



RETROFIT 2050 DOCTORAL RESEARCH WORKSHOP ON SUSTAINABLE URBAN ENVIRONMENTS

Alex Opoku and Peter Guthrie

Book of Abstracts & Workshop Programme

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WORKSHOP PROGRAMME

AUTHOR	Affiliation	TOPIC	TIME
Dr Alex Opoku	Cambridge University	Registration /Lunch	12:00
Prof. Peter Guthrie	Cambridge University	Welcome Address	12:40
SESSION 1			
PRESENTATIONS			
Tim Forman	Cardiff University	Solid wall and hard-to-treat cavity wall insulation in existing UK dwellings: the impact of installer practices, training and supply chains	12:50
Eleni Soulti	Cambridge University	Retrofit in practice: solid wall insulation and the energy performance gap	
Peter Keig	University of Ulster	Analysis of the operational energy performance of a retrofitted solid wall terraced house versus designed performance	
DISCUSSIONS: Chaired by Prof Malcolm Eames, Cardiff University			13:20
SESSION 2			
PRESENTATIONS			
Rebecca Ince	University of Salford	Mediating domestic Retrofit: Macro-conditions and micro-manifestations	13:55
Teresa McGrath	Queen's University Belfast	Life cycle thinking in retrofit projects	
Madalena Vaz Monteiro, Tijana Blanusa, Ross W.F. Cameron, Paul Hadley	University of Reading	Urban Temperatures and plants-Differences matter!	
Aidan Parkinson	Cambridge University	Sustainable Investment: The Energy Performance of Real Estate	
DISCUSSIONS: Chaired by Dr Mike Hodson, University of Salford			14:35
TEA BREAK			15:10
SESSION 3			
PRESENTATIONS			
Tina Schmieder	Cardiff University	Building retrofit and financial innovation – Decarbonising the UK domestic building stock	15:25
Kayla Friedman	Cambridge University	Comparative Information Quality Assessment of Council Conservation Retrofit Guidance	
Sergio Kemmer	University of Salford	Development of guidelines for improving production management of refurbishment projects	
Margaret Thorley	Cambridge University	The Role of Property Professionals in Promoting Building Retrofits: Insights from Letting Agents across England	
DISCUSSIONS: Chaired by Prof Tim Dixon, University of Reading			16:05
SESSION 4			
PRESENTATIONS			
Neil Campbell	Queen's University Belfast	The use of Building Element Heat and Moisture Transport (BEHAM) Software in the UK Retrofit Sector: Laboratory Examination and Case Studies	16:40
Oluwafeyikemi Akinwolemiwa	Cardiff University	Vertical Greening Systems and Their Importance to Sustainability in the Urban Environment	
Mahawattha P. Nuwan Dias	University of Salford	Evaluation of Regenerative Design as an Approach for Urban Design	
DISCUSSIONS: Chaired by Simon Lannon, Cardiff University			17:10
Prof. Peter Guthrie	Cambridge University	Closing Remarks	17:45

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Solid wall and hard-to-treat cavity wall insulation in existing UK dwellings: drivers and hindrances of consistent quality in installation and delivery

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Abstract

This research investigates solid wall insulation (SWI) retrofits in UK housing and explores the causes of gaps between designed and as-built SWI performance. The project is sited in a range of UK area-based social housing retrofit projects and installer training programmes and includes an extended study of a medium-sized SWI installation company. Research draws on qualitative methods to examine the challenges to following best practice guidance for SWI design, specification and installation at each site. It asks how those who deliver SWI affect retrofits by their actions, skills and behaviours and how this is correlated to their technical knowledge, motivation and perspective. The research investigates wider SWI actor-networks, which include SMEs and corporate entities, government-led economic instruments, industry professionals, clients, and occupants. It identifies patterns of ‘short-termism’, financial pressure, and limited technical understanding as recurrently detrimental to installation quality. Correspondingly, it outlines potential mechanisms for improving the delivery of SWI retrofits such as expanded quality assurance programmes, wider installer training and certification, and more finely-tuned government funding programmes.

The research utilises participant observation, direct observation, unstructured and semi-structured interviewing methods. Broader contexts of the research include knowledge transfer theory, science and technology studies, and the implications of installation quality for retrofit lifespan, operational performance, whole life cost, and life-cycle environmental impact.

Keywords: solid wall; insulation; installer training; retrofit; refurbishment; policy

Retrofit in practice: solid wall insulation and the energy performance gap

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Abstract

The UK has set legally binding targets to achieve significant CO₂ emissions reduction. Buildings are responsible for a great percentage of the country’s energy use and they are regarded as the low hanging fruit for the achievement of CO₂ emissions reduction. During the past years, retrofit has become very important, given the fact that most of the existing buildings will still be standing in 2050.

However, the energy performance gap is a major challenge, due to technical as well as behavioural factors. This research examines and evaluates the energy performance gap, its causes and challenges involved, with a focus on solid wall buildings.

Literature reviews conducted as part of this research, seek to identify and quantify the energy performance gap, focusing on the insulation sector and more specifically on solid wall energy retrofit. Research shows a significant discrepancy between estimated and actual energy consumption and there is a need for more evidence in order to quantify and bridge this gap. Specifically solid wall insulation improvements are hard to evaluate, partly due to the knowledge gap on traditional solid walls.

Keywords: insulation; retrofit; energy efficient technologies; performance gap

Analysis of the operational energy performance of a retrofitted solid wall terraced house versus designed performance

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Abstract

A solid wall Victorian house located in north Belfast was retrofitted as part of the Technology Strategy Board's Retrofit for the Future programme. The retrofit design for the three storey mid terraced house was based on conducting a sensitivity analysis of each proposed retrofit measure using *Passivhaus Planning Package* software with the *Trias Energetica* concept employed to establish a hierarchy of measures.

This paper compares the designed performance with the first twelve months of operational performance and investigates which retrofit measures contributed towards the energy performance of the house being higher than predicted.

Keywords: Designed performance; operational performance; PHPP; retrofit; solid walls

Mediating domestic retrofit: Macro-conditions and micro-manifestation

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Abstract:

Domestic retrofit for energy efficiency sits at an interesting intersection between a number of different issues, policy areas, social interests and economic concerns. These span climate change, technological trends, the economic crisis and social justice. This paper seeks to do two things: first, to outline the conditions, peculiar to the United Kingdom, in which domestic retrofit activity at the city scale occurs, exploring the key institutions involved, their interests and priorities and the issues and pressures that emerge at this level. This will examine the influence of - and tensions between - central government departments like the Department for Energy and Climate Change (DECC) and the Department for Communities and Local government (DCLG), as well as commercial actors such as energy suppliers and construction companies and regulatory organisations including the Building Research Establishment (BRE). Second, it will outline the roles of cities, communities and localities at different scales in this national agenda, as well as the function and positions of different kinds of intermediary organisations such as community groups, local authorities, co-operatives, energy companies and third sector environmental organisations. The manifestation of these issues and pressures will be illustrated through examples drawn from Manchester, Bristol and Birmingham.

Life cycle thinking in retrofit projects

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Abstract

Current retrofit practices to improve energy efficiency in homes prioritise actions such as reducing thermal transmittance, improving air-tightness and the addition of renewable technologies. Reduction of operational energy is considered paramount with little consideration given to the embodied energy or carbon associated with the retrofit materials.

A number of retrofit case studies are currently being monitored in the Belfast area with internal conditions and energy consumption measurements being gathered. A range of different retrofit measures and renewable technologies were implemented in the seven case studies. This study aims to assess the effectiveness of measures implemented in terms of operational energy savings and internal comfort. It will also examine the effect of measures implemented on total life cycle energy/carbon emissions. IES-VE is being used to simulate operational energy consumption in the monitored households, while Sima-Pro is used to quantify life cycle impacts of retrofit measures implemented.

The aim of the work is to develop a decision making process for the implementation of retrofit measures, validated from the long term monitoring of case studies, that considers both embodied and operational energy/carbon consumption encouraging life cycle thinking within the industry.

Urban temperatures and plants - Differences matter!

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Abstract

Plants in urban green spaces provide numerous ecosystem services essential for a greater sustainability of urban environments. For example, in comparison to an impervious surface, vegetation can provide summertime cooling, by means of emitting less heat and leading to lower localised air temperatures. Also on green, vegetated, roofs plants will offer better roof insulation, reducing the temperature inside the building. Different plants, however, are unlikely to provide this 'temperature regulation' service in the same way. Consequently, this research project focuses on understanding how herbaceous plant species which differ in leaf traits, such as leaf colour, succulence (higher leaf thickness) and pubescence (presence of hairs), particularly in the scenarios of reduced water availability, influence the overall thermal performance of green spaces. The implications of canopy's energy transfer differences for substrate temperature below the canopy, air temperature above the canopy and heat emission differences were studied. In this paper we will be discussing the implications of these species' differences for the regulation of the substrate temperatures.

Keywords: Leaf traits, soil moisture content, summertime temperature regulation

Sustainable Investment: The Energy Performance of Real Estate

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Abstract

Facility quality is highly dependent on the performance of local weather and utility infrastructure in addition to social context. Improvements in facility quality, including resource efficiency, effectively reduce the marginal cost of utilities used to produce equivalent value and thus would likely impact on rental value (Browning & Zupan, 2012). Thus, the ability to identify the risks and opportunities for creating such value through appropriately evaluating expectations of future energy performance should be of keen interest to property investors. This research asks the question: How can one evaluate the specific market risks arising from expectations for the energy performance of real estate?

This research seeks to develop a framework for evaluating financial risks to real estate assets relative to market expectations of future energy performance. This research is constrained to the UK context as a leading case, being one of a few developed countries to enact legislation that commits the government to delivering the scale of emission reductions required to almost entirely mitigate the nation's effects on climate change (UK Parliament, 2008). It also focuses specifically on evaluating commercial offices within the concepts developed, being a sector of the property market with particularly high value, heterogeneous, and complex systems. It is challenging to adequately understand such assets during contracting processes which potentially incurs significant transaction costs. The high capital values of these assets also mean the marginal costs of the research presented are relatively low.

Keywords: Asset pricing; building simulation; energy performance; finance; foresight.

Building retrofit and financial innovation – Decarbonising the UK domestic building stock

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Abstract

Since UK has committed to reducing its GHG emissions by 80% by 2050, its domestic building stock has emerged as a significant challenge to the country's carbon reduction efforts. While the biggest opportunity to decarbonise the UK housing sector lies undoubtedly within deep retrofitting, green technologies and long-term strategies, as yet only a limited number of funding opportunities have become available for these ambitious schemes. This PhD project argues that financing is potentially a key barrier to systemic domestic retrofit and aims to investigate the financial obstacles to domestic retrofitting schemes. In particular, it attempts to understand the impact of European energy efficiency policy on investment and financing decisions and to compare selected retrofit case studies on a national and regional level across several European countries. The research will be of a qualitative nature whereby a critical literature review will form the basis for semi-structured interviews with academic, industrial, financial and policy experts, supplemented by a range of other quantitative data. Academically, the project aims to make contributions to the transitions and transitions management theory as well as the co-evolutionary theory, while also providing policy makers with a clearer understanding of the funding landscape for deep domestic retrofitting projects. Ultimately, the project endeavours to provide a typology of innovative financial structures and an assessment of their applicability for scaling up deep retrofit of domestic properties in the UK.

Keywords: Deep retrofits, domestic building refurbishment, retrofit financing, energy efficiency policy, transition studies

Comparative Information Quality Assessment of Council Conservation Retrofit Guidance

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Abstract

This research hypothesizes that the lack of consistency in local Council guidance for energy efficient conservation retrofit contributes to planning being identified as a barrier to retrofit, and suggests possible further investigations and actions to address this. This paper develops an adapted Information Quality assessment method in order to interrogate local Council guidance for energy efficient conservation retrofit guidance. The method tests for areas of consistency and divergence between Councils, looking specifically at planning, building control, and energy efficiency information and guidance. Areas of consistency identified included: the level of authority and confidence of the information provided; the use of clear and understandable language; information on the planning application process; information on the building control application process; the integration of the use of the Planning Portal into local planning; and the use of Article 4 directions to restrict permitted development. Areas of divergence included: the location of energy efficiency information; the promotion of energy efficient retrofit; the measures suggested for energy efficiency improvements; and specific guidance on conservation retrofit. A consistent lack of connection between planning, building control and energy efficiency information was also identified.

Key Words: Conservation, E-Government, Energy Efficiency, Information System, Information Quality, Planning, Retrofit

Development of guidelines for improving production management of refurbishment projects

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Abstract

A literature review, focused on the management of refurbishment works, revealed that the research on this matter is scarce. Clearly, there is a gap in this research domain. According to the literature, construction organisations have predominantly used traditional methods for managing the production of refurbishment projects. The problem is that those tools and techniques are not often appropriate to cope with the complex characteristics inherent to construction projects, especially in the case of refurbishments. As a result, numerous types of wastes have been identified in refurbishment projects such as waiting time, disruptions in performing tasks on site, unnecessary transport, among others. Such problems are likely to lead to unsatisfactory project performance in terms of low productivity, project delays, cost overrun, besides tenant's annoyance. In this respect, lean construction is identified as an appropriate way to deal with the complexity and uncertainty inherent in refurbishment projects, given that this management philosophy fully integrates the conversion, flow, and value views. It is argued that production management of refurbishment projects needs an appropriate approach, specifically tailored and in line with lean tenets, to be able to cope with the complexity and uncertainty inherent to those projects, hence increasing the efficiency of the production system, e.g., lead time compression and disruption minimization. Therefore, this research aims to devise guidelines for improving production management of refurbishment projects.

Keywords: Refurbishment; lean construction; production management.

The Role of Property Professionals in Promoting Building Retrofits: Insights from Letting Agents across England

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Abstract

The United Kingdom (UK) is a world leader in efforts to mitigate climate change, prioritizing retrofitting of the existing building stock as a part of its national carbon dioxide (CO₂) emissions reduction strategy. Multiple government-initiated retrofitting programmes have been implemented focusing interventions and incentives on residential property owners, but to date uptake has not been optimal. This research investigates how to encourage private sector contributions to address climate change and create a more sustainable and resilient built environment. It has been noted that buildings in the private rented sector (PRS) are of particularly poor quality and that landlords in this sector are hard to reach. Property professionals, particularly Letting Agents, can contribute to building retrofit initiatives as they play a key role in advising landlords regarding appropriate refurbishments to be compliant with regulations and competitive in the marketplace. Engaging Letting Agencies to promote appropriate building retrofits can help extend the reach of retrofit initiatives, but it is critical to ensure that interventions and incentives are developed that address the needs of these Agencies. With the aim of identifying mechanisms and incentives to engage Letting Agencies focusing on the PRS in promoting energy-efficient building retrofits to their property-owner clients, this presentation describes the theoretical underpinnings and mixed method approach used in this research, offers preliminary findings from semi-structured interviews with 32 Letting Agents across England, and outlines follow-on research activities.

Key words: property professionals, letting agencies; private rented sector (PRS); social ecological theory; retrofitting

The use of Building Element Heat and Moisture Transport (BEHAM) Software in the UK Retrofit Sector: Laboratory Examination and Case Studies

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Abstract

Retrofitting wall insulation within existing houses is common practise within the UK housing sector in an effort to reduce their energy demand. Three main methods for achieving this are cavity fill insulation, internally fitted insulation and externally fitted insulation. External insulation has the advantage of being relatively quick to install but is disadvantaged by the loss of the buildings original architectural detail. Internal insulation is becoming more popular in architecturally significant buildings or terrace rows, but insulation takes up internal space. In a growing number of retrofits inhabitants have complained of condensation problems, damp patches on wall surfaces, interstitial condensation or high internal humidity have been measured. The development of building element heat and moisture (BEHAM) transport modelling software has led to professionals looking more closely at moisture transport phenomena, with a number of UK and Ireland practises now specialising in hygrothermal building performance. These software packages, although based on well-defined scientific principals and laboratory experimentation, lack site validation studies and practical examples from a UK climate. This study looks at three main BEHAM models (WUFI, HygIRC and CHAMP-BES) and compares their performance in the laboratory as well as from monitoring data from 6 internally insulated and one externally insulated home.

Vertical Greening Systems and Their Importance to Sustainability in the Urban Environment

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Abstract

VGS are simply plants on walls. They are known for their aesthetics and their natural ability to enhance thermal comfort, especially in warmer climate. Other uses includes, personal gardening (vertical farming) These systems potential of mitigating the urban heat island effect phenomenon has been proven in several researches. In this presentation, we will see how these VGS can be used in cities, the long term and short term benefits they offer as well as the drawbacks of using these systems. Finally, we would also discuss on the relevance of these systems to the present issue of sustainability and global warming.

Keywords: Vertical Greening Systems (VGS); Urban Heat Island (UHI); Sustainability

Evaluation of Regenerative Design as an Approach for Urban Design

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Abstract

Today Urban Design plays a key role in city development. Creating sustainable urban environments is a key objective of urban design. The applications of urban designs range from regional spatial entities to neighbourhood. A sustainable urban environment is just not a place where sustainable environmental protection methods and precautions are applied. A sustainable environment should be sustainable in terms of social economic and environmental. Therefore to create a sustainable environment a bottom up approach for urban design is required especially for the neighbourhood design. The key factor of a bottom up approach is community engagement. At the meantime regenerative design is a novel approach which is trying to achieve sustainable condition in development or trying to reach more than the current span of sustainability. The regenerative design concept highly encourages the bottom up approach and community engagement in development. Therefore in this research the researcher is trying to evaluate regenerative design as an approach for urban design and finally to develop a new approach for urban design to create sustainable urban environments especially considering about the neighbourhood design.

Keywords: Sustainable Urban Environments; Social Economic and Environmental; Bottom up Approach; Community Engagement; Regenerative Design; Neighbourhood Design