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UKIEG ANNUAL CONFERENCE

Resilient and Healthy Indoor Environments for the 21st Century: Priorities and Challenges

Pressures arising from climate change, demographic changes, resource depletion and financial instability mean that 'future-proofing' the building stock is a must, in order to safeguard occupants' health and wellbeing, as well as help prevent inequalities.

Topics include:

- Criteria and approaches for establishing priorities in future-proofing the building stock;
- Research and case studies on guidelines for indoor environmental quality;
- Design principles and indicators for health and wellbeing in buildings;
- Research and case studies on refurbishments aimed at producing resilient and healthy indoor environments;
- Studies on the trade-offs between health/well-being/equality and issues such as climate change, resource depletion and demographic changes.

The conference will include invited speakers, a poster session, a discussion session and networking opportunities. The UKIEG AGM will take place during the lunch break.

A one-day meeting organised by the **UK Indoor Environments Group**

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Date: 11th June 2015

Venue: The London School of Hygiene and Tropical Medicine

The UKIEG annual conference is a networking event for a multidisciplinary audience of academics, policy makers and industry experts with an interest in improving indoor environments for health and wellbeing.

Registration Now Open

Few Places Still Available for Posters! (contact m.ucci@ucl.ac.uk)

Venue Details: London School of Hygiene and Tropical Medicine, Keppel Street, WC1E 7HT

Conference Fee: £65 for students and UKIEG members; £120 for non-members

Event registration: http://www.eventbrite.co.uk/e/ukieg-conference-2015-tickets-14631000717

Industry Stands available on request: m.ucci@ucl.ac.uk

Further Information: events@lshtm.ac.uk

UKIEG 2015 Scientific Conference

Resilient and Healthy Indoor Environments the 21st Century: Priorities and Challenges?

London School of Hygiene and Tropical Medicine, London
11th June 2015

Conference Programme

09:30-10.00	Registration & coffee	
10:00	Welcome & Chairman's introduction	Marcella Ucci University College London
	Morning session	Chair: Paul Harrison
10:05	INVITED SPEAKER *'If Only'* – the gap between how we would make our buildings if we focused on a whole life performance and impact and how we actually make them; and the structural and political obstacles to overcome in driving reform.	Paul Morrell Principal, Paul Morrell Consulting and formerly Government Chief Construction Adviser
10:25	Health impacts and cost-effectiveness of home energy efficiency interventions in England	James Milner London School of Hygiene and Tropical Medicine
10:45	Indoor Overheating Risks in Dwellings Across London	Jonathan Taylor University College London
11:05	Effect of urban pollution on indoor air quality in energy-efficient buildings in the UK	Zhiwen Luo University of Reading
11:25	**Coffee**	
11:40	Home energy efficiency investments: comparison with winter fuel payments for meeting housing-related health and environmental objectives in England	Paul Wilkinson London School of Hygiene and Tropical Medicine
12:00	Poster 'quick fire session' (2 min presentations)	
12:20	***Lunch and Poster Viewing***	Chair: Derrick Crump
13:15	***AGM & Workshop Discussion***	Chair: Marcella Ucci
	Afternoon Session	Chair: Sani Dimitroulopoulou
14:00	INVITED SPEAKER Climate change and health – how air pollution is saving the day	Louise Newport Department of Health
14:20	Putting up with cold homes: Exploring the relationships between fuel poverty, housing and mental wellbeing in low-income areas of Wales	Charlotte Grey Cardiff University
14:40	Energy-efficiency interventions in housing: monitoring impact on health, comfort and energy consumption	Shiyu Jiang Cardiff University
15:00	Standardisation work on light for circadian rhythms, and related lighting guidance and regulations for indoor environments	Luke Price Public Health England
15.20	Development of a harmonised approach to controlling emissions of hazardous substances from products used indoors	Derrick Crump and Paul Harrison Cranfield University
	Discussion session and coffee	Chair: Paul Wilkinson
15:40	General discussion, closing remarks	
16.00	***Close of Meeting***	

*The UKIEG Conference Organizing Committee reserves the right to amend the program at short notice.

UKIEG 2015 Conference: Invited Speakers Bios

Paul Morrell is a chartered quantity surveyor and was formerly senior partner of Davis Langdon (now part of Aecom), where he had worked since graduating from university until retiring in 2007.
He was subsequently appointed as the Government's first Chief Construction Adviser in November 2009, with a brief to champion a more coordinated approach to affordable, sustainable construction.
He has extensive experience of major construction projects in both the public and private sectors, with a particular specialisation in commercial development (becoming President of the British Council for Offices in 2004), arts projects, value management and procurement strategy and practice.
He is a Fellow of the RICS and of the ICE, and an Honorary Fellow of the RIBA and the Association for Project Management. He served as a Commissioner on the Commission for Architecture and the Built Environment from 2000 to 2008*;* and was awarded an OBE for services to the industry in the 2009 New Year Honours list.
In Government, Paul chaired the Government Construction Board, responsible for the development of a new cross-Government construction strategy. He also served on the Board of the Cabinet Office Major Projects Authority; and led the department of Business Innovation and Skills' Innovation and Growth Team study into low carbon construction.
He now practises as an independent consultant, and is a Visiting Professor at Nottingham Trent University.

Louise Newport is a Scientific Policy Manager at the UK Department of Health. Louise covers climate change adaptation policy and extreme weather, to protect public health from the impacts of climate change and improve the resilience of the health and care system.

Her work includes Secretariat for DH's Director-level Sustainable Development and Climate Change Steering Group; Chair for Living with Environmental Change (LWEC)'s Health and Wellbeing Task Force; representing DH on LWEC's Partner's Board.

Internationally, she co-chairs the WHO (Europe)'s Health Impacts of Climate Change Working Group, and led the UK Delegation to the WHO's first global conference on Climate Change and Health.

She studied microbial genetics for her doctorate with St Thomas' Hospital and the University of London, leading to collaborative work in Germany and Holland. She moved to London's Royal Free Hospital to continue microbiology/TB research in 1992 and set up a Clinical Microbiology Molecular Diagnostic Service from 1996 as the department's first clinical scientist. Joining the Department of Health in 1998, Louise has held a number of policy scientist posts in areas such as dangerous pathogens, antimicrobial resistance/hospital infections, NHS genetics and environmental hazards.

Quick Fire Poster Session

- Lennart Larsson, Lund University, Sweden, ***Experiences in Using the Surface Emissions Trap to Improve the Indoor Air Quality by Efficient Exposure Reduction***

- Sani Dimitroulopoulou, Public Health England, ***Development of environmental public health indicators in Europe***

- Paul Farren, Assist Design, ***Research Project to Investigate Occupier Influence On Indoor Air Quality In Dwellings***

- Aikaterini (Katerina) Kademoglou, University of Reading, ***Emerging flame retardants in indoor environment: a multi-location study between the UK and Norway***

- Tom Wooley, Rachel Bevan Architects, ***Fuel Poverty in Northern Ireland - A Healthy Indoor Environment Issue***

- Argyris Oraiopoulos, Loughborough University, ***Measured internal temperatures in UK homes - A time series analysis and modelling approach***

- Fergus Nicol, London Metropolitan University and Oxford Brookes University, ***How are indoor environments different in domestic and non-domestic buildings?***

UK INDOOR ENVIRONMENTS GROUP

ANNUAL GENERAL MEETING, London, 11th June 2015

AGENDA

1. Welcome and Chairman's Report
2. Status of Committee Membership
3. Future ideas for UKIEG:
    i. Membership
    ii. More events
    iii. International Links
    iv. Others
4. Topics and Venue for the next UKIEG annual conference
5. Ambassadors and LinkedIn
6. AOB: Motions/Comments from the floor

Abstracts

Corresponding author: James Milner, London School of Hygiene and Tropical Medicine

Health impacts and cost-effectiveness of home energy efficiency interventions in England

Objective: To examine the health impacts and cost-effectiveness of different ventilation strategies for energy efficiency interventions designed to meet climate change mitigation targets in the English housing stock.

Design: Modelling study.

Setting: England.

Intervention: Energy efficiency interventions installed in all English houses where such measures were absent or sub-optimal. Different scenarios were modelled to account for varying assumptions about meeting UK building regulations for provision of adequate ventilation following retrofits.

Main outcomes: Modelled changes in indoor pollutant exposures (PM2.5 from indoor and outdoor sources, environmental tobacco smoke, radon, mould) and indoor winter temperatures. Associated changes in quality adjusted life years (QALYs) over 50 years estimated using disease-specific life tables in combination with direct estimates of change in disease prevalence. Corresponding incremental cost-effectiveness ratios (ICER) calculated relative to estimated installation and fuel saving costs.

Results: Assuming existing building regulations are met resulted in a beneficial impact on health of 2,241 QALYs per 10,000 persons due to improved winter temperatures and reduced exposure to indoor pollutants. Relative to the installation and fuel saving costs, this would represent an ICER of £11,875/QALY. Assuming no additional compensatory ventilation resulted in an adverse impact of -728 QALYs per 10,000 persons and a negative ICER of -£43,187/QALY due to increases in indoor pollutant exposures. Including additional ventilation only in homes identified as being at risk of poor ventilation resulted in a limited improvement but still a negative impact of -539 QALYs per 10,000 persons and an ICER of -£32,601/QALY.

Conclusions: Energy efficiency retrofits in the English housing stock can be beneficial for health as long as the risk of poor indoor air quality is mitigated through provision of purpose-provided ventilation. Guidance for installers regarding adequate levels of ventilation to protect health is therefore needed before more widespread introduction of energy efficiency measures into the housing stock.

Co-Authors: Ian Hamilton, Zaid Chalabi, Payel Das, Benjamin Jones, Clive Shrubsole, Mike Davies, Paul Wilkinson

Corresponding Author: Jonathan Taylor, University College London

Indoor Overheating Risks in Dwellings Across London

While temperature-related mortality effects in the UK are dominated by cold, excess mortality during hot weather and heatwaves is currently estimated to cause more than 2,000 deaths a year. Under climate change, this may rise substantially by mid-century without additional measures to protect against heat risks. A key target for adaptation is the housing stock whose thermal performance is particularly important for the segments of the population most vulnerable to heat – the elderly, the socially isolated, or those with long-term health problems, who may not leave their homes or be able to take appropriate adaptation measures to cool their homes down.

We therefore explored the variation in indoor temperatures under hot weather conditions across the London housing stock in order to determine the potential contribution of dwelling characteristics to heat-related risks. We used EnergyPlus 8.2, a dynamic thermal simulation model, to predict indoor temperatures in a set of buildings representative of the housing stock during hot summer conditions, with the variation of these temperatures used to demonstrate the potential changes in heat-exposure risk for building occupants. An epidemiological relationship between temperature and relative risk of mortality is described, and applied to the different dwelling typologies to illustrate how poor housing may contribute to heat-related mortality. We demonstrate the importance of appropriate heat-resilient housing in reducing heat-related mortality, and describe how social housing policy may help reduce the risks faced by the most vulnerable individuals.

Co-authors: Paul Wilkinson, Mike Davies, Ben Armstrong, Zaid Chalabi, Anna Mavrogianni, Phil Symonds, Roberto Picetti, Eleni Oikonomou

Corresponding Author: Zhiwen Luo, University of Reading

Effect of urban pollution on indoor air quality in energy-efficient buildings in the UK

UK government has launched the target for reducing its greenhouse gas (GHG) emissions by 80% below 1990 levels by 2050. However, half of the CO2 emissions results from building sector. Naturally, promotion of energy efficiency measures for the new-built as well as refurbished buildings is the key factor to achieve such ambitious and stringent goal of carbon reduction apart from low-carbon power generation and behavioral change. Increasing the air-tightness and therefore reducing heat loss in winter is one of the important energy-efficient measures being implemented in the UK. There are two views currently in relation to the impact of insulation and airtightness on the indoor air quality and health. One believes increases in air-tightness will degrade the indoor air quality due to the insufficient ventilation, and the other holds the view that higher airtightness will minimize indoor exposure by providing more protection from the ingress of outdoor pollutants. These two views sound contradictory but both are based on reasonable ground. In this paper, we hope to shed some lights on this issue by using UK as a case study. We developed a simple one-compartment model to investigate how the urban pollution in different urban districts in London affects the indoor air quality in London dwellings. The results reveal that the current trend toward more airtight dwellings by adopting Passivhaus standard in UK may have two sides. It can greatly improve indoor air quality for the buildings located the urban centers with low or light indoor sources by enhance the protection of ingress of outdoor pollutants. However, it may cause problems in some rural dwellings with high indoor pollutant source.

Corresponding Author: Paul Wilkinson, London School Hygiene and Tropical Medicine

Home energy efficiency investments: comparison with winter fuel payments for meeting housing-related health and environmental objectives in England

Objective: To compare winter fuel payments (WFPs) with subsidized home energy efficiency (HEE) investments in terms of health, carbon dioxide (CO2) emissions, energy costs and equity in the context of the urgent need to transform the UK housing stock to meet both health and climate change objectives.

Design: Modelling study.

Setting: England.

Intervention: Existing WFPs (£200 to £300 per household/winter) vs retrofit HEE improvements of approximately equivalent annualized cost.

Main Outcome: Quality adjusted life years (QALYs) relating to indoor temperature and air pollution changes; CO2 emissions; energy costs; socio-economic differentials.

Methods: Intervention-related changes to the indoor environment were estimated using validated building physics models from which health impacts were computed using life-table-based methods accounting for time lags. The effect of WFPs was estimated to increase mean standardized indoor temperature by 0.31 ˚C, improve health by 44.1 QALYs per 10,000 persons over 10 years, and increase average household energy use by 7870 kW.hr per year and CO2 emissions by 1510 kg per year. Corresponding figures for HEE interventions were 0.36 ˚C, 441.3 QALYs per 10,000 persons over 10 years, and a decrease of 6200 kW.hr per year and 1190 kg CO2. Monte Carlo simulations suggested strong evidence of greater benefits for HEE investment, and more winners than losers compared with WFPs.

Conclusions: Home energy efficiency improvements of similar annualized cost to current WFPs achieve greater improvements in health and reduce rather than increase CO2 emissions. Replacing policies that incentivize additional fuel consumption for home heating with a rapid full-scale programme of energy efficiency could help transform the UK stock, important for health and essential for climate change mitigation, without substantial financial burdens.

Co-authors: Ian Hamilton, James Milner, Roberto Picetti, Zaid Chalabi, Oliver Bonnington, Judy Green, Mike Davies

Corresponding author: Charlotte Grey, Cardiff University

Putting up with cold homes: Exploring the relationships between fuel poverty, housing and mental wellbeing in low-income areas of Wales

Living in a cold, energy-inefficient home has been linked to poor mental well-being. Previous research has shown that those with common mental disorders are more likely to live in cold and mouldy houses. Fuel poverty is central to understanding the relationships between housing and health. Fuel poverty is the situation where a household cannot heat their home to a comfortable level at a reasonable cost, resulting in households either not heating their home adequately or running up debts in order to stay warm.

This presentation will report results of the first wave of data collection that was conducted as part of a community-based field study to examine the health impacts of energy-efficiency investments in Wales under the Arbed programme (n=1,051). The dataset was analysed cross-sectionally to explore the associations between fuel poverty, housing and mental wellbeing in low-income areas of Wales, as well as potential mediating social and economic processes.

Much of the evidence linking fuel poverty to poor health outcomes is associated with living in cold homes. However, it is also possible that fuel-poor households trade warmth for other household essentials, such as food (the 'heat-or-eat' dilemma). Other pathways focus on the financial stress fuel poverty places on households, a lack of thermal comfort, and social isolation caused by economising and a reluctance to invite friends and family into a cold home. These socio-economic pathways are less well understood due to their subjective nature.

The study found a strong associations between fuel poverty and poor mental wellbeing. Those in fuel poverty reported lower levels of thermal comfort and higher levels of financial stress, food insecurity and social isolation. The implications of the results for energy-performance investments and fuel poverty policy are discussed.

Co-authors: Shiyu Jiang, Wouter Poortinga

Corresponding author: Shiyu Jiang, Welsh School of Architecture, Cardiff University

Energy-efficiency interventions in housing: monitoring impact on health, comfort and energy consumption

It is widely acknowledged that living in cold conditions poses severe health risks, in particular for low income, fuel poor households (Marmot et al 2011). Existing WHO recommendations are to maintain a minimum indoor temperature of 18˚C for the healthy sedentary occupant, and a temperature of 20˚C for rooms occupied by vulnerable groups, with indoor temperatures under 16˚C further increasing the risk of cardio-respiratory conditions. However, most of the evidence is based on single temperature measurements. Little is known about the duration and total exposure to low temperatures.

This paper presents preliminary analyses of household monitoring data that were collected as part of a study examining the health impacts of energy-efficiency investments in Wales under the Arbed programme (Arbed 2). In total, 99 households from 5 communities were monitored, 50 of which were part of an Arbed 2 scheme and the rest served as a control group. Air temperature and humidity of living room, kitchen and main bedroom were recorded at a 15 minute interval for 4 weeks or longer during the 2013-14 heating season. Each community also had its own weather station to be able to adjust for external meteorological conditions and determine heating demand for the different communities.

A methodology is presented in which indoor temperature and humidity are linked to heating demand to assess building performance under different external condition. The study also determined the length and amount of exposure to risky internal conditions over a fixed 4-week period (i.e. < 18˚C, < 16˚C, and > 60% relative humidity). The standardised building performance and exposures to risky internal conditions are subsequently linked to a number of cardio-respiratory health outcomes.

Co-authors: Grey, C. Poortinga, W. and Tweed, C.

Corresponding author: Luke Price, Public Health England

Standardisation work on light for circadian rhythms, and related lighting guidance and regulations for indoor environments

In 1999, the fifth light sensitive cell type in the human eye was discovered. Called intrinsically photosensitive Retinal Ganglion Cells (or ipRGCs), they are quite different to rods and the three cone types in many ways. The most important difference is that ipRGCs sense ambient light levels over a long period of time (they are not used for vision) and related standards are only just starting to take shape.
Standards relating to ipRGCs and the non-visual effects of light may be needed quickly, to promote healthy indoor environments and adequate daily access to outdoor spaces. ipRGCs play a pivotal role in the human body's daily temporal regulation of its physiology at a very fundamental level. Inappropriate patterns of exposure to light and darkness are known to be an important factor in many progressive diseases, such as breast cancer, heart disease, diabetes, and dementia. The cause may be shift work, being restricted to indoor environments during the daytime, or sleep disruption due to invasive light at night.
All of these suboptimal exposure scenarios disrupt circadian rhythms, the term given for the regulation of physiology to follow a daily pattern.
At first standards in this area will inevitably relate to what can be established most easily. In Didsbury 2013 a group of international experts in the field of human non-visual responses to light, provided a model for the spectral sensitivity of the five types of photosensitive cells in the human eye. American, International and European efforts are being made to enable this guidance to be adopted as a standard. An International interior lighting/design group is also working on the role of windows in buildings for best practice, including circadian rhythms amongst its key factors. It is hoped balanced regulations may follow in a few years.

Corresponding authors: Derrick Crump, Cranfield University; and Paul Harrison, IEH Consulting

Development of a harmonised approach to controlling emissions of hazardous substances from products used indoors

Buildings are increasingly being designed or modified to achieve a very airtight and highly insulated structure as regulators aspire to ‘zero carbon performance’ to address the climate change issue. Concern has been raised about the impact that such measures may have on indoor air quality if these changes are associated with lower rates of ventilation and greater use of materials that may emit hazardous substances. Controlling the strength of indoor sources of hazardous substances such as VOCs reduces the risk of poor indoor air quality and the associated health risks for the occupants. Initiatives in a number of countries across the world - Europe in particular - have defined methods of testing products under laboratory conditions and evaluating the emissions to characterise the product with respect to its impact on indoor air quality. The results of such evaluation may be used as the basis for limiting the availability of products on the market and/or informing consumers about the impact on indoor air of the product by means of appropriate labelling.

Currently within Europe there are a number of national as well as industry led schemes for characterising and labelling products. This hinders the free trade of products and adds cost for manufacturers. It is also confusing for consumers who wish to select products with low impact on indoor air. Initiatives are underway to achieve a more harmonised approach to the assessment and labelling of products with respect to emissions. This presentation outlines the current state of progress to agree an EN standard for the testing of construction products and to define EU-LCI values for the assessment of emission test results as part of a system for labelling based on impact on indoor air.

Corresponding author: Lennart Larsson, Lund University, Sweden

Experiences in Using the Surface Emissions Trap to Improve the Indoor Air Quality by Efficient Exposure Reduction

Unsatisfactory indoor air quality can result from emissions e.g. of volatile organic compounds (VOCs) from the materials in a building. Here we describe some experiences in using the surface emissions trap (cTrap) to reduce emissions from building material surfaces indoors e.g following water damage thus preventing the emissions from reaching the individuals in the building.

A cTrap cloth was developed from a laminate consisting of one adsorption and one polymer layer, in laboratory tests found to stop and bind emissions virtually quantitatively (>98% of >20 tested VOCs, 100% of 3 tested mycotoxins) at the same time having virtually no resistance to water vapour. The device (1.9 mm thick, 1.15 m width, in rolls of 30 m) may easily be attached on surfaces indoors from which emissions are spread, i.e. floor, ceiling or wall. The emissions may often, but not always, be moisture related.

The cTrap has proved to be efficient in reducing and binding odors and moisture-driven emissions in water-damaged buildings having an adsorption capacity large enough to be used for several decades following installation. Typically, already a few days after a cTrap installation a clear improvement in the perceived air quality is found (less of asthma, fatigue, headache, skin irritations etc) together with a measurable decrease of the emissions. The device is an efficient barrier e.g. against emissions from the floor following degradation of components in the glue used to attach a PVC flooring on a concrete slab.

In conclusion, emissions of VOCs (including odours) from a surface indoors may be stopped efficiently by applying the cTrap cloth onto the surface; by contrast, the device allows ready passage of water vapor. Use of the cTrap may constitute a cost-efficient and effective way of restoring the indoor air quality e.g. following water damage leading to unwanted emissions indoors.

Corresponding author: Sani Dimitroulopoulou, Public Health England

Development of environmental public health indicators in Europe

Health inequalities have been increasing in Europe, particularly in the context of an ageing society and economic crisis (Marmot et al., 2012) . This may lead to challenges in respect of health delivery, especially in countries with different levels of infrastructure and health system preparedness. The main objective of EURO-HEALTHY project, funded under Horizon 2020 (2015-2018), is to identify practicies that have the highest potential to enhance health and health equity across European regions with particular focus on metropolitan areas. To achieve this, the project will develop a population health index, based on the relationship between multiple determinants (e.g. demographic, social, economic, environmental, lifestyle, and health care) and health outcomes in the past 15 years. The index will be eventually used to evaluate the population's health and wellbeing in 273 NUTS 2 European regions and 9 selected pilot metropolitan areas (Athens, Barcelona, Berlin, Lisbon, London, Paris, Prague, Stockholm and Turin), covering populations of 28 EU countries.

The current paper presents the results from a comprehensive literature review that was carried out to identify the key environmental risk factors affecting public health and wellbeing in Europe. The focus was on: a) climatic and environmental factors and b) urban and built environment factors.

A list of the identified indicators is presented as well as the rationale for their prioritisation. Based on this selection, a document with the metadata specifications of environmental indicators will be produced.

Co-authors: S. Vardoulakis, C. Heaviside, K. Katsouyanni, E. Samoli, P. Santana

Reference

Marmot M et al. WHO European review of social determinants of health and the health divide. Lancet 2012, 380:1011–29.

Corresponding author: Paul Farren, Assist Design Architects

Research Project to Investigate Occupier Influence On Indoor Air Quality In Dwellings

The aim of the research was to investigate dwelling occupant interaction with natural ventilation components and record levels of indoor air quality. The project also identify options for making natural ventilation in dwellings a robust strategy

Co-authors: Tim Sharpe, Jonathan McQuillan, Stirling Howieson, Paul Tuohy

Corresponding author: Katerina Kademoglou, University of Reading

Emerging flame retardants in indoor environment: a multi-location study between the UK and Norway

Flame retardants (FRs) are man-made chemical compounds widely used in industry during the manufacturing of various commercial products such as computers, plastics, fabrics, textiles and polyurethane foam products in order to minimise or prevent fire. Worldwide phase-out campaigns and legislative restrictions on the use of polybrominated diphenylethers (PBDEs) have resulted in the production of new PBDE-replacement products, also known as emerging FRs (Stapleton et al., 2008).

Sampling sites representing three different indoor environments (houses, stores and offices) were selected at the area of Reading (UK) and the area of Oslo (Norway) respectively. N=18 samples of indoor dust were collected from vacuum cleaner bags in houses, stores, offices and libraries in the area of Reading (UK) during August - December 2013. N=10 samples of indoor dust were collected during November 2013-April 2014 from vacuum cleaner bags in houses from the wider area of Oslo (Norway) as a part of a cohort study of N=60 people within the framework of the '*Advanced Tools for Exposure Assessment and Biomonitoring'* (A-TEAM) project, a Marie Curie Initial Training Network aiming to establish tools for human exposure biomonitoring of emerging FRs.

In the present study the emerging FRs examined are: 1,2- bis(2,4,6-tribromophenoxy)ethane (BTBPE), 2-ethylhexyl-2,3,4,5-tetrabromobenzoate (EH-TBB) and bis(2-ethylhexyl)-3,4,5,6-tetrabromophthalate (BEH-TEBP). Prior to extraction, all samples were spiked with 13C-labelled TBB, TBPH and BTBPE used as internal standards. A two-step Solid-phase extraction (SPE) using Florisil (step 1) and 44% acidified silica gel (step 2) was performed coupled with ultrasonication-assisted solvent extraction.
We report levels of emerging FRs in British and Norwegian indoor environments where humans spend eight hours minimum on a daily basis. Preliminary results will be presented on how variability from diverse indoor dust sources such as houses, stores and offices can affect the levels of emerging FRs, as well as to compare the geographical trends of emerging FRs between Norway and the UK.
This project is financially supported by the European Commission FP7 Marie Curie Initial Training Network "A-TEAM" grant number 316665.

Co-authors: Chris D. Collins

Corresponding Author: Tom Wooley, Rachel Bevan Architects

Fuel Poverty in Northern Ireland - A Healthy Indoor Environment Issue

Recent Environmental Health data suggests that 42% of the population of Northern Ireland live in fuel poverty. Income poverty, according to JRF is at 24%

Current Government schemes such as NISEP, Affordable Warmth and proposals for HEAT, a Northern Ireland 'Green Deal,' are barely scratching the surface of the problem. Academic studies claim that adding insulation to fuel poor houses improves the health of occupants, whereas anecdotal evidence and studies elsewhere (e.g. Exeter) cast doubt on the health benefits of standard energy efficiency measures.

14% of all deaths in Northern Ireland are from respiratory illnesses and over 100,000 people are registered with GPS as having asthma. Serious problems of dampness and mould exist in many old houses, but is also a problem in new build, as shown by recent indoor air quality test results.

Corresponding author: A. Oraiopoulos, Loughborough University

Measured internal temperatures in UK homes - A time series analysis and modelling approach

Heat related mortality is likely to increase as heatwaves become more common due to climate change. The aim of this research is to use empirical data to predict internal temperatures in dwellings based on external climate data by employing classical time series analysis. This novel approach is used to understand the mechanisms behind the formation of time series room temperature data and to construct statistical models that allow the prediction of future temperatures based on past measured values.
This work presents the time series analysis of the internal air temperatures measured hourly in the living rooms and main bedrooms of a large-scale, city-wide monitoring study, comprising of 230 domestic buildings in the city of Leicester, UK. The data were recorded for 62 consecutive days (1st July till 31st August) during summer 2009.
The analysis is based on the model-building paradigm of Box and Jenkins (1976) for univariate time series modelling and it includes a sequence of procedures that form the methodology applied. Six methods are used in the analysis of the time series temperature data: 1) the series is inspected to identify trends and seasonal effects; 2) a number of adjustments and transformations are performed to remove these observations; 3) the type of model giving the best possible fit to the data is identified; 4) the model parameters are estimated; 5) the model is checked and validated and 6) future values are forecasted.
It is concluded that this method is suitable for the development of empirical models capable of predicting the summertime internal temperatures in domestic buildings. By applying the models to national datasets, this can provide significant insights for the developments of future policies to mitigate overheating, to evaluate the impact of retrofitting and to supply at-risk households with timely information on how to reduce indoor temperatures during hot summer weather conditions.

Co-authors: A. Oraiopoulos, Dr Tom Kane, Dr Steven Firth, Prof Kevin Lomas

Reference: Box, G. E. P and Jenkins, G. M. (1976). Time series Analysis, Forecasting and Control. Holden Day.

Corresponding author: Fergus Nicol, London Metropolitan University and Oxford Brookes University

How are indoor environments different in domestic and non-domestic buildings?

Despite the fact that about twice as much energy is used in Domestic than in Non-domestic buildings, nearly all the research effort into temperatures in buildings has been done in the latter. The reasons are legion – relatively simple to find subjects, cost of energy is more closely monitored, the 'cost' of reduced productivity and so on – but the contradiction remains, we really have little idea how two thirds of our heating (and sometimes cooling) energy is used. New information from domestic buildings in the UK and elsewhere has revealed surprising differences between the temperature profiles of Domestic and Non-domestic buildings. The differences suggest that new methods and approaches will be required if building energy use is to be effectively properly understood, simulated and regulated in the domestic sector.