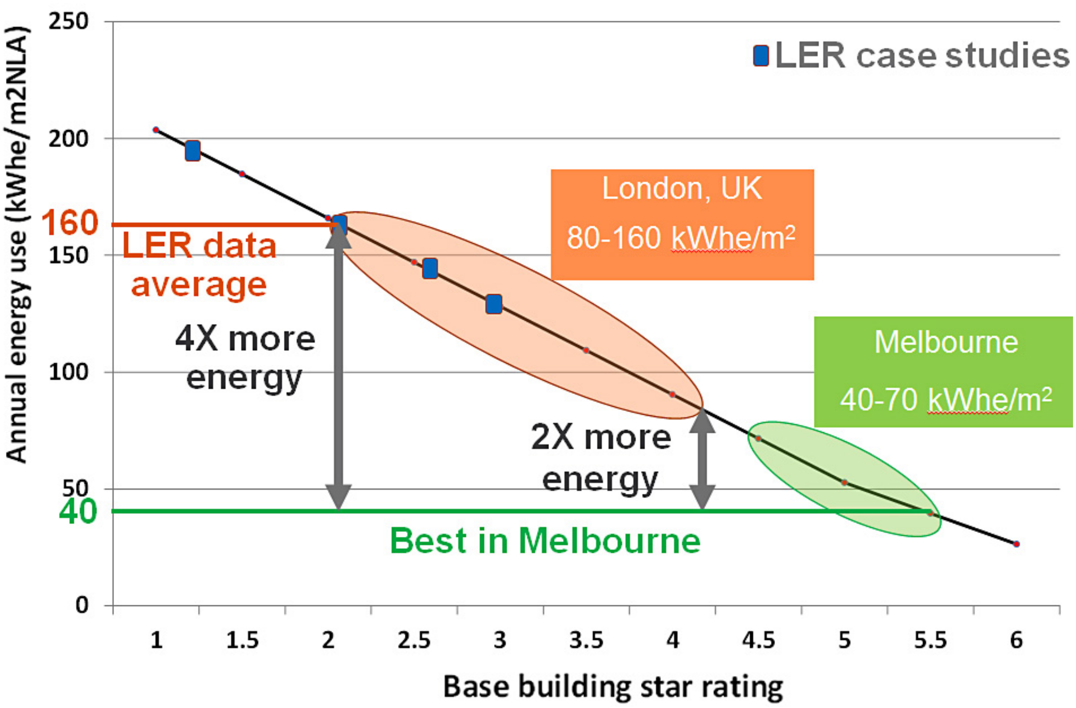

Figure 3. Base building energy use for new prime offices in London and Melbourne.

comparisons of energy efficiency we favour the kWhe energy metric[3]). Most new offices in Melbourne achieve 4.5 stars (70 kWhe/m²/yr) or better, with the best at 5.5 stars (40 kWhe/m²/yr).

Where do new London prime offices sit on **Figure 3**? We cannot say precisely, because UK base building operational performance is rarely measured. However, a set of base building energy use data collected in 2013 averaged 160 kWhe/m²/yr, close to the average performance of buildings in Melbourne in 1999, but four times the best in Melbourne today. From other confidential data sources, London's best performing offices currently seem to be at 80 kWhe/m²/yr, twice the best in Melbourne.

Conclusions

The requirement for new buildings to be 'nearly zero energy' from the end of 2020 creates a unique opportunity for Europe. Let's grasp the nettle and make the claim credible to stakeholders by targeting in-use performance outcomes, verified by measuring and benchmarking. The NABERS 6 star base building performance level is a tried and tested precedent for an achievable 'nearly zero energy' target. ■

[3] kWhe is the "electricity equivalent" of total energy use: kWh of electricity are added to kWh of any fuel multiplied by 0.4 and kWh of hot or chilled water multiplied by 0.5. NLA is net lettable floor area.

References

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(3) Australian Property Institute (2011). Building Better Returns: a Study of the Financial Performance of Green Office Buildings in Australia. Can be downloaded at: http://www.api.org.au/folder/news/building-better-returns-research-report.

(4) von Weizsacker, E., Lovins A.B., Lovins, L.H. Factor Four: Doubling Wealth, Halving Resource Use - Report to the Club of Rome, December 1998

(5) Cohen RR and Bordass WT, "Mandating transparency about building energy performance in use", Building Research & Information Volume 43, Issue 4, 2015 special issue: Closing the policy gaps: from formulation to outcomes, pages 534-552. Can be downloaded at BR&I online: http://www.tandfonline.com/doi/full/10.1080/09613218.2015.1017416

The Energy Performance of new buildings before they come into use is necessarily expressed as an "asset rating" (see EN ISO 52003-1), in most EU countries based on the building "as built" data (or data collected on basis of as built information and additional information collected when the building is inspected in its current existing situation). For existing buildings, it is possible to base an EP on the "operational rating" (using measured energy) or an "asset rating" (based on calculations). The EPBD requires that the Energy Performance rating includes the assessed (in most cases calculated but possibly measured) energy use for HVAC, DHW and (to some extent) lighting under typical conditions (standard outdoor climate, specific indoor climate conditions and standard -well-defined- user behaviour).

A tailored calculation could adapt the typical conditions deployed in the standard EP calculation methodology to the actual running conditions of a building. It would then be technically applicable to compare (and verify) the predictions of a tailored calculation with measured energy values during a year of actual use of the building e.g. per service (heating, DHW). During the construction of the building, users of this approach would need to ensure sub-meters were located where needed to measure the parameters of interest. The managers of the building could use the calculated values for each parameter to set the targets for metered performance. This because measurement data must separate between EPB use and non-EPB use, correcting for effects on the internal heat load due to this not-standardized non-EPB use and correcting for the real user pattern and real weather. Only when the tailored calculation is done properly, does it make sense to verify a tailored asset rating with a measured operational rating for the same parameter (see article on EN ISO 52003-1).