An overview of Indoor Environmental Quality Research in Irish Energy Efficient Dwellings

Dr James A. McGrath
NUI Galway

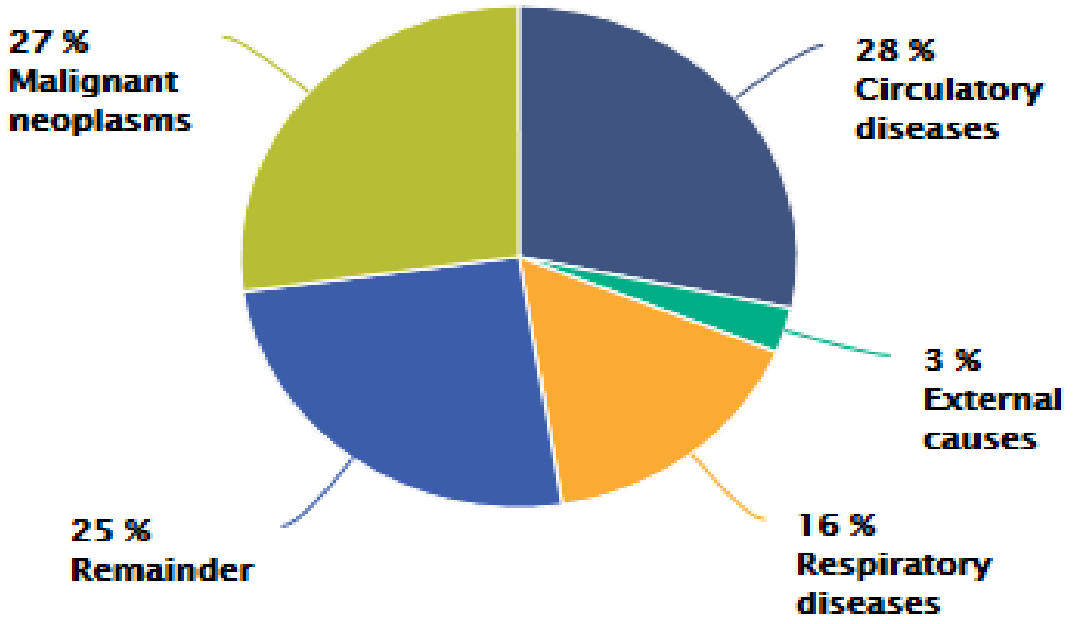
OÉ Gaillimh
NUI Galway

Ryan Institute

C-CAPS

Ionad Aeráide agus Truailliú Aeir
Centre for Climate & Air Pollution Studies

IAQ – relationship with health Ireland

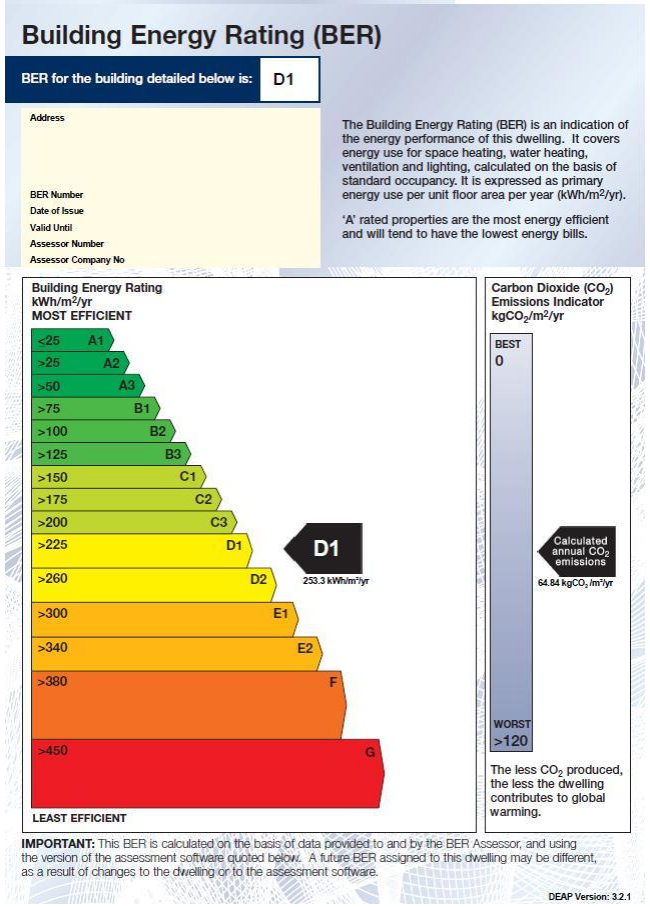


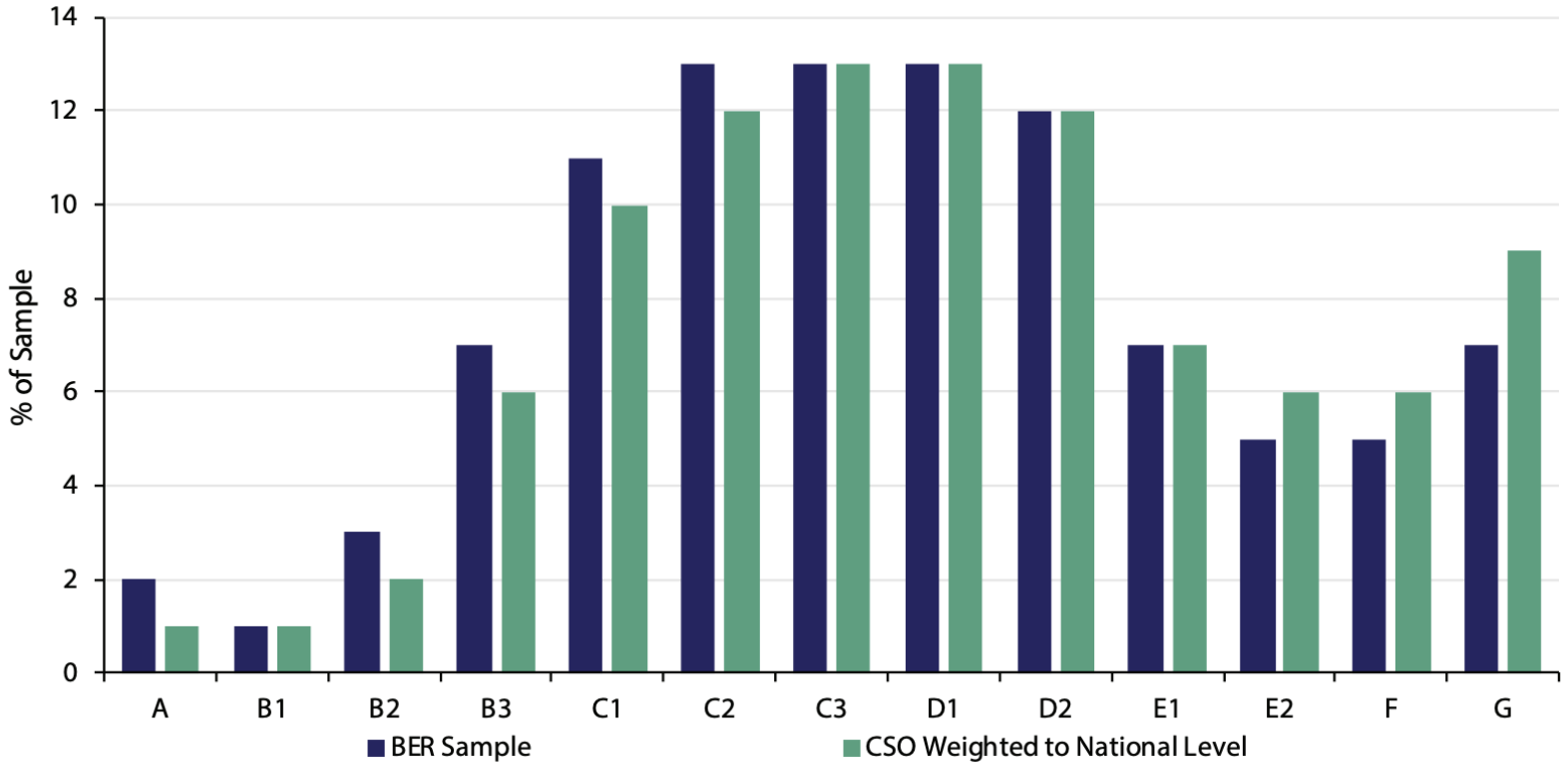
Source: CSO Ireland

Principle causes of death Q1 2018

- 4th highest prevalence of asthma in the world
- 3rd highest rate of COPD in Europe
- Respiratory disease 1/3 emergency hospital admission
- Mortality rate 113.6 / 100,000 v's EU 28 average 85.2
- Lung cancer leading cause of cancer death in Ireland, 1 in 10 due to radon exposure

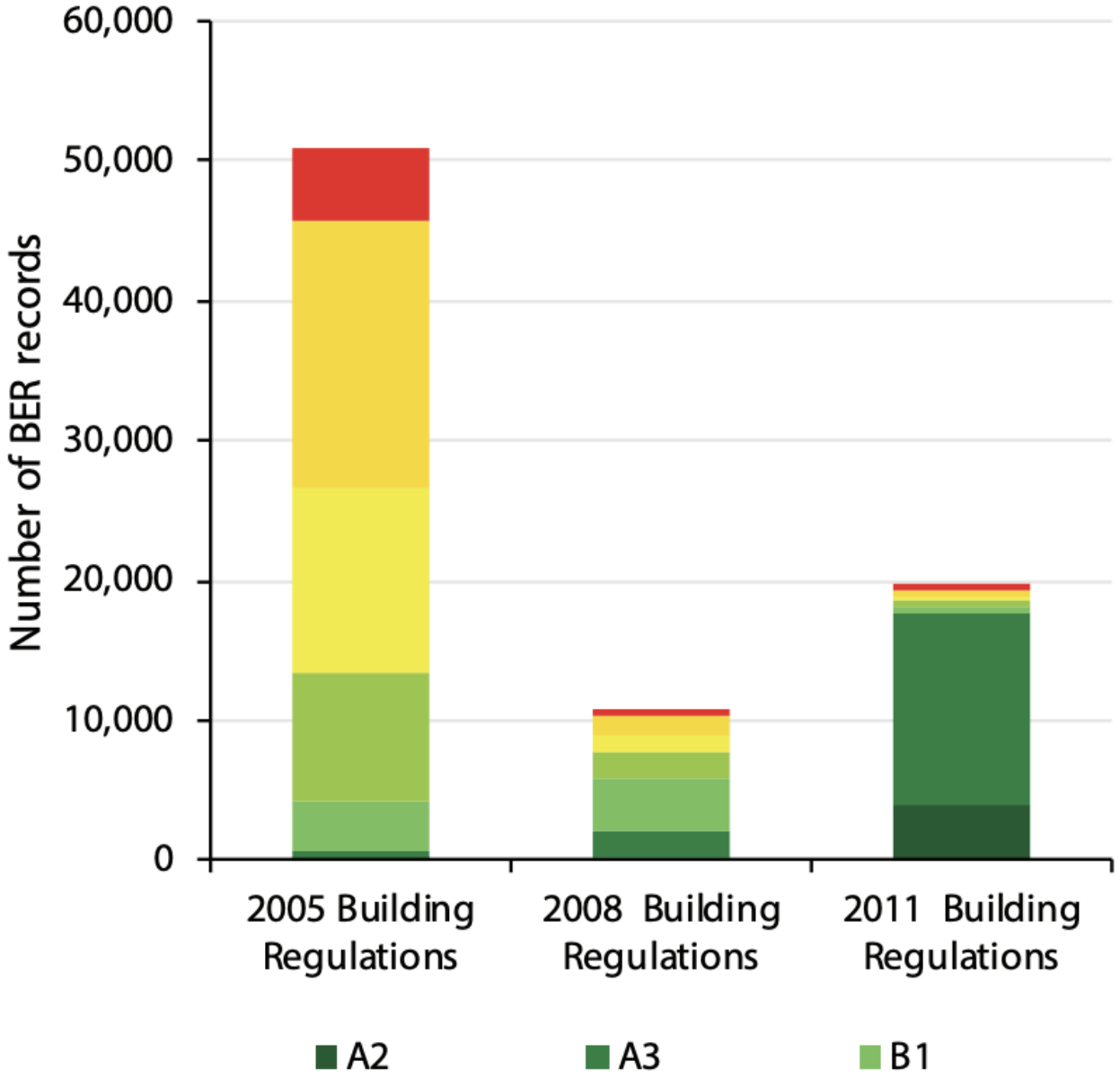
Energy Performance of the Building Stock

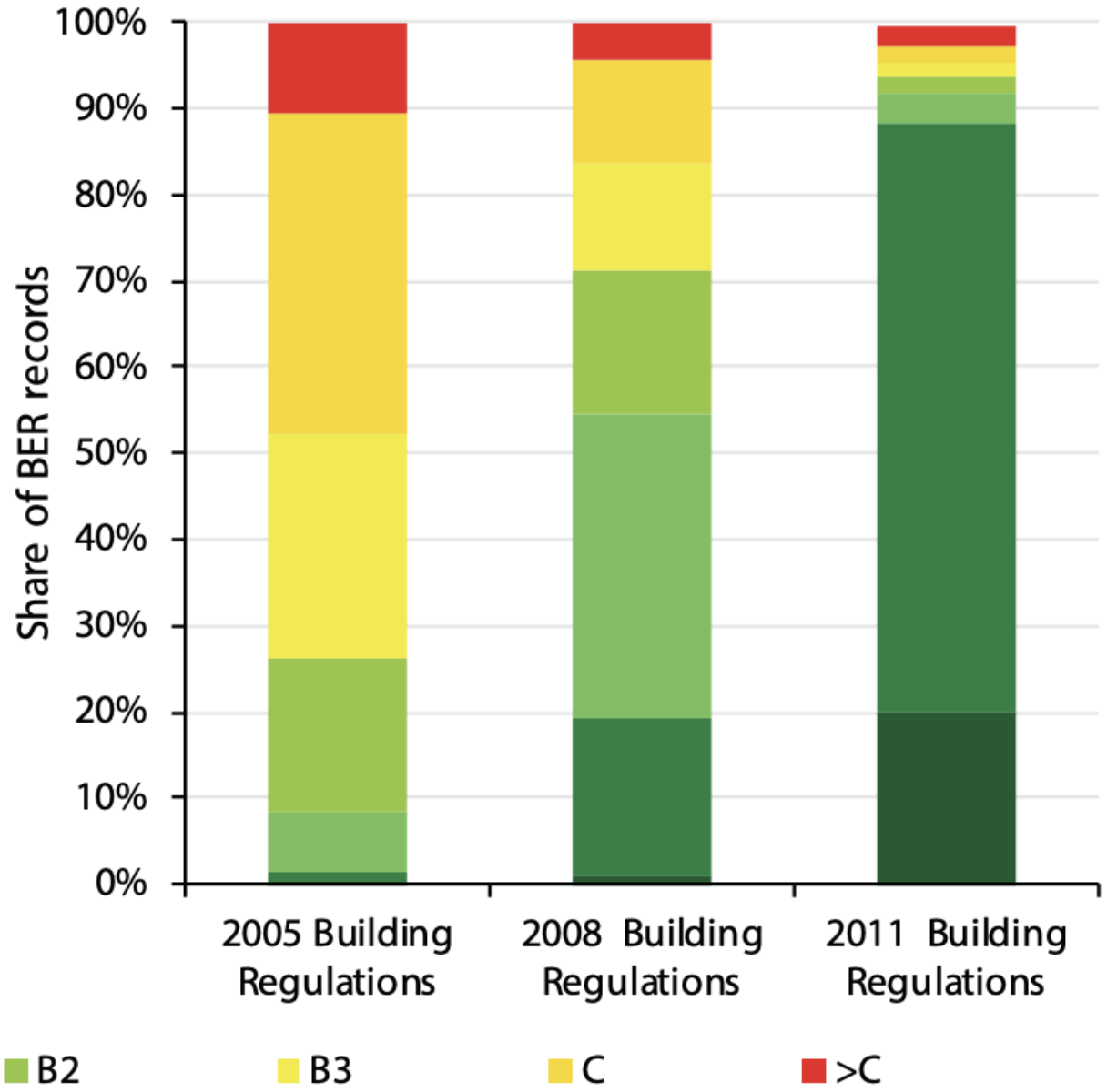




Distribution of BERs in the BER database and for the national housing stock, 2016

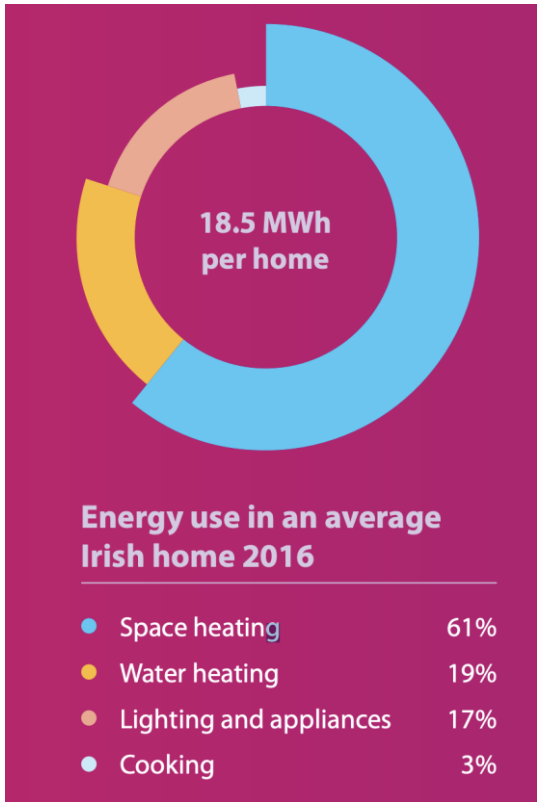
Changes in the Building Regulations





Current status

- Residential buildings accounts for 27 % of Ireland's total energy use
- In 2017, residential energy use when adjusted for weather increased by 0.2%



Moving Forward

- 500,000 homes required to be retrofitted by 2030
- Improved buildings regulations – minimum requirement A2 (34.45 kWh/m^2/yr)

Technical Guidance Document F- Ventilation

Current Edition

- Technical Guidance Document F - Ventilation (2019)

Previous Editions

- Technical Guidance Document F - Ventilation (2009)
- Technical Guidance Document F - Ventilation (2002)
- Technical Guidance Document F – Ventilation (1997)
- Technical Guidance Document F- Ventilation (1991)

Supplementary Documents

Installation and Commissioning of Ventilation Systems for Dwellings - Achieving Compliance with Part F 2019

Technical Guidance Document L- Conservation of Fuel and Energy – Dwellings

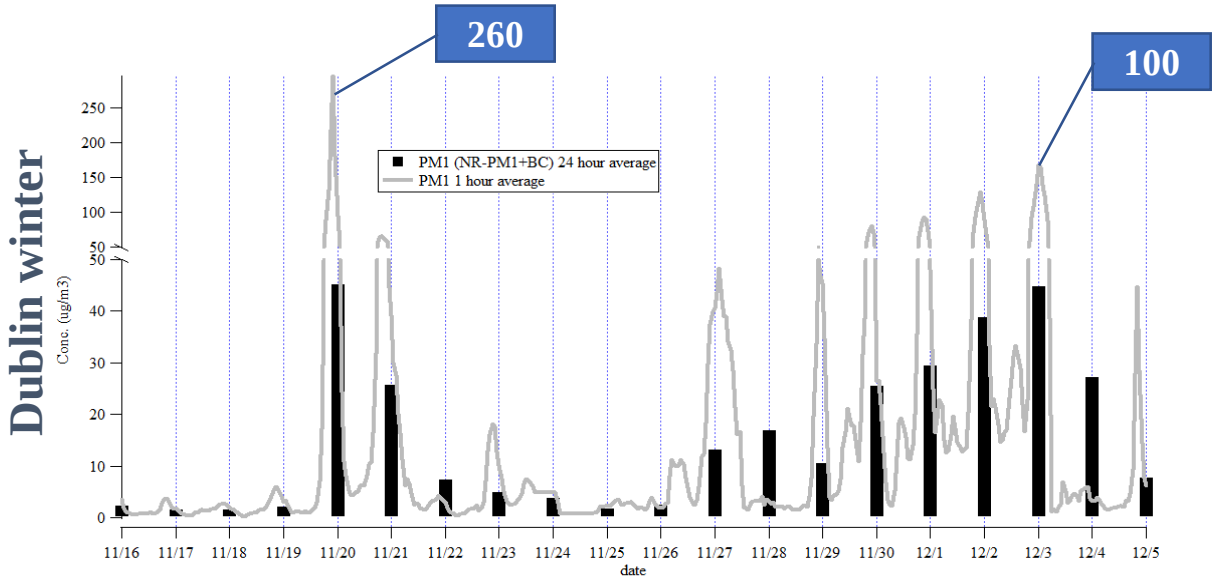
Current Edition

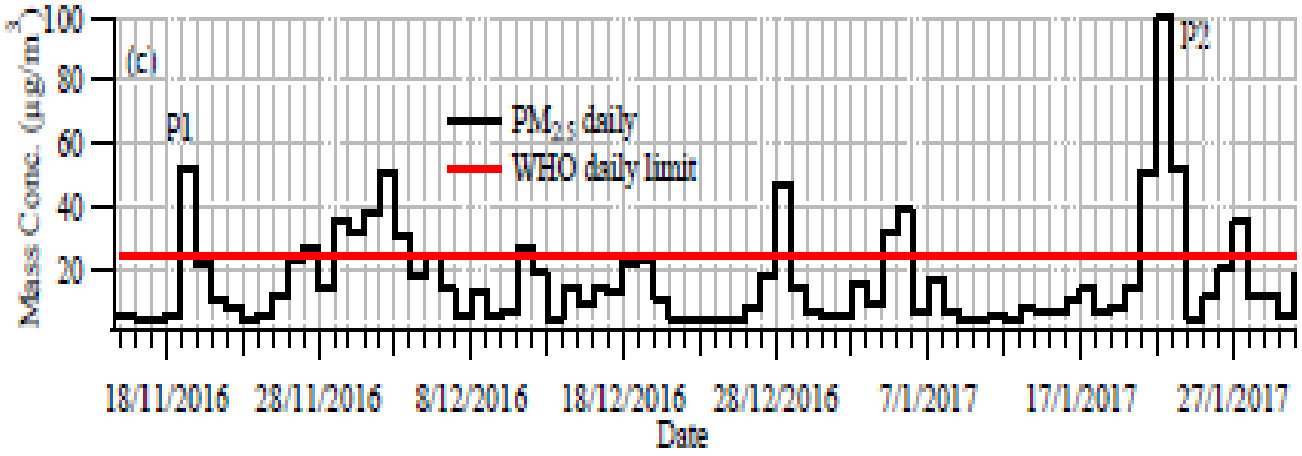
Part L - Conservation of Fuel and Energy - Dwellings (2019)

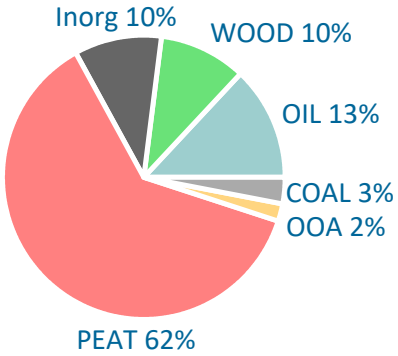
Previous Editions

- Part L - Conservation of Fuel and Energy - Dwellings (2017)
- Part L - Conservation of Fuel and Energy - Dwellings (2011)
- Part L- Conservation of Fuel and Energy - Dwellings (2007) (Reprint 2008)
- Part L- Conservation of Fuel and Energy - Dwellings (2002)(Reprint 2005)
- Technical Guidance Document L- Conservation of Fuel and Energy – Dwellings 1997
- Technical Guidance Document L- Conservation of Fuel and Energy – Dwellings 1991

Outdoor PM - Dublin winter





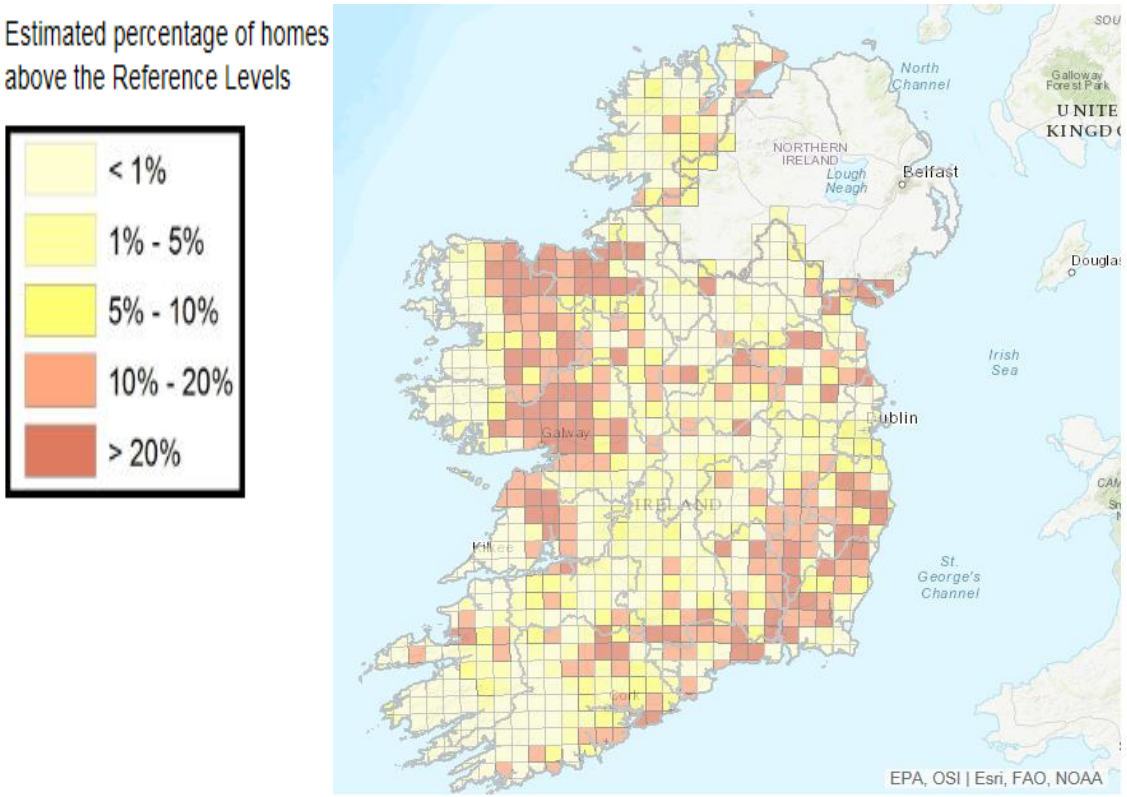


ANALYSIS
https://doi.org/10.1038/s41893-018-0125-x
nature sustainability

Extreme air pollution from residential solid fuel burning

Chunshui Lin[1,2,3], Ru-Jin Huang[1,3*], Darius Ceburnis[1,2], Paul Buckley[4], Jana Preissler[1,2], John Wenger[4], Matteo Rinaldi[5], Maria Christina Facchini[5], Colin O'Dowd[1,2*] and Jurgita Ovadnevaite[1,2]

Specific Irish challenges – Radon



Average radon concentration

Irish homes 77 Bq/m^3

UK homes is 20 Bq/m^3

Worldwide average of 39 Bq/m^3

300 lung cancer cases per year

New builds - tight building envelope

Adequate and **<u>balanced</u>** ventilation

Retrofits

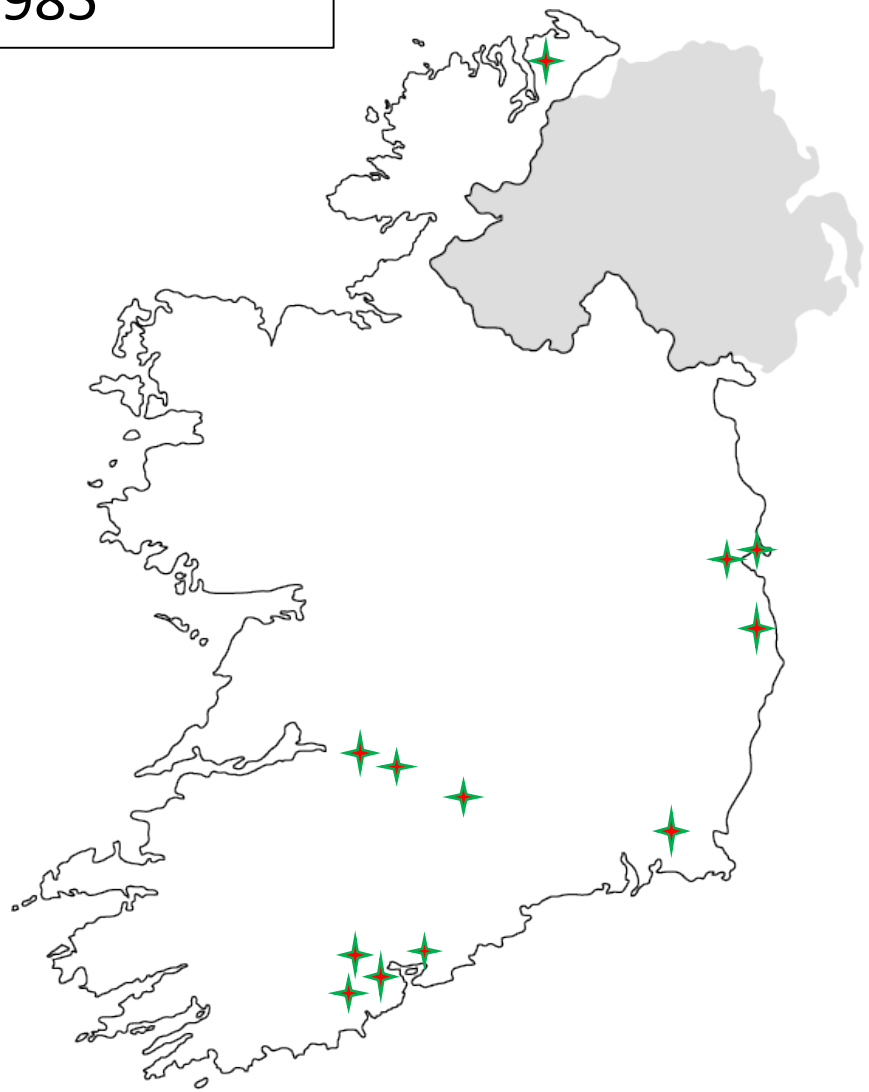
Potentially greater risk due to substructure

The **ARDEN** Project:
Indoor **A**ir, Ventilation and comfo**R**t in Irish Domestic dwellings post **DE**ep Energy re**N**ovations

- Measure 11 indoor air pollutants and thermal parameters in a sample of homes participating in SEAIs Deep Retrofit programme
- Pre & Post retrofit @ 12 months
- Sample of 10 homes > 1 year post retrofit

"This project is funded by the Government of Ireland through the Sustainable Energy Authority of Ireland's Research, Development and Demonstration Funding Programme 2018".

Built pre 1985

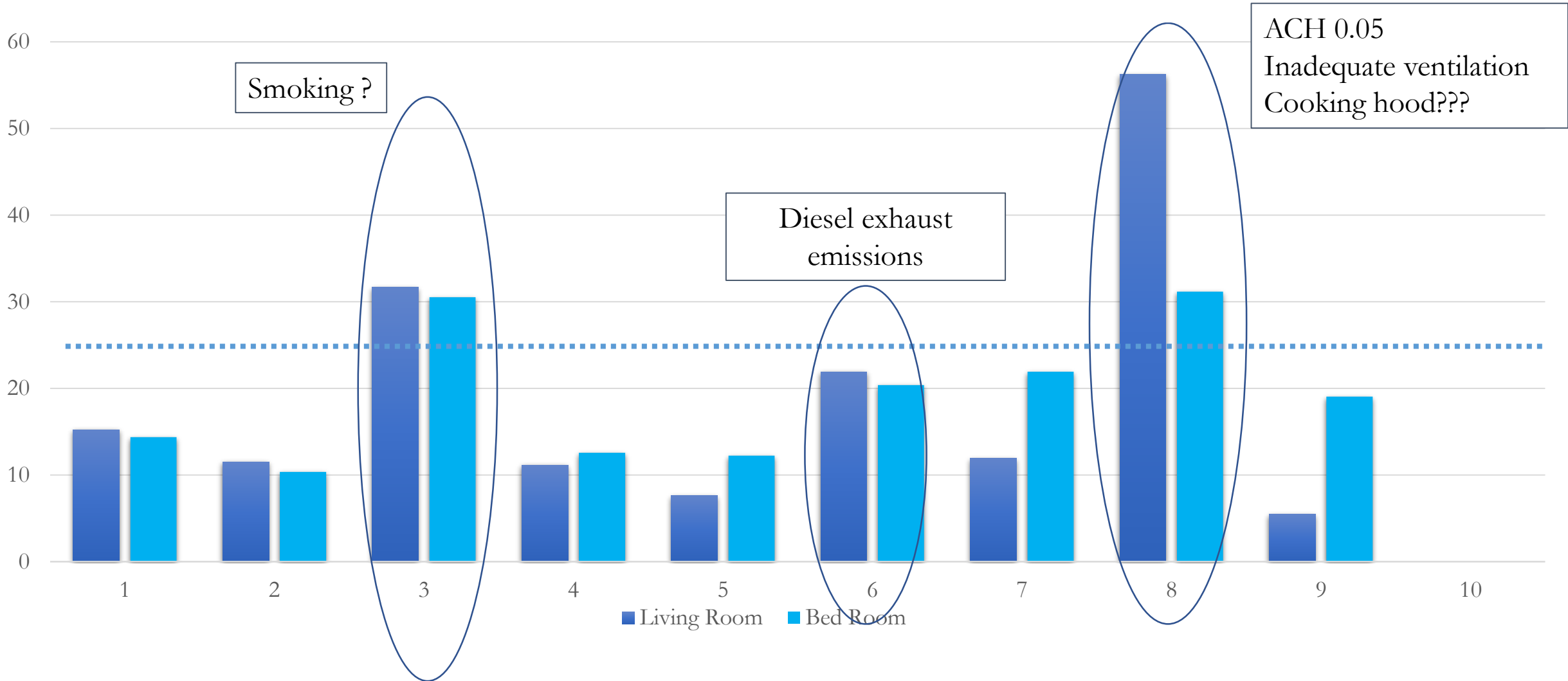


BER Rating	Air tightness ($m^3/(hr\ m^2)$)	ACH	Heating Source	Ventilation
C3	12.0		G,O	CH, BE, WV
D1	8		O	-
D1	8.1	0.2	G,S	CH, BE
D1	13.6		G,S,O	CH, BE
D2	5.9		S,O	CH
E1	TBC		S,O	CH, BE
E1	5.6	0.05	S,O	CH, BE
E2	5.2	0.4	S	CH, WV (blocked)
G	7.6	0.2	G,S,O	-

G = Gas, S = Solid, O = Oil

CH – cooker hood, BE= bathroom extract, WV = Wall vents

$PM_{2.5}$ 24 hr average concentration ($\mu g/m^3$) before the retrofit



The **VALIDate** Project: Assessment of VentilAtion effectiveness via a Longitudinal indoor environmental study in 'A' rated Irish Dwellings

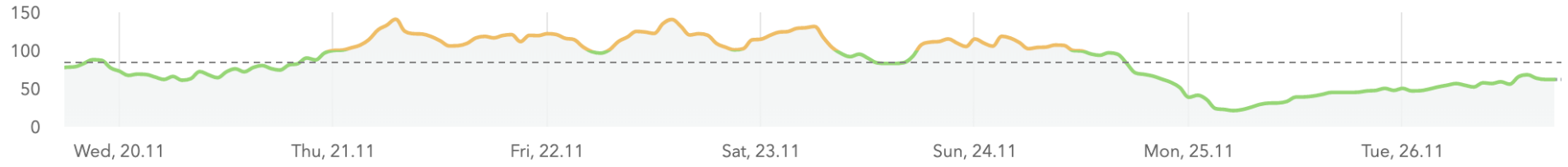
- Monitor IEQ over two heating seasons and a cooling season
- Representation of whole-house ventilation effectiveness
- Questionnaires will capture occupants awareness
- Simulations examining the energy and operational performance of the ventilation system

"This project is funded by the Government of Ireland through the Sustainable Energy Authority of Ireland's Research, Development and Demonstration Funding Programme 2018".

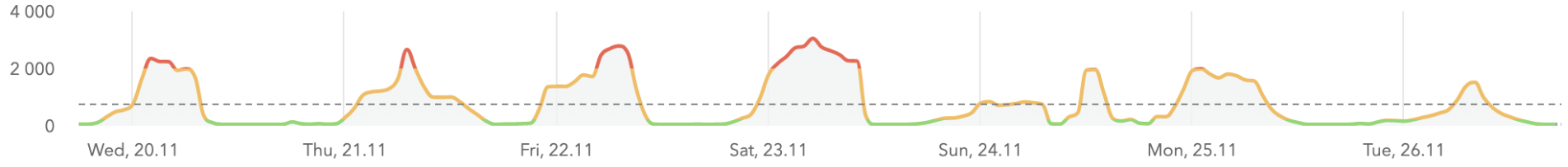
- Monitor temperature, humidity, CO_2, TVOCs, radon and air pressure
- Four rooms per dwellings based on different ventilation guidelines
- A combination of natural and mechanically ventilated dwellings
- Up to 100 dwellings across Ireland
- Data will be stored in an open-repository and accessible to all relevant stakeholders

"This project is funded by the Government of Ireland through the Sustainable Energy Authority of Ireland's Research, Development and Demonstration Funding Programme 2018".

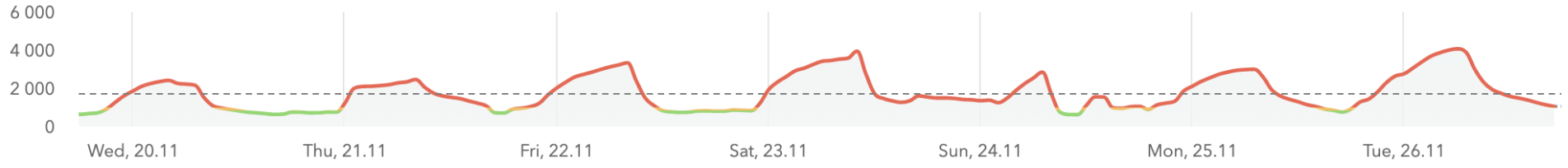
Bq/m³
86
RADON



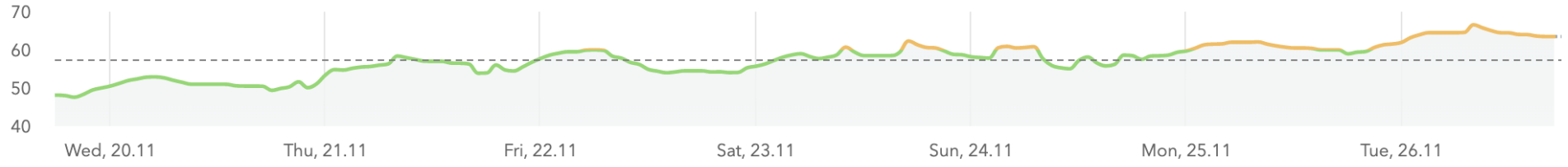
ppb
779
TVOC



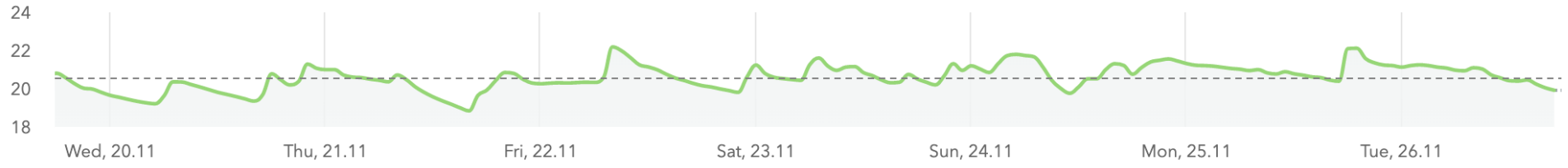
ppm
1741
CO_2



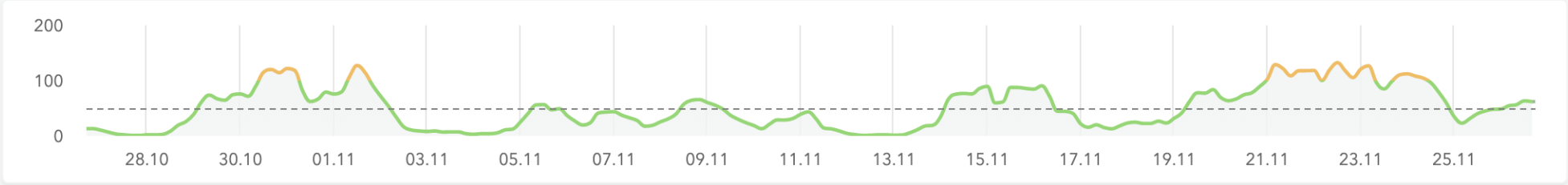
57%
HUMIDITY



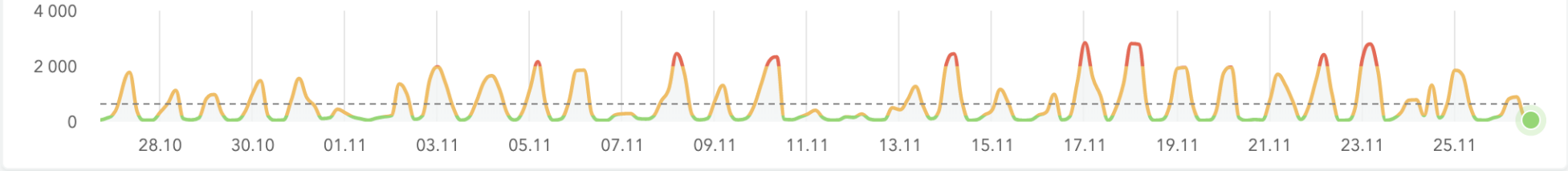
21°
TEMP



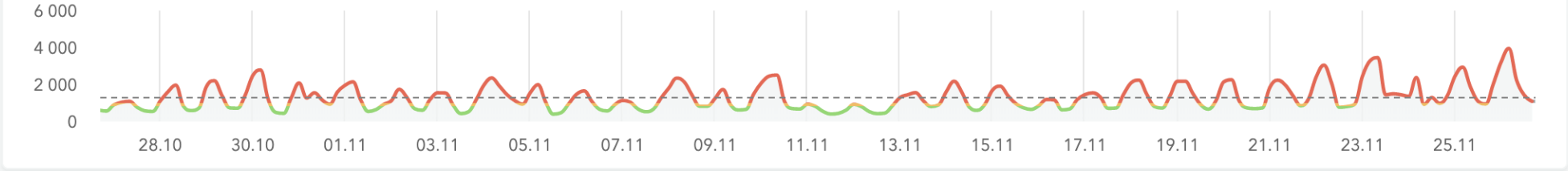
Bq/m³
51
RADON



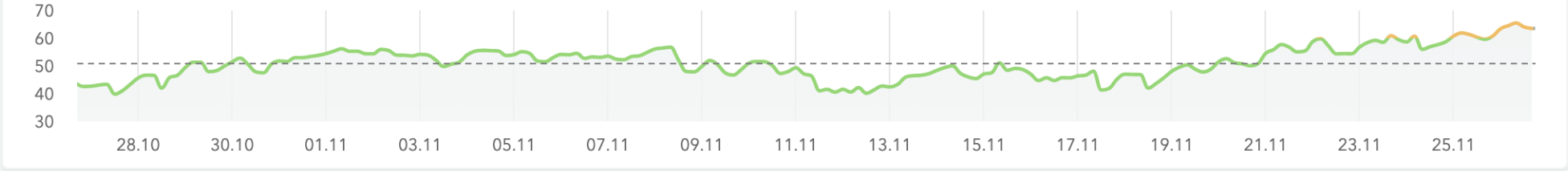
ppb
678
TVOC



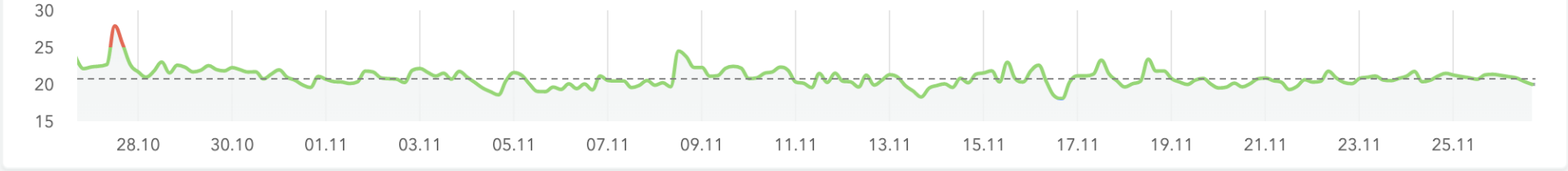
ppm
1313
CO_2



51 %
HUMIDITY

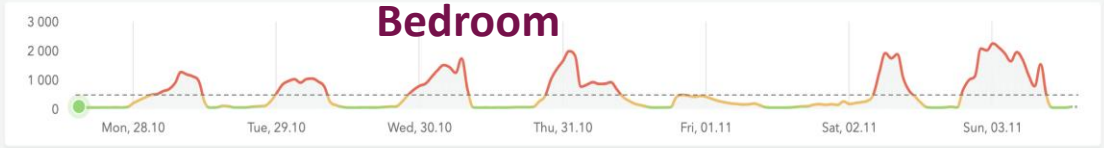


21°
TEMP

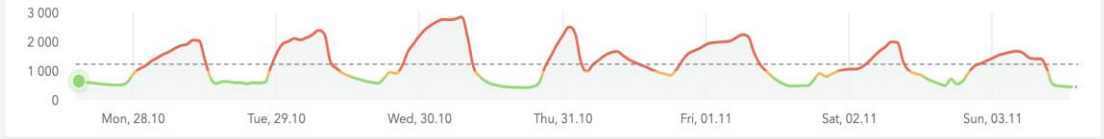


Bedroom

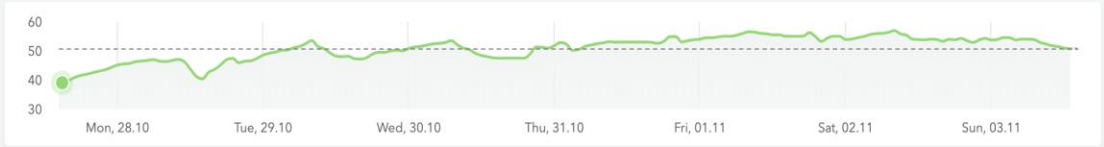
ppb 520 TVOC



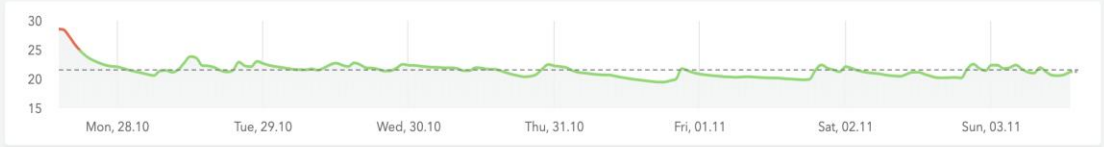
ppm 1246 CO_2



51% HUMIDITY

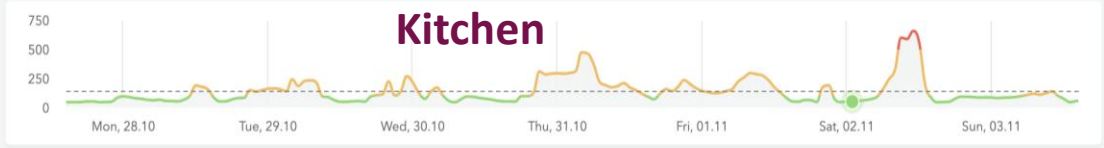


22° TEMP

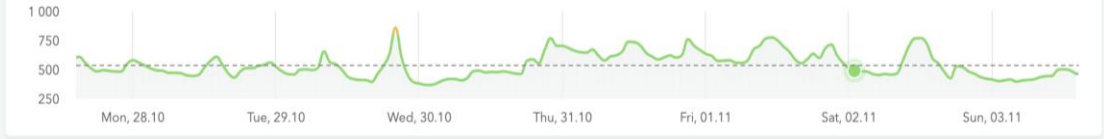


Kitchen

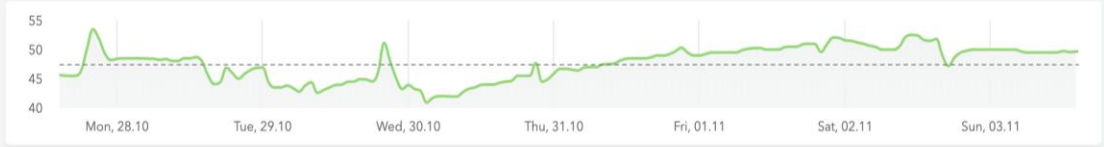
ppb 142 TVOC



ppm 544 CO_2



48% HUMIDITY



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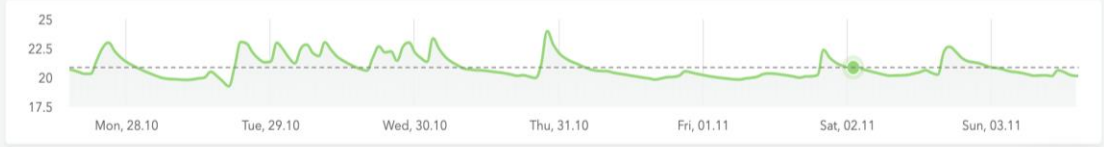
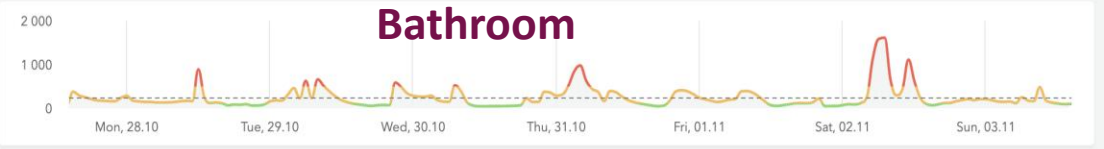
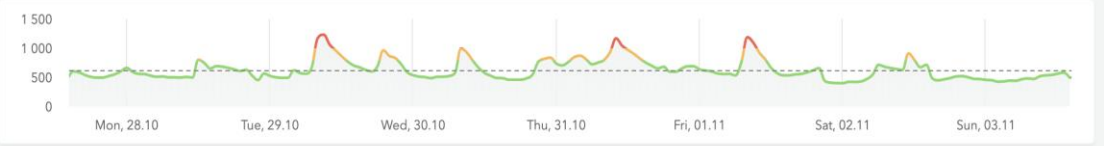


Bathroom

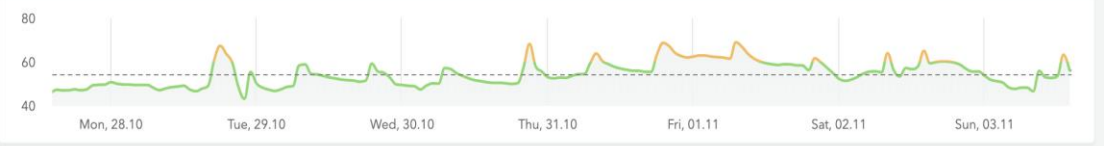
ppb 247 TVOC



ppm 633 CO_2



55% HUMIDITY



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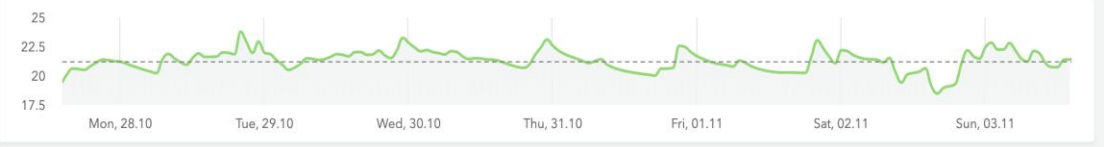
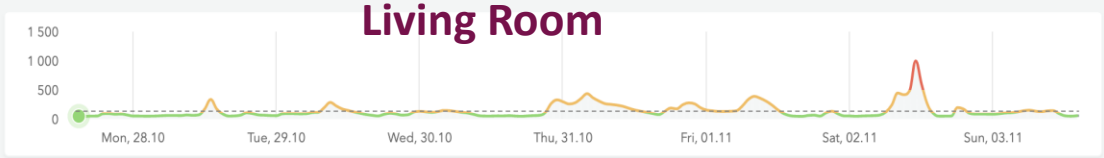
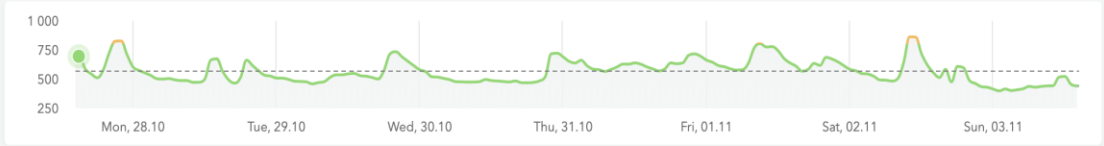


Living Room

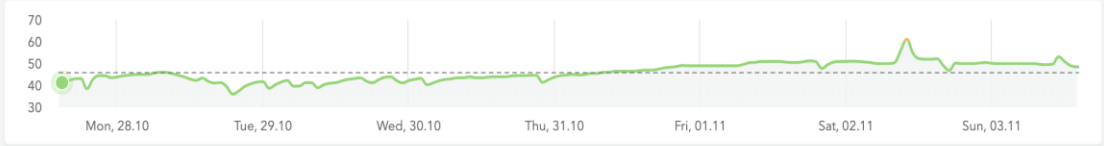
ppb 142 TVOC



ppm 569 CO_2



46% HUMIDITY



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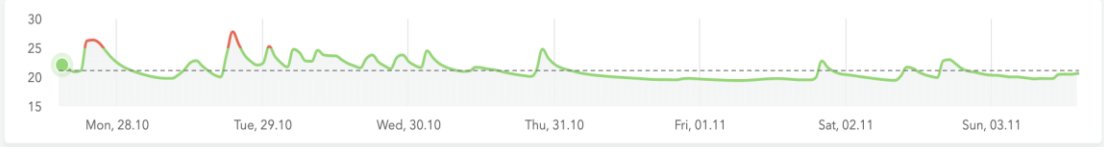
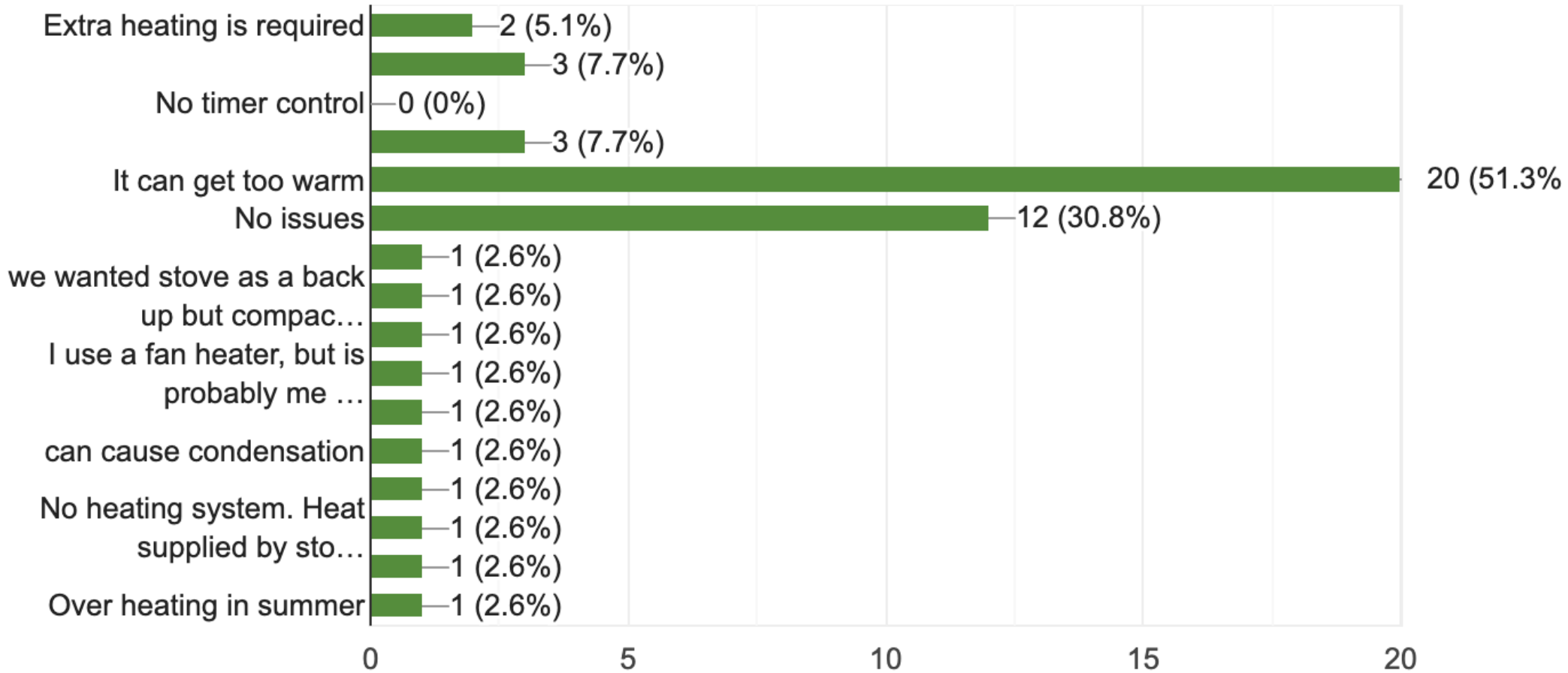


Do you experience any of the following issues relating to heating in your house? (Tick all of the boxes that apply)

39 responses



ALIVE: Assessing Indoor Environmental Quality and Energy Efficiency In a range of Naturally-Ventilated Buildings: A Multi-Disciplinary Approach

- Energy consumption, overheating and IEQ in natural-ventilated dwellings
- A hybrid approach; low-cost sensors and high-grade instrument
- Validated Building Energy Performance Simulation models
- Evaluate potential impacts to BER and NEAP ratings
- Assess the impact on the national building stock

NUI Galway
OÉ Gaillimh

UCD DUBLIN

seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND

"This project is funded by the Government of Ireland through the Sustainable Energy Authority of Ireland's Research, Development and Demonstration Funding Programme 2019".

Summary

- Research focusses on changes in energy-efficient retrofits and changes in the building regulations
- Research approaches; research-grade and customer grade instruments, and computer simulations
- Ireland has unique factors that need to be taken into consideration
- Risk of overheating is a concern in energy efficient buildings
- (Two new PhD positions available starting in the new year)

Project Team

ARDEN Project Team

Marie Coggins, Paul O'Dea, Nina Wemken, Andrew Apsley, Miriam A. Byrne, Hilary Cowie (IOM)

VALIDate Project Team

James A. McGrath, James O'Donnell (UCD), Miraim Byrne

ALIVE Project Team

James A. McGrath, James O'Donnell (UCD), Eleni Mangina (UCD), Miriam Byrne

Acknowledgments

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Thank You