#UKPHC20

HOW CERTIFIED PASSIVE HOUSE REDUCES RADON RISK

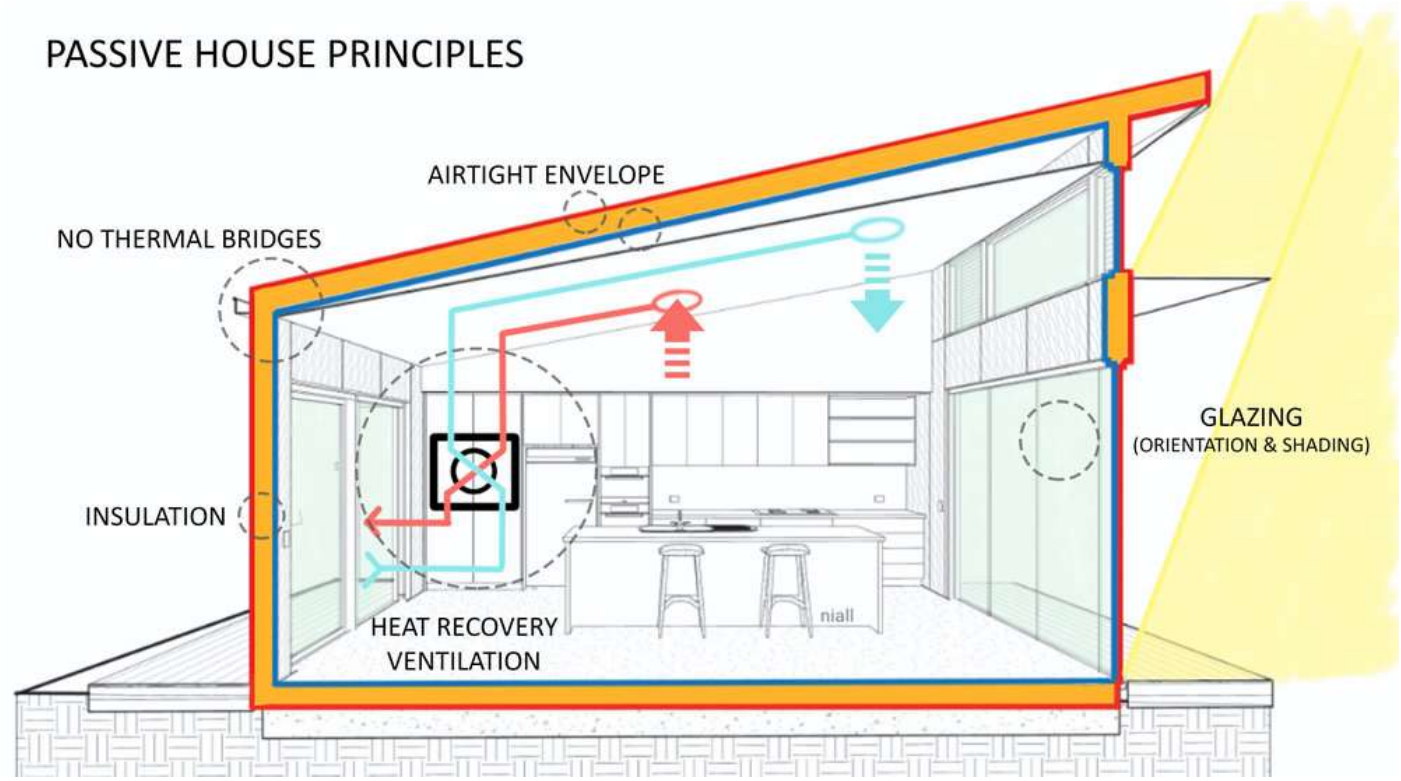
Dr. Barry Mc Carron


Certified
Passivhaus
Passivhaus Institut
classic | plus | premium |

PhD OPPORTUNITY - HEPD

- The opportunity to do a PhD was presented in 2015 through the HEPD scheme within South West College.
- The proposal was to investigate a topic relevant to Passive House. This was part of a program called project 10.
- Research and Development Project with a radon protection company lead to the idea of radon monitoring in Certified Passive House Buildings.

CERTIFIED PASSIVE HOUSE



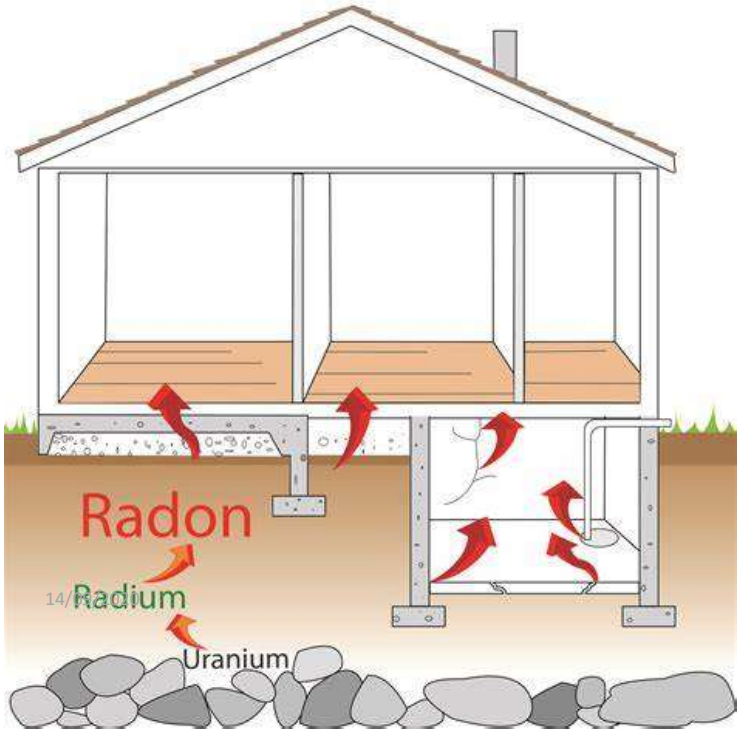
QUEEN'S UNIVERSITY BELFAST

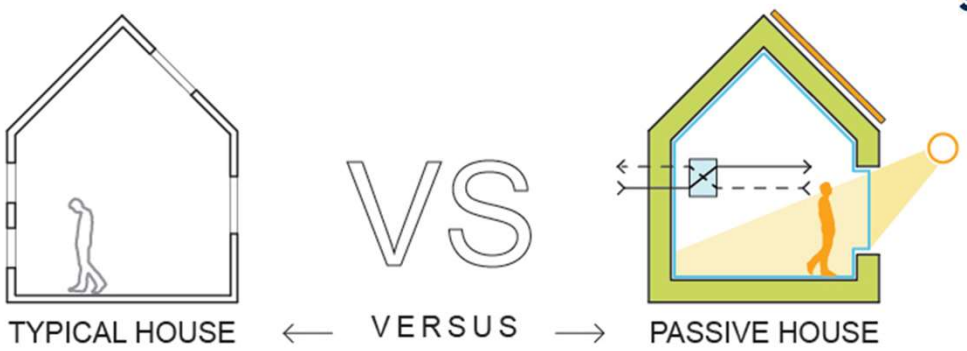
South West College

DESIGNER
CERTIFIED PASSIVE HOUSE DESIGNER

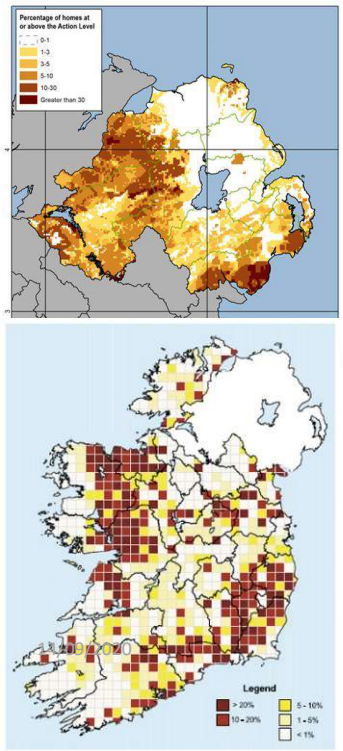
CERTIFIED PASSIVE HOUSE TRADESPERSON
TRADESPERSON

WHAT IS RADON

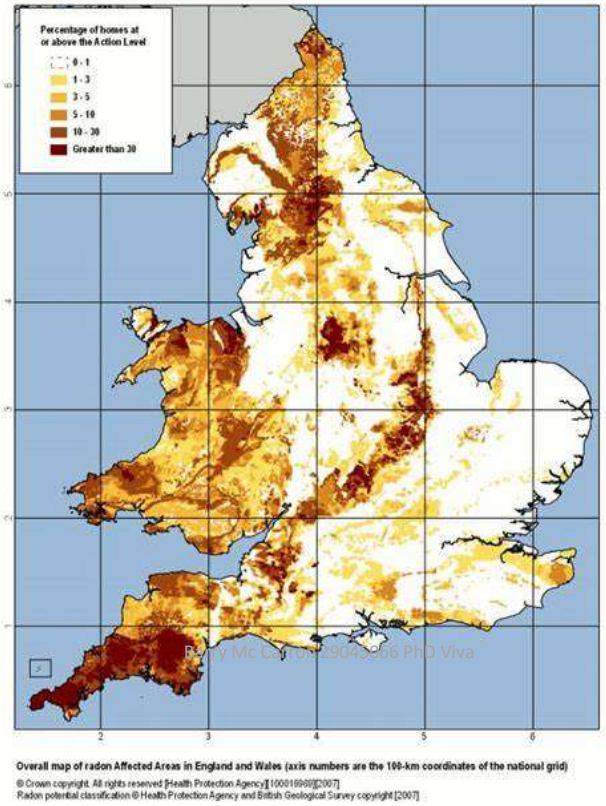




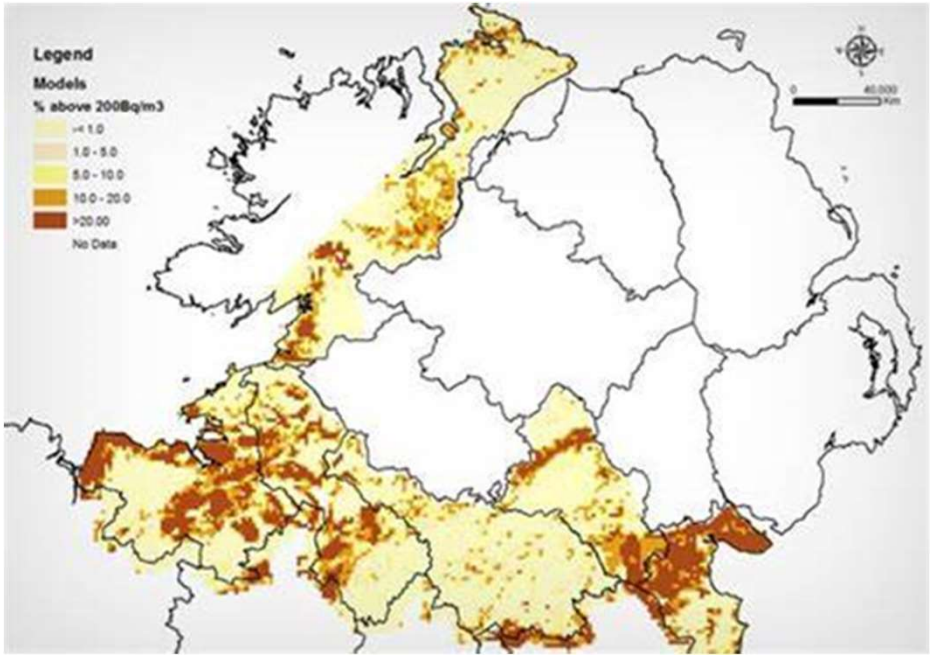
RADON GEOLOCATION



Prediction map of Radon in Irish dwellings.



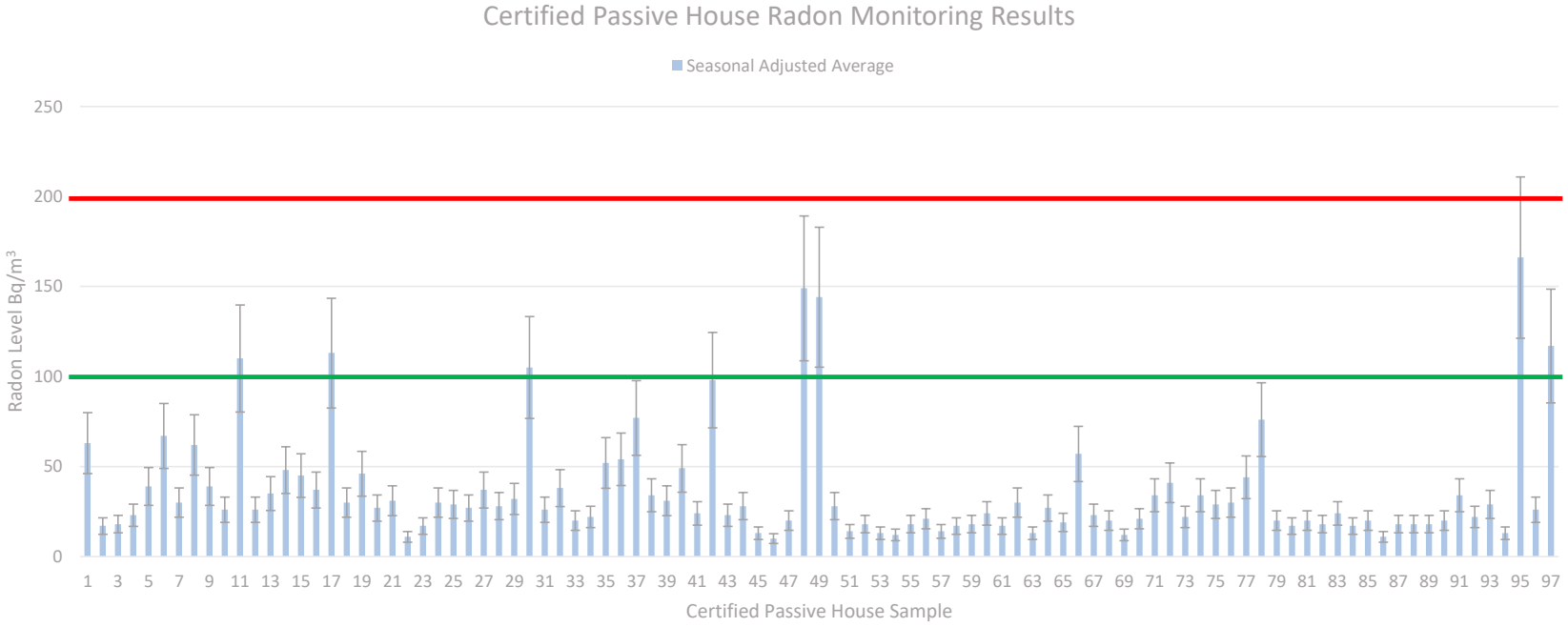
Overall map of radon Affected Areas in England and Wales (axis numbers are the 100-km coordinates of the national grid)



SIGNIFICANCE OF RESEARCH

- Radon gas is classified in group one as carcinogenic to humans by the International Agency for Research of Cancer (IARC).
- Radon is estimated to cause between 3-14% of all lung cancers in a country, depending on the national average radon level coupled with occupant smoking prevalence.
- In addition to this there is limited research specifically on certified passive house buildings and even less research with a focus on indoor radon concentration levels.
- The significance of the research sits against the backdrop of growth in low energy building standards coupled with the incoming energy performance building directive which will require all buildings to be near zero energy buildings from the 1st of January 2021.

MAIN FINDINGS



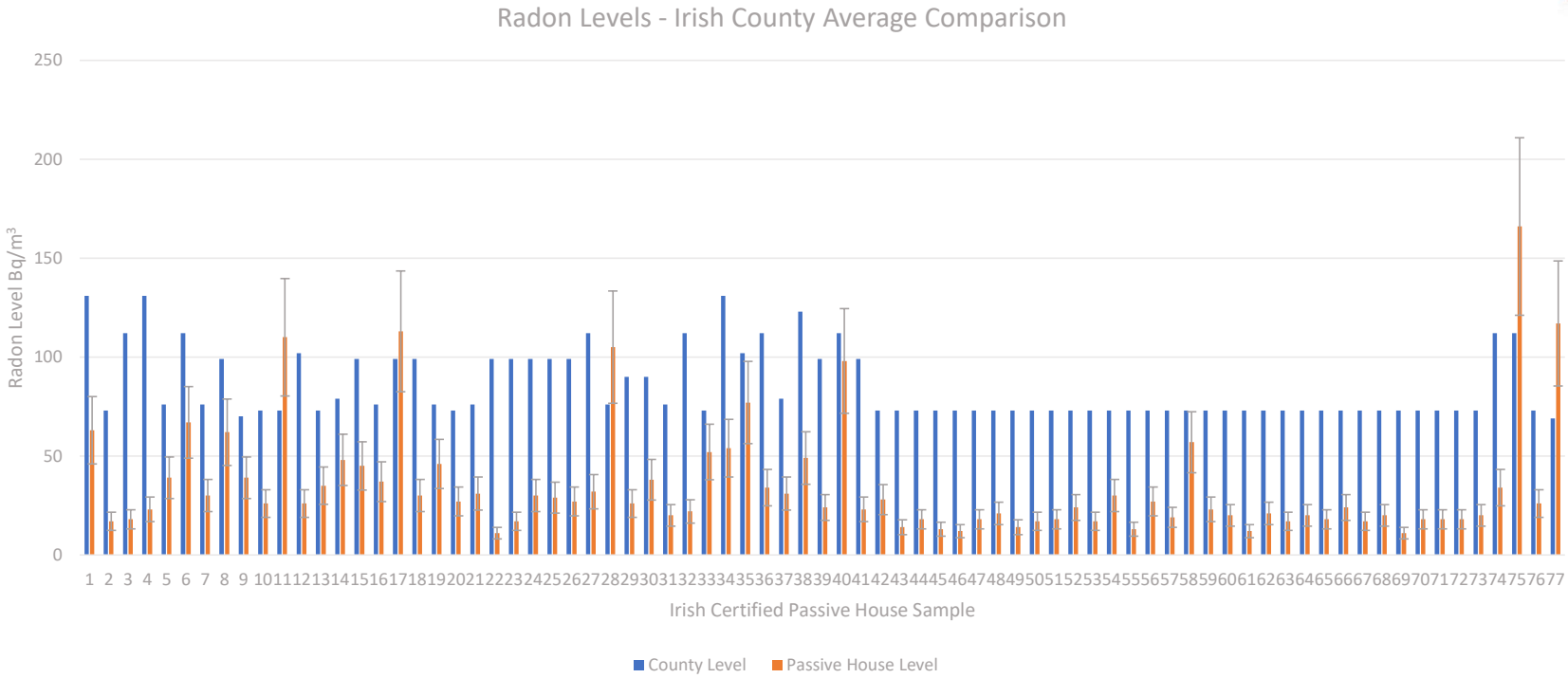
9

97 Results – **Average 36 Bq/m³ = 60% Lower Radon Level**

Target Level 100 Bq/m³ – Action Level 200 Bq/m³

National Average 77 Bq/m³

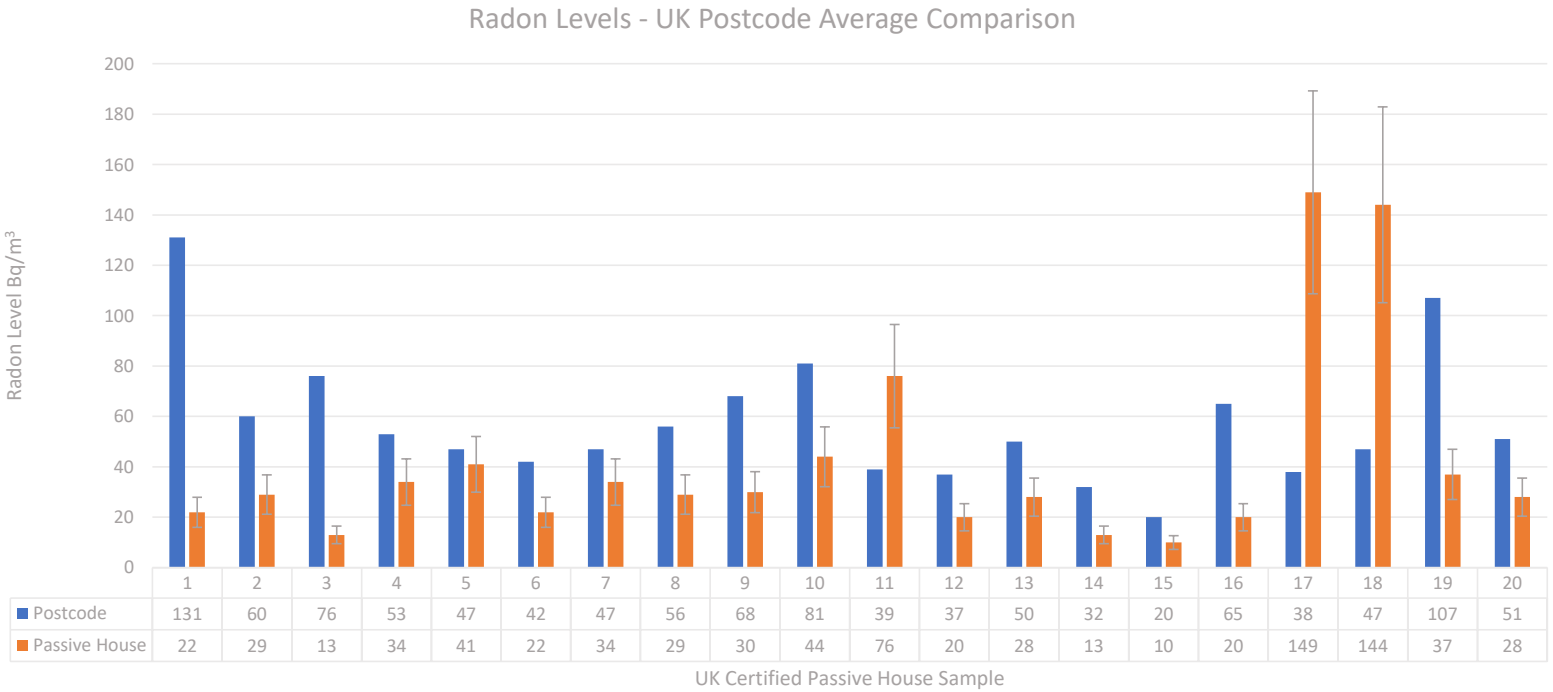
MAIN FINDINGS



77 Results – **Average 32 Bq/m³ = 64% Lower Radon Level**

Target Level 100 Bq/m³ – Action Level 200 Bq/m³

MAIN FINDINGS



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Postcode	131	60	76	53	47	42	47	56	68	81	39	37	50	32	20	65	38	47	107	51
Passive House	22	29	13	34	41	22	34	29	30	44	76	20	28	13	10	20	149	144	37	28

20 Results – **Only 3 presented with higher levels than postcode average**

2 Results above Target Level 100 Bq/m^3 and None above Action Level 200 Bq/m^3

MAIN FINDINGS

Metric	EPA 2015 NRS	Comparison Sample	PH Sample
Number of homes measured	649	25	97
No. of homes > 200 Bq/m^3	8%	8%	0%
No. of homes > 100 Bq/m^3	25%	16%	7%
Minimum concentration (Bq/m^3)	14	21	10
Maximum concentration (Bq/m^3)	1393	598	149
SAA[1] average for Sample	77	88	36

97 Results – **80% of sample below 45Bq/m^3 = ALARA Principle**

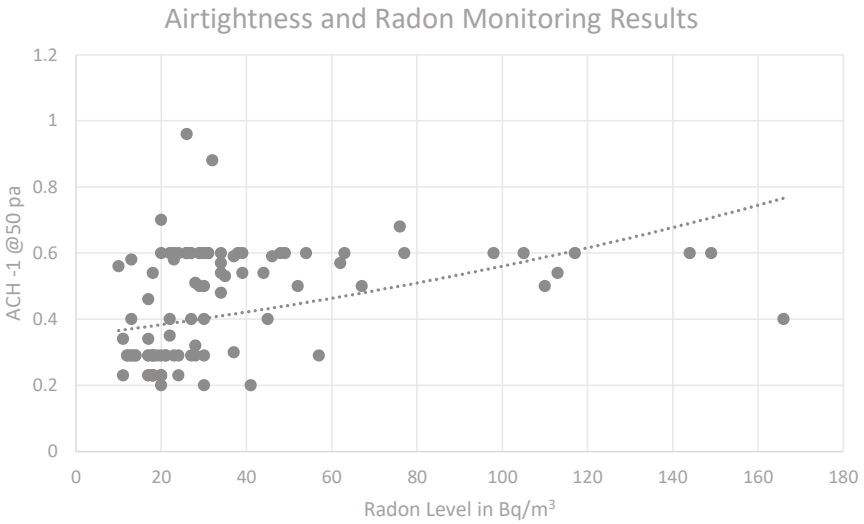
97 Results – **93% of sample below 100Bq/m^3 = Target Level**

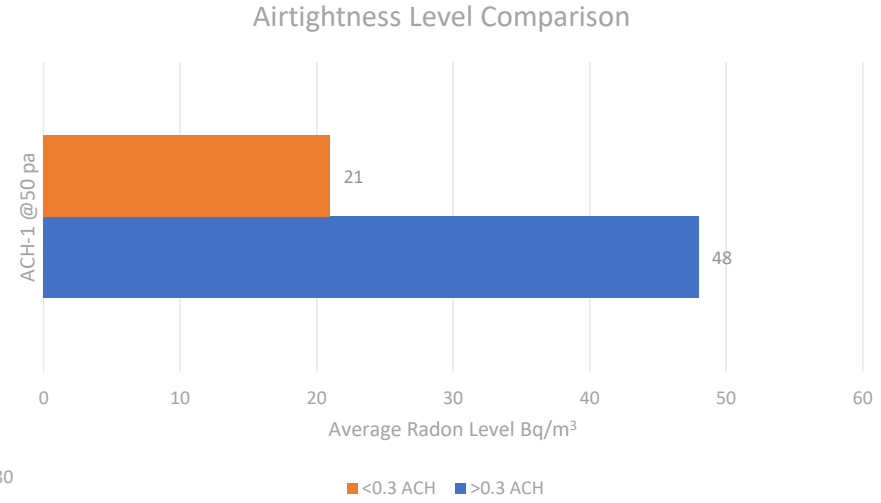
MAIN FINDINGS

Timber presented with lower indoor radon concentrations

18% Lower Radon in Timber Sample

MAIN FINDINGS

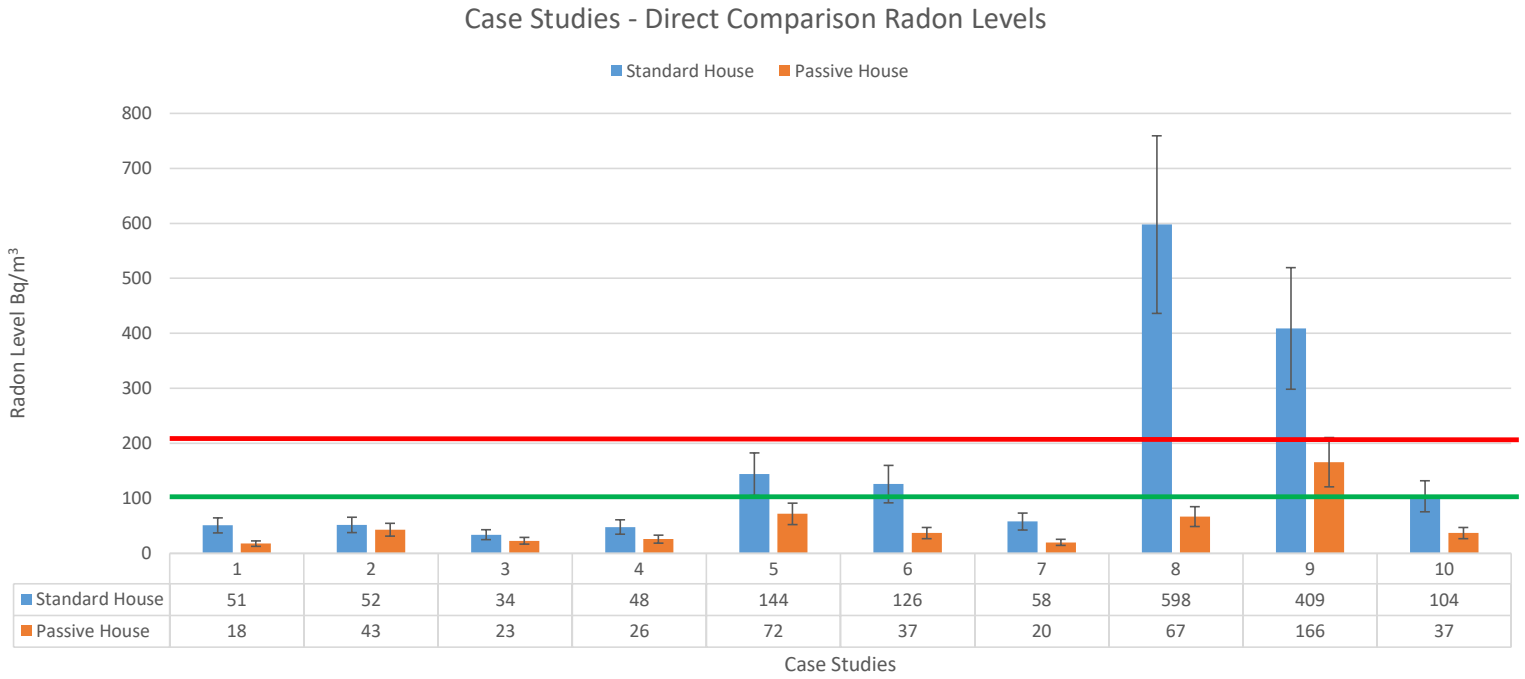




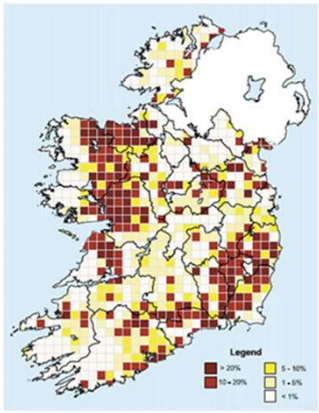
These findings follow logic that increased airtightness levels will result in reducing indoor radon concentrations, however as many argue that increased airtightness levels will result in increased radon.

44% drop between 0.3 to 0.6 ACH per hour.

MAIN FINDINGS



	1	2	3	4	5	6	7	8	9	10
Standard House	51	52	34	48	144	126	58	598	409	104
Passive House	18	43	23	26	72	37	20	67	166	37

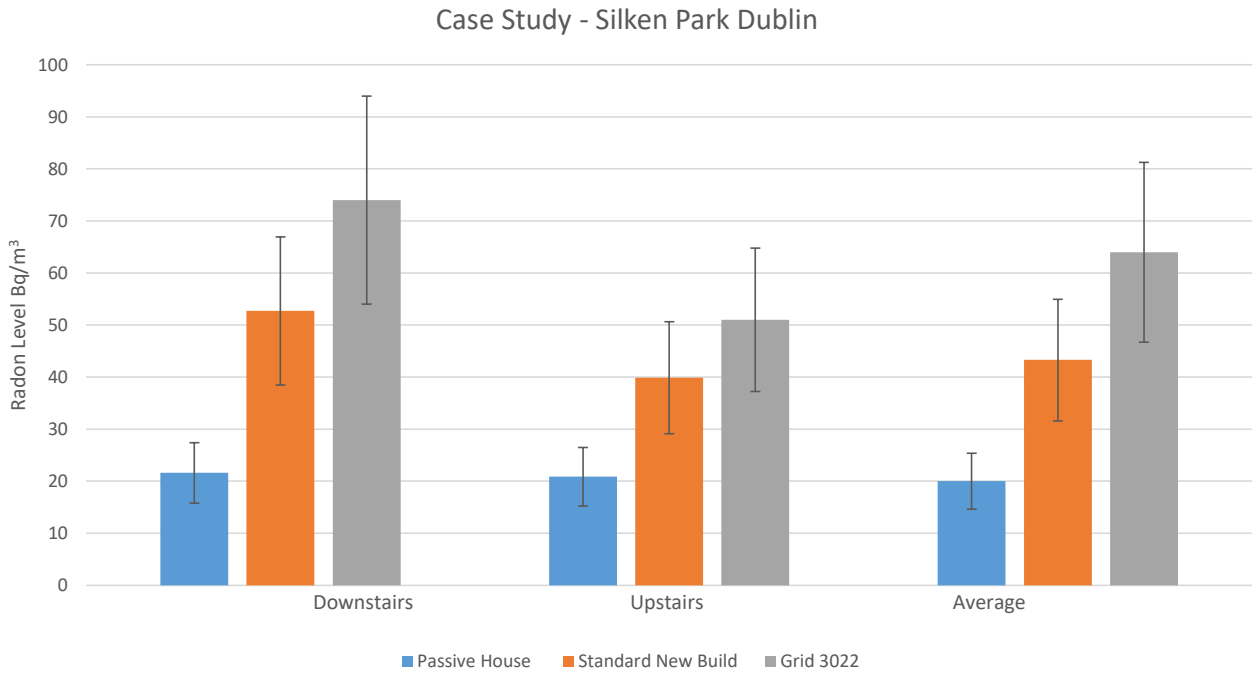


Prediction map of Radon in Irish dwellings.

5 Breach Target Level 100 Bq/m^3 – 2 above Action Level 200 Bq/m^3

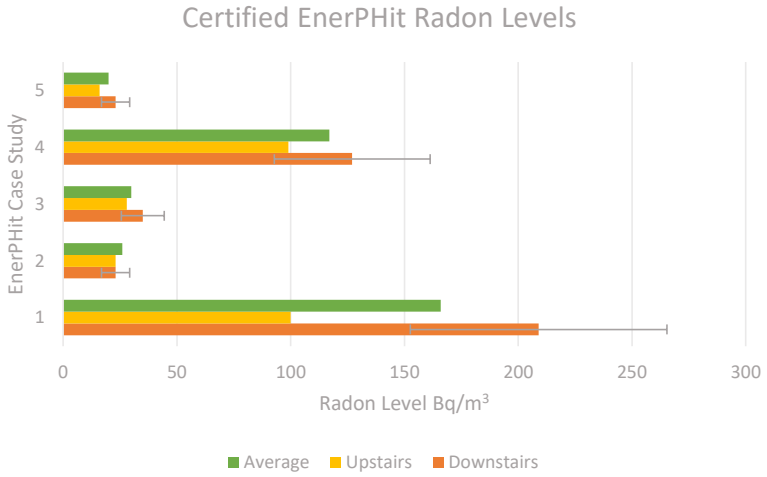
Only 1 Passive House above Target Level None above the Action Level

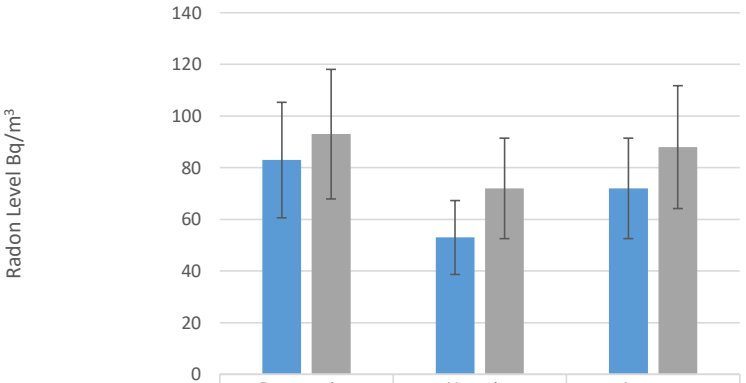
MAIN FINDINGS



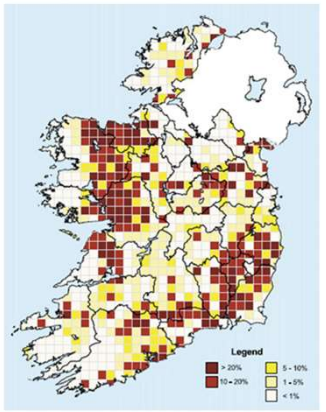
20 Bq/m³ v 43 Bq/m³ or 54% lower in the PH Sample v Phase 2
20 Bq/m³ v 64 Bq/m³ or 69% lower in the PH Sample v Grid 3022

MAIN FINDINGS





	Downstairs	Upstairs	Average
EnerPHit = n5	83	53	72
Standard House = n 25	93	72	88



Prediction map of Radon in Irish dwellings.

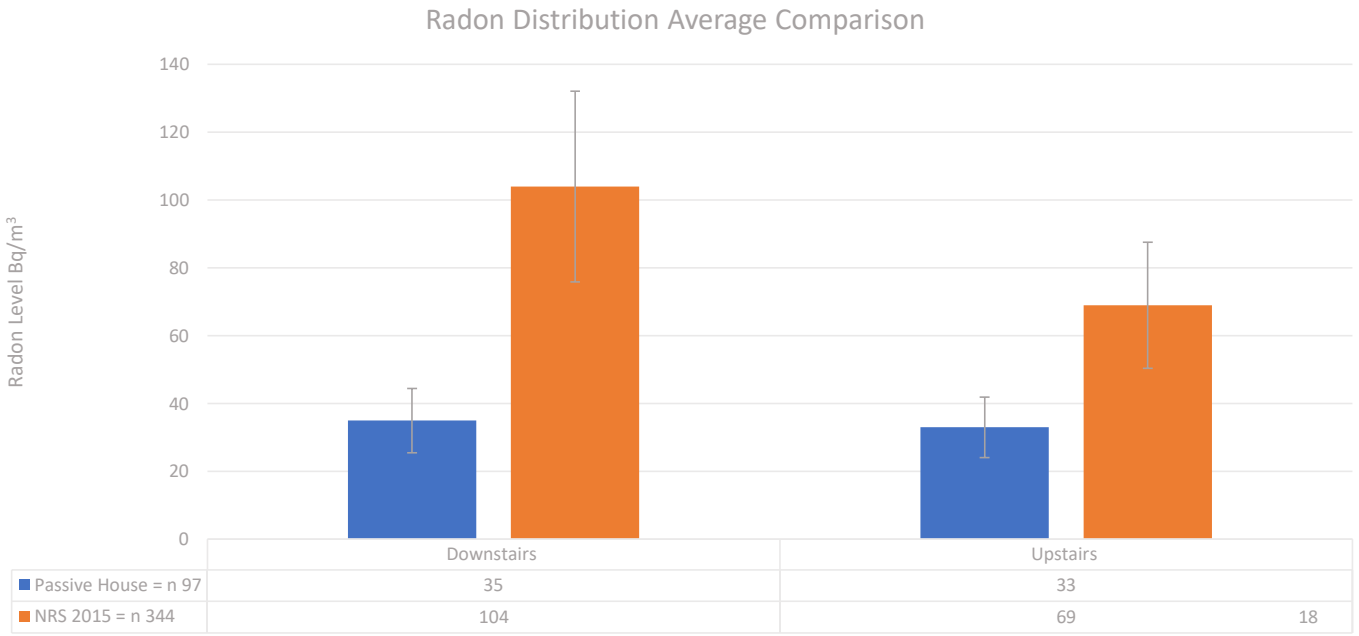
Only 5 in the Sample

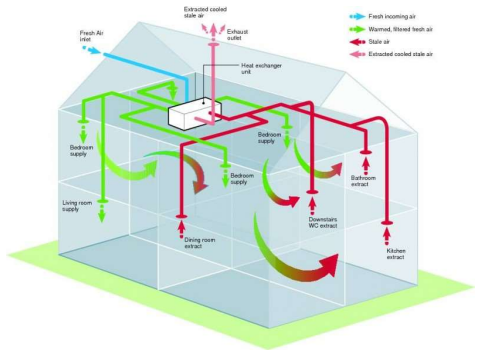
None breach Action Level of 200 Bq/m^3

18 % Reduction in EnerPhit against Comparison Sample

7% Reduction in EnerPhit against National Average

MAIN FINDINGS

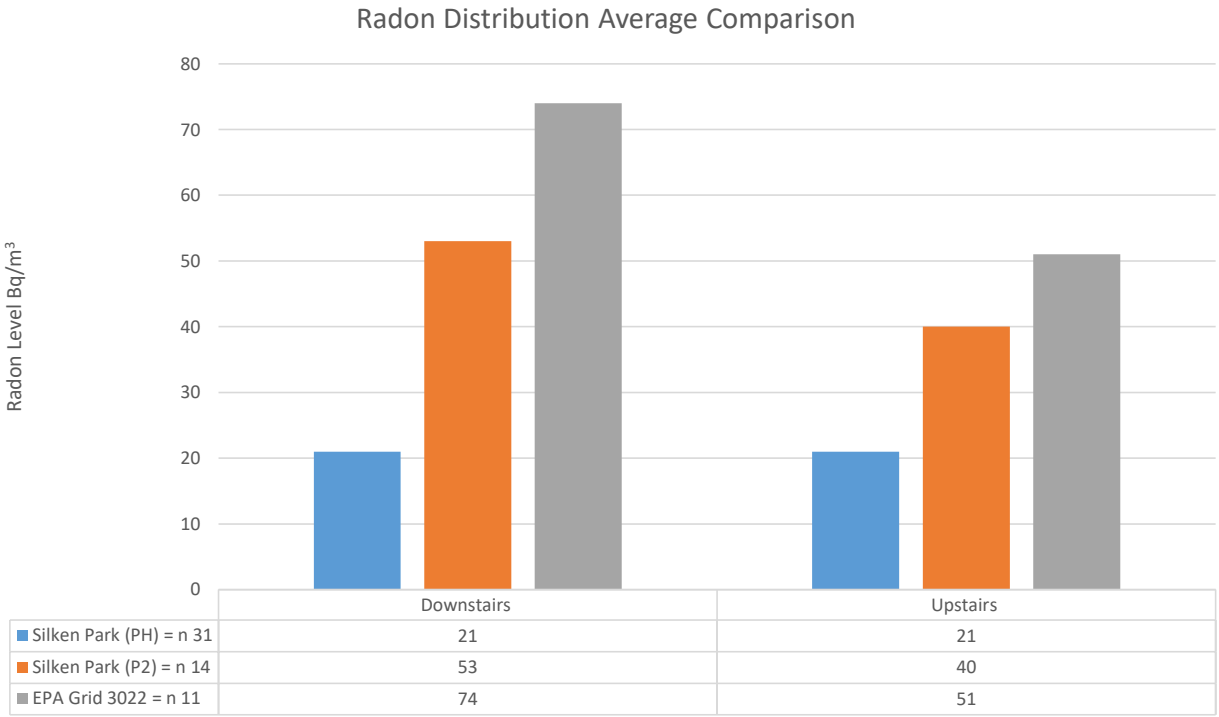


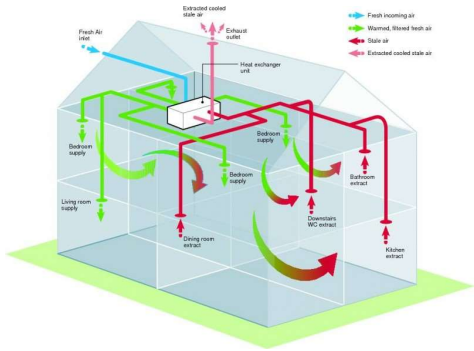


Radon Distribution levels presented with a more uniform ratio than expected.

6% lower on upper floor compared to the typical 33-35%

MAIN FINDINGS



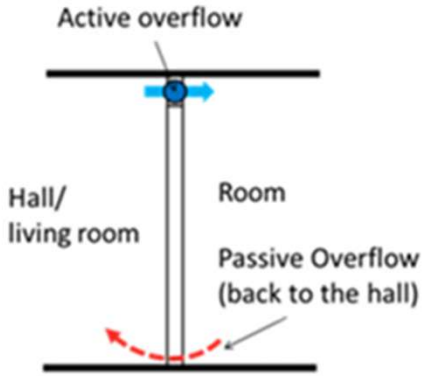


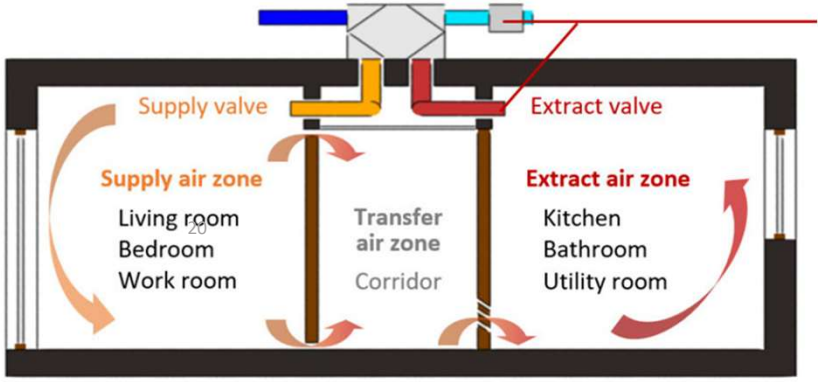
Radon Distribution levels presented with a more uniform ratio than expected.

6% lower on upper floor compared to the typical 33-35%

DISCUSSION

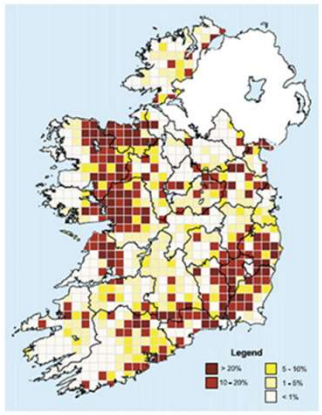
- The novel finding is the radon distribution pattern which was found in the Certified Passive House sample.
- The cross-flow principle coupled with a balance and properly commissioned MVHR system is what is attributed to the change in distribution.
- Previous research in this area has found the typical distribution to be 35% and my own analysis of the secondary data corresponded with this with 33% found in the NRS.
- An opportunity now exists for future research on this phenomenon and an investigation into the contribution from building materials.





RECOMMENDATIONS

- I have constructed a risk matrix on the various ventilation systems commonly available here in the UK and Ireland.
- Radon sticks to dust particles so an F9 Filter could be used in known geogenic risk areas.
- This filter is an inexpensive upgrade and performance is not affected as the pressure drop is low.
- Higher levels of airtightness could also be pursued in known geogenic risk areas.
- At commissioning the MVHR system could be balanced on the positive pressure side to as not to induce ingress on radon.



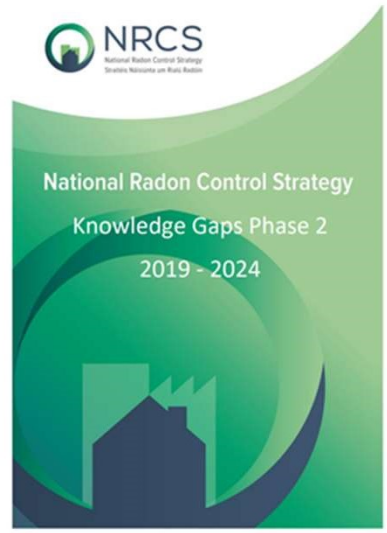
Prediction map of Radon in Irish dwellings.

RISK MATRIX

Ventilation System	Pressure	Filtration	Heat Recovery	Radon Risk	Moisture Risk
PIV	Positive +	Yes	No	Low	High
Natural	Variable +/-	No	No	Medium	Low
MVHR	Balanced	Yes	Yes	Low	Low
DCV	Intermittent Negative -	Yes	Yes	Medium	Low
Extract	Negative -	No	No	High	Low

CONCLUSION

- Certified Passive House successfully mitigates against high indoor radon concentrations.
- MVHR systems are responsible of closer radon distribution levels between upstairs and downstairs.
- Certified Passive House guidance on Quality and certification process has a direct influence on performance.
- EnerPHit is an effective methodology for successful retrofit with lower radon levels.
- Timber as a building material will have an incremental effect on indoor radon.
- The Research also directly address the Knowledge Gap outlined in the NRCS Report.



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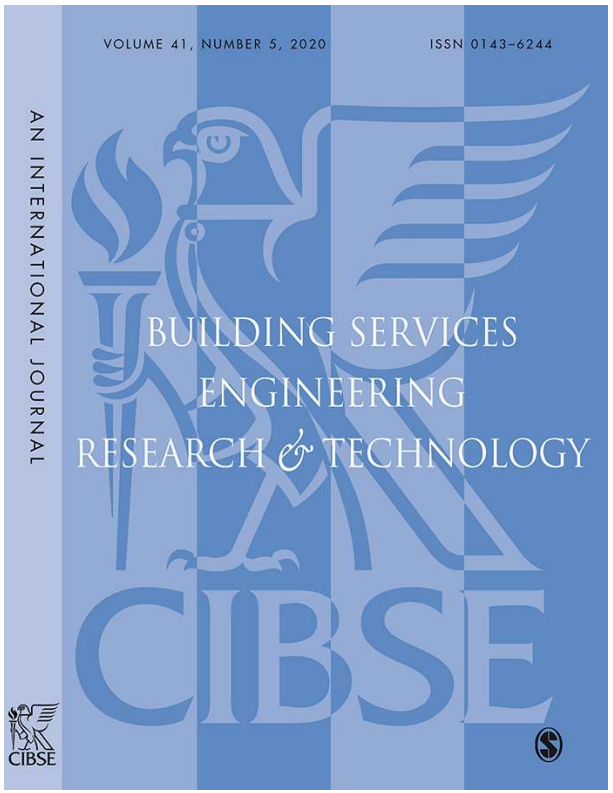

Technical Note

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A pilot study of radon levels in certified passive house buildings

Barry McCarron[1], Xianhai Meng[1] and Shane Colclough[2]

Abstract

The international Passive House Standard delivers high thermal comfort based on the principles of excellent building fabric and balanced mechanical heat recovery ventilation. Considering that the typical person in industrial countries (such as the UK) spends ~90% of their time indoors, there are surprisingly few academic studies on air quality in the home. Indoor air quality and the prevalence of overheating are attracting an increasing amount of research attention across Europe, but post occupancy monitoring of indoor radon concentrations is severely underrepresented, especially in Ireland and the UK. Radon is a naturally occurring radioactive gas and known carcinogen that presents a potential risk to occupier health. This pilot study investigates measured radon levels in certified Passive House buildings in Northern Ireland and presents an overview of technical radon prevention design options for new builds and mitigation measures for existing buildings. Initial findings indicate that buildings built to the Passive House Standard correspond with reduced indoor radon gas concentrations.

Practical application: This Technical Note addresses an issue pertinent to the industry at this time. The growth of energy-efficient standards (such as Passive House) and common principles (such as increased airtightness levels and mechanical ventilation systems) has accelerated the need for research data on indoor radon concentrations. This research bridges the knowledge gap between the fields of indoor air quality (specifically radon), health, sustainability and the built environment.

Keywords

Certified Passive House, EnerPHit, radon, indoor air quality

Introduction

Implementation of the new, legally binding Paris Agreement on climate change has reinforced the need to reduce energy consumption in buildings. Currently, European buildings account for

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International Journal of Environmental Research and Public Health

MDPI

Article

An Investigation into Indoor Radon Concentrations in Certified Passive House Homes

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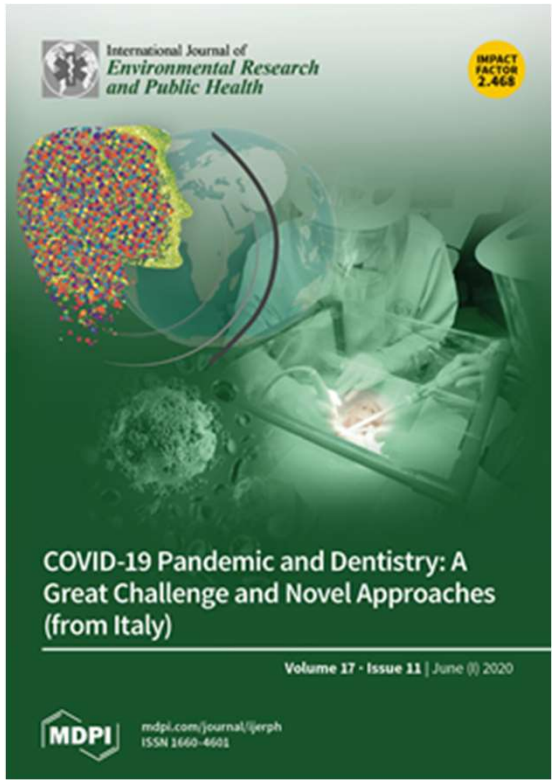
Abstract: The Energy Performance of Buildings Directive (EPBD) has introduced the concept of Nearly Zero Energy Buildings (NZEB) specifying that by 31 December 2020 all new buildings must meet the nearly zero- energy standard, the Passive House standard has emerged as a key enabler for the Nearly Zero Energy Building standard. The combination of Passive House with renewables represents a suitable solution to move to low/zero carbon. The hypothesis in this study is that a certified passive house building with high levels of airtightness with a balanced mechanical ventilation with heat recovery (MVHR) should yield lower indoor radon concentrations. This article presents results and analysis of measured radon levels in a total of 97 certified passive house dwellings using CR-39[3] alpha track diffusion radon gas detectors. The results support the hypothesis that certified passive house buildings present lower radon levels. A striking observation to emerge from the data shows a difference in radon distribution between upstairs and downstairs when compared against regular housing. The study is a first for Ireland and the United Kingdom and it has relevance to a much wider context with the significant growth of the passive house standard globally.

Keywords: indoor radon; certified passive house; mechanical ventilation with heat recovery



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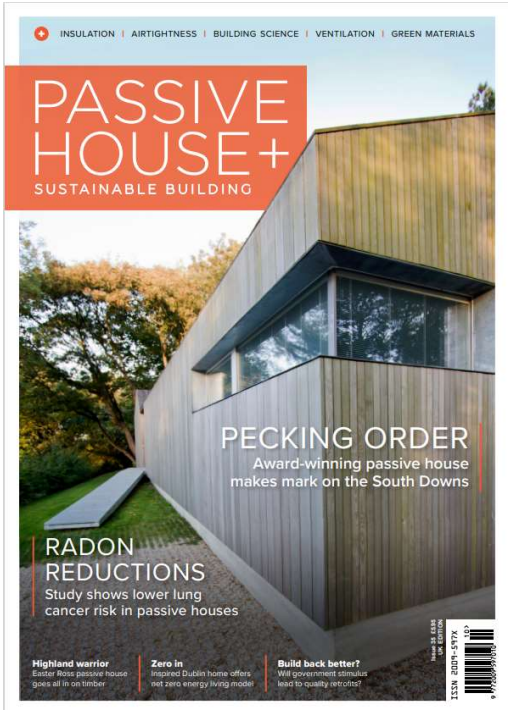

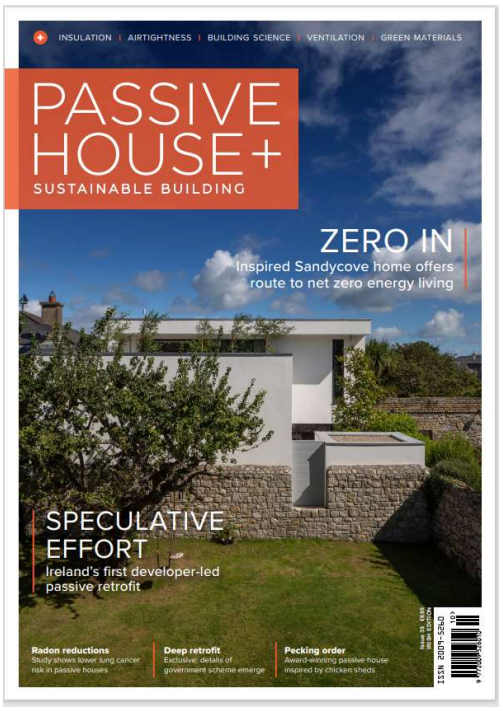

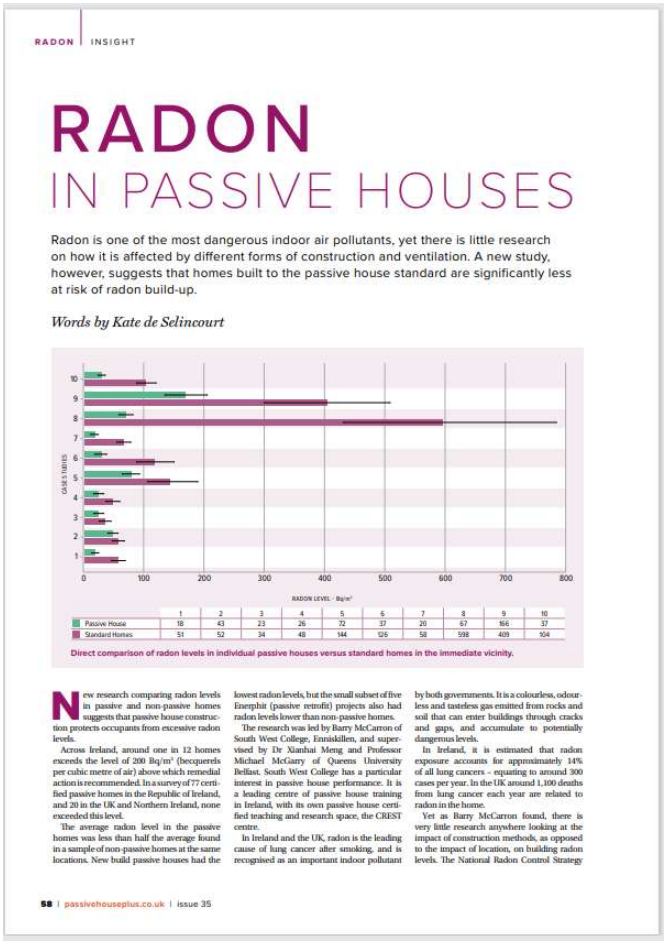

RADON | INSIGHT

RADON IN PASSIVE HOUSES

Radon is one of the most dangerous indoor air pollutants, yet there is little research on how it is affected by different forms of construction and ventilation. A new study, however, suggests that homes built to the passive house standard are significantly less at risk of radon build-up.

Words by Kate de Selincourt

	1	2	3	4	5	6	7	8	9	10
Passive House	18	43	23	26	72	37	20	67	166	37
Standard Homes	51	52	34	48	144	126	58	598	409	104

Direct comparison of radon levels in individual passive houses versus standard homes in the immediate vicinity.

New research comparing radon levels in passive and non-passive homes suggests that passive house construction protects occupants from excessive radon levels.

Across Ireland, around one in 12 homes exceeds the level of 200 Bq/m³ (becquerels per cubic metre of air) above which remedial action is recommended. In a survey of 77 certified passive homes in the Republic of Ireland, and 20 in the UK and Northern Ireland, none exceeded this level.

The average radon level in the passive homes was less than half the average found in a sample of non-passive homes at the same locations. New build passive houses had the lowest radon levels, but the small subset of five EnerPhit (passive retrofit) projects also had radon levels lower than non-passive homes.

The research was led by Barry McCarron of South West College, Enniskillen, and supervised by Dr Xianhai Meng and Professor Michael McGarry of Queens University Belfast. South West College has a particular interest in passive house performance. It is a leading centre of passive house training in Ireland, with its own passive house certified teaching and research space, the CREST centre.

In Ireland and the UK, radon is the leading cause of lung cancer after smoking, and is recognised as an important indoor pollutant by both governments. It is a colourless, odourless and tasteless gas emitted from rocks and soil that can enter buildings through cracks and gaps, and accumulate to potentially dangerous levels.

In Ireland, it is estimated that radon exposure accounts for approximately 14% of all lung cancers - equating to around 300 cases per year. In the UK around 1,100 deaths from lung cancer each year are related to radon in the home.

Yet as Barry McCarron found, there is very little research anywhere looking at the impact of construction methods, as opposed to the impact of location, on building radon levels. The National Radon Control Strategy

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