The Passive House standard and its relevance for the implementing nZEB and the Global UN framework for energy efficient buildings.

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Introduction

Relevant information must be useful, understandable, timely, and needed for decision making. This paper presents information which has been produced for decision-makers in Northern Ireland (NI) and the Republic of Ireland (RoI). It strives to be useful for decision makers in that it relates specifically to the prevailing regional and national building regulations and the Irish climate. It has been written in plain English to make it easily understandable and uses the terms relevant for policy decision-makers. Finally, it is timely given that the near Zero Energy Buildings (nZEB) standard is currently undergoing a review process in RoI.

At global level, the United Nations Economic Commission for Europe (UNECE) Committee on Sustainable Energy is leading efforts within the UN to develop Framework Guidelines for the global transformation of energy efficiency in the built environment (Anon, 2017).

The Passive House (PH) standard has been in existence for over 27 years and potentially offers a tried and tested method of implementing both standards.

A costed case study of a scheme of PH dwellings in the Republic of Ireland has demonstrated that PH has been used as a cost-effective means of achieving high performing nZEB buildings (Colclough et al 2017, a,b), and the energy efficiency required by the UNECE framework.

Further papers have detailed that the PH performs well compared with dwellings built to the prevailing minimum building regulations in NI and RoI (Colclough et al c ,d). This paper collates these findings for decision makers and indicates that, despite being 27 years old, the PH standard can potentially be a key enabler for the buildings of the future.

Method and Results

Information relevant for decision-makers in Northern Ireland and the Republic of Ireland indicates that the passive house standard

1. Can be a cost neutral method of complying with the EU's nZEB requirement
2. Provides an excellent indoor air quality
3. Provides excellent thermal comfort in Ireland, and provides a means of significantly reducing the risk of overheating which is inherent in low-energy buildings
4. Reduces the Performance Gap
5. Is in agreement with overarching global aspirations such as the United Nations framework guidelines for energy efficient buildings

Cost

Figure 1 gives the cost differential of building dwellings to the nZEB standard (via the passive house methodology), in comparison to building to the prevailing current minimum building regulations in RoI (full details are available in Colclough et al, 2017b). The case study dwellings consist of a scheme of 12 certified passive houses (PHPP figures: n_{50} = 0.5; Annual heating demand18 kWh /(m^2a); Heating load10 W/m^2 and Primary energy requirement of 99 kWh /(m^2a)).

The costs are compared on an Element by Element basis using the National Standard Building Elements and Design Cost Control Procedures (NIPPCR 1970) format for comparison, an accepted industry standard for subdividing the overall cost of construction into logical and defined cost headings and is assembled in order of the sequence of construction. The analysis focuses specifically on the build costs and exclude items such as VAT, the cost of site purchase, etc and are carried out for a designated date of construction of 1st June 2017.

Extra costs include increased airtightness, insulation levels, a heat recovery and ventilation system and higher performing windows and doors. For example, for line (21) the extra insulation and cold bridging detailing required in the nZEB dwelling compared with the current building regulations results in an additional cost of cost of €3,170 (€12,108 - €8,938). Cost reductions are achieved in the elimination of the traditional heating system, chimney stack and reduced site overheads. For example, it can be seen that the "Preliminaries" (overhead) for the nZEB dwelling (€3,800) are €2,265 less than those for the A3 dwelling (€6,065). This is because it takes one week less to build the nZEB dwelling due primarily to the elimination of the chimney stack and a more streamlined process.

The comparison shows that while differences exist in individual elements, the overall cost differential between constructing a residential dwelling to current building regulations (B Regs) and that of PH standard can be as low as €131 excl VAT. It is noted that while this specific analysis has been carried out on the basis of a case study, the analysis is of general applicability given the similarities in the large cost items between those mandated by the building regulations, and those required in order to achieve the Passive House standard (such as insulation levels).

Schedule of Areas (M²)	M²		M²
Gross Floor Area of New Build (GIFA M2)	102		102
Total Gross Floor Area (GFA M²)	**102**		**102**
Elemental Breakdown of Estimated Costs	**€**		**€**
Building Regulationss	**nZEB (A1)**		**Current (A3)**
(19) Substructure	6,923		6,208
(21) External Walls	12,108		8,938
(22) Internal Walls	7,462		7,462
(23) Suspended Floors	4,233		4,233
(24) Stairs/Ramps	1,894		1,894
(27) Roof	8,114		8,114
(28) Frames	-		-
(31) External Wall Completions	11,850		10,950
(32) Internal Wall Completions	7,989		7,989
(33) Suspended Floor Completions	-		-
(34) Stair Completions	621		621
(37) Roof Completions	-		-
(41) External Wall Finishes	4,554		4,554
(42) Internal Wall Finishes	4,905		4,905
(43) Floor Finishes	1,946		1,946
(44) Stair Finishes	-		-
(45) Ceiling Finishes	5,444		5,444
(47) Roof Finishes	6,665		6,665
(52) Drainage/wastes	704		704
(59) Mechanical Services (inc associated builders works)	7,907		10,557
(66) Transport services	-		-
(69) Electrical Installation (inc associated builders works)	4,740		4,740
(74) Sanitary Fittings	2,266		2,266
(79) Building Fittings	3,156		3,156
(-) External Works	2,500		2,501
Sub Total 1	**105,981**		**103,847**
Preliminaries	3,800		6,065
Sub Total 2 EX VAT	**109,781**		**109,912**

Figure 1 Comparison of Costs of NZEB Dwelling and Dwelling Built to Minimum Building Regulations for Designated Date of 1st June 2017. (Colclough et al, 2017b)

Indoor Environmental Quality and Energy Consumption

Results from monitoring 9 houses built to the passive house standard and eight houses built to the prevailing minimum building regulations quantifies the difference in IAQ, using the proxy of bedroom Carbon Dioxide Concentrations (see Figure 2). The graph shows the mean and maximum bedroom CO2 concentrations (ppm) recorded over a seven-hour period from midnight to 7 AM on 21/06/17 (or if data for 2017 was not available, on 21/06/16).

For the passive houses (all of which have MVHR), the mean carbon dioxide concentrations over the seven-hour monitoring period do not go above 1000 PPM, apart from PH4 (1104 ppm). In contrast, the mean CO_2 concentrations do not *go below* 1000 PPM, apart from one (B Regs 6) for the dwellings constructed to the minimum building regulations (all of which use natural ventilation).

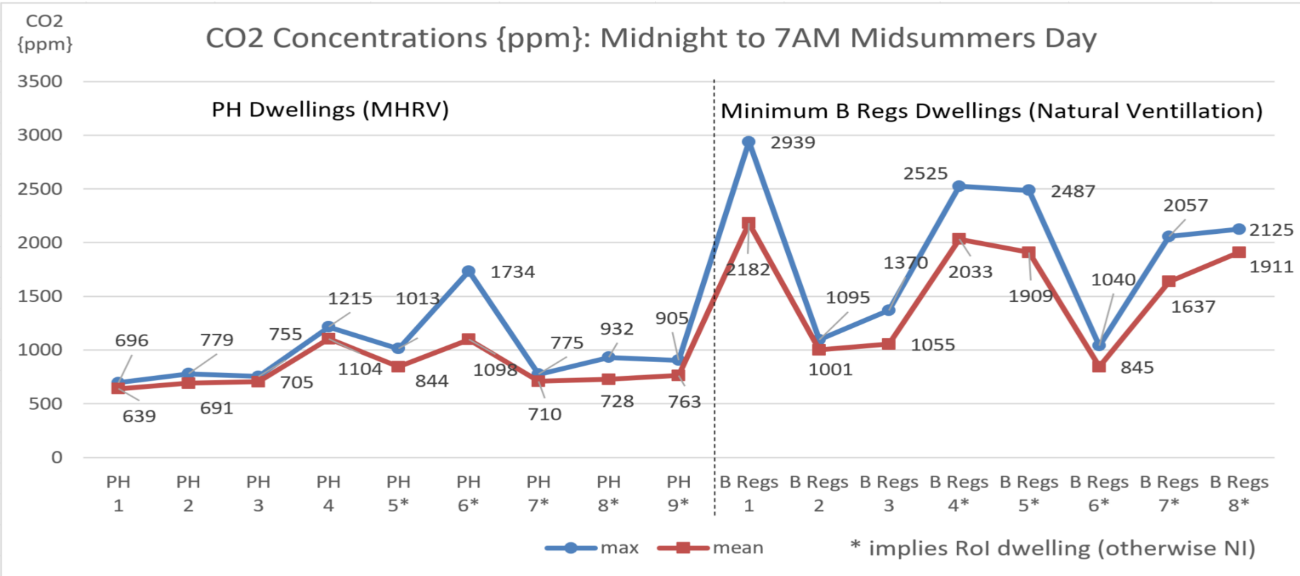

Figure 2 Bedroom Max and Min Carbon Dioxide Concentrations in monitored dwellings

Figure 3 demonstrates that, for 9 monitored properties in Northern Ireland, PH living room temperatures are higher, with temperatures on average 1°C higher. Att the same time the Passive Houses consume 38% of the space heating energy demand compared with the houses constructed to the minimum building regulations.

Data is still being collated for energy consumption and indoor air quality for the monitored dwellings in the Republic of Ireland and will be reported on in 2018. Particular attention will be paid to the potential of the Passive House Planning Package (PHPP) in reducing summer overheating in nZEB at the planning stage, something which is not currently catered for with the national Building Energy Rating software. In addition, focus will be put on the IAQ given recent concerns within the EU on simultaneously achieving good IAQ and good energy efficiency.

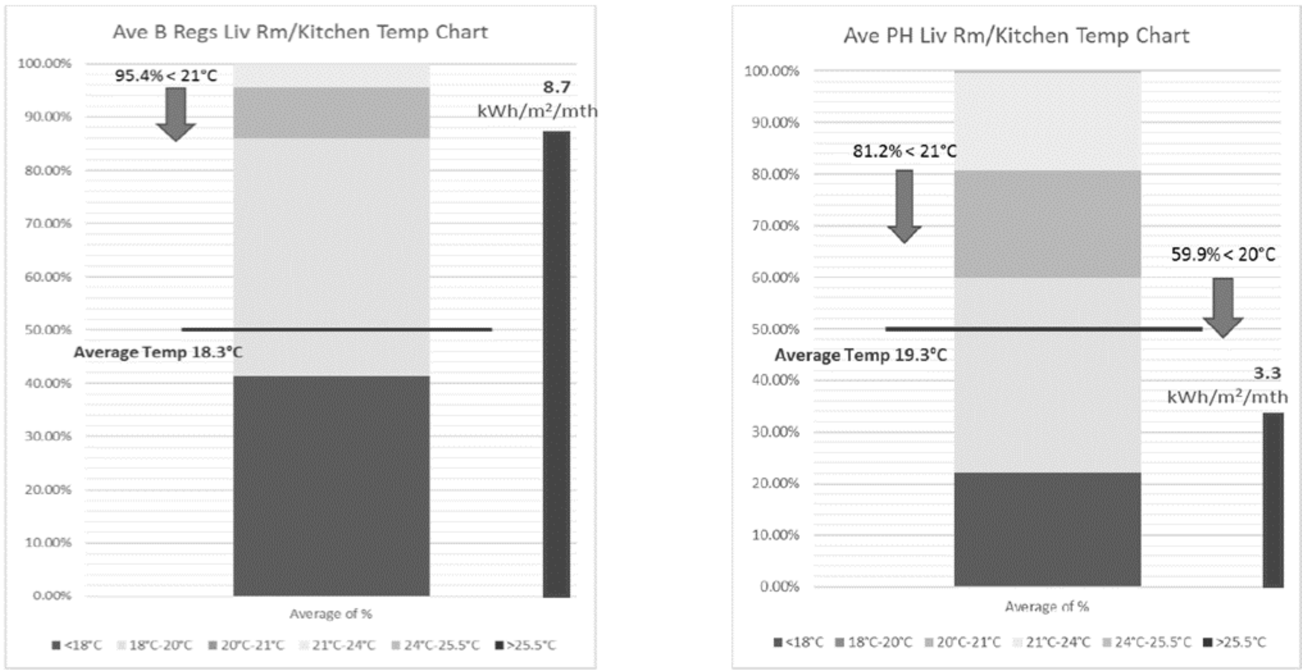

Figure 3 Living Room Temperatures and Building Heating Energy Consumption - NI Properties (Colclough et al, 2017b)

Relevance to Standards

The work of quantifying the performance of the PH standard continues with the monitoring of dwellings in the Republic of Ireland, including a scheme of 8 nZEB compliant dwellings which have been purchased by Wexford County Council for social housing purposes. The dwellings were designed and built as certified PH buildings, and given the requirements for the integration of renewables in dwellings in the Republic of Ireland, were also demonstrated as achieving the nZEB standard, two years ahead of the national target (Colclough et al, 2017a). Through ongoing monitoring, lessons are being learned by Wexford County Council to assist with the future deployment of nZEB dwellings at local and national level.

UNECE framework Guidelines for Energy Efficiency Standards in Buildings are a set of principles to improve sustainability in the conception, design, construction and maintenance of buildings worldwide. The principles reflect lessons learned and best practices from around the world and include a requirement to limit heating and cooling demand to 25 kWh/m^2/a.

Through the engagement of the County Council, a research establishment, a local developer, and an education company focusing on energy efficiency and the UN, the concepts espoused by the UNECE have been embraced.

The dwellings not only meet the energy requirements stipulated by the UNECE framework guidelines, but they also comply with many of the Strategic, Design and Construction, and Management Principles espoused in the standard.

Further, with the announcement of the UN Centre of Excellence in Energy Efficiency which will be located in Enniscourthy, in Co. Wexford, Ireland (Byrne, 2017), the fourth strand of the framework strategy (Implementation) will be demonstrated through the activities of dissemination, education, research, consultation and participation.

Conclusion

This paper has outlined the work undertaken in Ireland to assist policymakers through demonstrating the potential of the PH standard in meeting the mandated nZEB standard. In addition to analysing the potential at national level, it has also considered the potential of the passive house standard in helping realise the UNECE vision through a case study of a near zero energy buildings (nZEB) social housing scheme in Wexford, Ireland.

While much analysis has been carried out on the passive house standard most particularly on the European continent, analysis at a local level is considered key to demonstrating the potential to interested parties at both regional and national level. Without this, the potential of the PH standard may not be fully clear.

References

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Abstract

The EU has mandated that all buildings are built to the near Zero Energy Buildings (nZEB) standard from 2020. At global level, the United Nations Economic Commission for Europe (UNECE) Committee on Sustainable Energy is leading efforts within the UN to develop Framework Guidelines for the global transformation of energy efficiency in the built environment. The Passivhaus standard has been in existence for over 27 years and potentially offers a tried and tested method of implementing both standards. Using a costed case study of a constructed dwelling, and the results of two years of monitoring of 23 dwellings, this paper examines if it can be used as a cost-effective means of achieving high performing nZEB buildings, and the UNECE framework.

The paper demonstrates that, using the passive house standard, an nZEB dwelling can be achieved at no extra cost compared with the current building regulations, and performs significantly better than dwellings built to the minimum building regulations. Further, the paper demonstrates that not only can the Passive House standard be instrumental in achieving nZEB, but it can also be the cornerstone in delivering the UN's Framework guidelines for energy efficiency standards in buildings. The paper therefore demonstrates that, despite being 27 years old, the PH standard can potentially be a key enabler for the buildings of the future.