Institution: The Glasgow School of Art

Unit of Assessment: 34 Art and Design: History, Practice and Theory

Title of case study: Environmental assessment of domestic laundering

1. Summary of the impact (indicative maximum 100 words)

The impacts of this study by the Mackintosh Environmental Architecture Research Unit (MEARU) with two other research units arise from auditing and analysing domestic laundering (100 homes surveyed), and positing solutions to mitigating 'fuel poverty' (energy cost >10% disposable income) and improving health-linked aspects of indoor air quality – identifying direct and indirect energy usage attributable to laundering, and the detrimental environmental consequences of added humidity. Impacts since completion in 2012 relate to public engagement – meetings with a key regulatory body, dissemination events and a successful publicity campaign at regional, national and international level, marking the launch of a Design Guide.

2. Underpinning research (indicative maximum 500 words)

Porteous (PI) initiated a European solar demonstration project (SE-167/88-UK) 'Passive Solar Retrofit of Thermally Substandard Housing at Easthall, Glasgow' – final report to Directorate General for Energy (Porteous 1994); various papers co-authored by Dr Ming Ho (RA from 1994-97; e.g. Porteous and Ho, 1997). Due to a leading participatory role by the residents association, a particular aspect of the retrofit with future relevance for the impacts of Case Study 1 (EP/G00028X/1) was a glazed extension accommodating 'wet' utility functions and thermally buffering existing kitchens. Designed relative to ventilation exhaust systems, as in this demonstration, they also enhance indoor air quality (IAQ) while reducing energy consumption. A lowered rate of air change, due to the adjacency of higher temperatures of the air supply in the glazed buffer spaces, was an important output of SE-167/88-UK. Case Study 1's well-publicised design guide (www.homelaundrystudy.net) stresses the presence of high levels of moisture and airborne mould spores, with new insights related to indoor drying and associations with health risk. The 'public engagement' impact has heightened awareness of need regarding predominant absence of such utility spaces or alternative means of ensuring good IAQ, and a conveniently economic and healthy means of drying washing loads. The Easthall project also included solar air collectors, whose purpose was to preheat domestic hot water and both warm and replenish air in access stairwells. Subsequently, MEARU continued to explore methods of exploiting solar energy via air collectors and dynamically insulated walls, collaborating with the Building Research Establishment, Scottish Laboratory, monitoring performance in standard test cells used in several EU countries, and with published output via international conferences and in a book (Porteous with Macgregor, 2005). The underpinning relevance of such techniques to impacts from Case Study 1 is that they can comprise part of the solution to the exacerbation of excessive humidity and airborne mould spores by passive indoor drying (PID) – such techniques can help to heat and ventilate discrete drying spaces. By this time it was evident that although demand for space heating was diminishing with increasing energy efficiency, control of IAQ remained a problematic issue, and, despite low-energy lighting, electricity use was increasing. Porteous and Rosalie Menon (MEARU research team 2005-present; CI Case Study 1 2008-2012) then explored issues around achieving carbon-neutral housing, partly reliant on mechanical ventilation with heat recovery (MVHR) powered by building-integrated photovoltaic (BIPV) panels. (Porteous and Menon, 2008). Theoretical assumptions of power use in this study paved the way for a rigorous examination of the issue as one output from Case Study 1, emphasising the role of laundering appliances (Porteous et al, 2012). The analysis indicates that meeting CO_2 reduction targets will be hard, with impacts aimed at regulators and other decision makers. A parallel output underpins multiple hazards of PID relative to IAQ (Porteous et al, 2013); this in turn underpinned by an overview of IAQ that highlights the interactive nature of environmental stressors in housing and points to the need for innovative, holistic solutions on the part of all providers and enablers (Porteous, 2011).

3. References to the research (indicative maximum of six references)

Colin D A Porteous, *Passive Solar Retrofit of Thermally Sub-standard Housing at Easthall, Glasgow: Final Report – Results of the Monitoring Programme 1992-94*, May 1994, Evaluation Report to CEC Energy Directorate, E-1049, Brussels. Mackintosh School of Architecture, The Glasgow School of Art, Glasgow G3 6RQ, UK.

C D A Porteous and H M Ho, *Do sunspaces work in Scotland? Lessons learnt from a CEC solar energy demonstration project in Glasgow,* 1997, International Journal for Ambient Energy, Vol. 18, No. 1, January, ed. J. C. McVeigh, pp. 23-35, ISSN 0143-0750.

Colin Porteous with Kerr MacGregor, Ch 6 Machine Control, Harvesting hot air – integrated collectors, *Solar Architecture in Cool Climates*, 2005, Earthscan, London, UK, and Sterling, Virginia, USA, pp 183-192, ISBN 1-902916-62-X (266 pages).

C D A Porteous and R Menon, *Towards Carbon-Neutral Housing in Scotland – New-build and Retrofit,* 2008, Open House International, The Quest for Zero Carbon Housing Solutions, Vol. 33, No. 3, pp 70-87, ISSN 0168-2601.

C D A Porteous, T R Sharpe, R. Menon, D Shearer et al, *Energy and environmental appraisal of domestic laundering appliances,* 2012, Building Research & Information, November-December, Vol. 40, No 6, pp 679-699, ISSN 0961-3218.

C D A Porteous, T R Sharpe, R. Menon, D Shearer et al, *Domestic laundering – environmental audit in Glasgow with emphasis on passive indoor drying and air quality,* 2013, Indoor and Built Environment, DOI: 10.1177/1420326X13508146.

Colin D A Porteous, Ch 8 *Sensing a Historic Low-CO_2 Future*, 2011, in Chemistry, Emission Control, Radioactive Pollution and Indoor Air Quality, Ed. Nicolàs A Mazzeo, InTech, Rijeka, Croatia, ©2011, ISBN 978-953-307-3116-3, pp. 213-246 (free online, 2,000 hits by 13/12/12).

4. Details of the impact (indicative maximum 750 words)

'Public engagement' impacts (Table D2, REF01.2012, p91) for Case Study 1 (EP/G00028X/1) involved several target audiences. Similar to previous scientific outputs from underpinning projects, two journal papers from the study are aimed at relatively specialised readers – e.g. those in a position to influence change to statutory or voluntary standards and best practice. The output that has already reached a very wide audience, including those in a position to influence a change to norms for housing design, construction and infrastructural facilities, is 'Design Guide: Healthy Home Energy Laundering', available online at www.homelaundrystudy.net (Menon and Porteous, 2012). The evidence of the underpinning technical papers, itself an incremental progression from earlier work (Section 2), is vital to stimulating regulatory change. Having first presented its original insights to the Scottish Government's Building Standards Division (BSD), the Design Guide (published spring 2012) was formally launched in autumn 2012, and generated a large amount of media interest (TV, Radio and newspapers), regionally, nationally and internationally. Prior to this widespread media airing, oral dissemination had been by means of seminars, again with targeted audiences – i.e. those who would not necessarily be aware of the issues, but who could instigate meaningful change (e.g. personnel from BSD, which is incrementally increasing the standards set for energy efficiency; housing association managers). The first of these was held at the University of Strathclyde in late 2011 and the second at Glasgow's Lighthouse in early 2012. The latter, 'Build Tight, Ventilate Right: Air Quality in Housing' (02/02/12) benefited from the joint organisational involvement with MEARU of CIC Start Online, a project that linked the activities of a significant number of institutions in Scotland, including those collaborating on Case Study 1. It also attracted a vibrant audience – perhaps also tempted by the international line-up of speakers, which notably included Prof Jan Sundell from Sweden and Prof Hugo Hens from Belgium. The title of that event indirectly sums up the key awareness revelation arising out of the domestic laundering study – namely even for relatively old housing that has been upgraded to the point of being fairly tightly sealed, 'ventilating right' is a rarity. The prevalence of 'passive indoor drying' (PID) on airing devices brings two consequences for 'indoor air quality' (IAQ) issue: firstly maintaining or boosting heating when not otherwise required, and often together with open windows (also venting tumbler

dryers); secondly adding moisture to already over-moist air. The first directly compromises energy efficiency and hence impacts on 'fuel poverty', this linked to power use by appliances. The second leads to two health risks: firstly a moisture level that is likely to add to dust mite populations, with proven links to asthma; secondly, it has been analytically shown through analysis of air samples taken during the course of the study to be associated with both higher overall airborne mould spore concentrations and higher incidence of specific hydrophilic or tertiary mould species. The latter effect in particular again carries a health risk for the vulnerable atopic sector of the population. The juxtaposition of energy impacts with potentially serious health impacts has yet to be satisfactorily resolved for either existing housing stock, including upgrades, or new-build. Also, MEARU's parallel work in connection with operation of MVHR systems has shown that this is no simple panacea to 'sealing tight' while 'ventilating right' (confirmed by data presented by key speakers at the February 2012 seminar cited above), or to mitigating power use. Therefore, the nature, significance and reach of the public engagement as an impact, raising awareness of the issues and problems and changing laundering tactics, implies vital succeeding impacts. Relatively minor, but critical, changes to regulation and best practice are needed, and the prevailing culture affecting the many 'players' involved in the housing field (including landlords and developers in both public and private sectors as well as numerous consultants) also requires to take on board the research findings, and proactively assist the process of reformative change. Such change would involve acquiescing to recommendations for solutions as suggested in the Design Guide – e.g. dedicated indoor drying facilities linked to mechanical exhaust (recommended by DEFRA, UK Government), improved covered outdoor drying, individual and communal, and greater provision of full communal laundering provision. As a corollary, related public health research would shed further light on the findings, and it is envisaged that a future medically-led research team should include the issue of volatile organic compounds (VOCs – some from detergents and fabric softeners) together with further work in relation to mould spore concentrations and indoor drying.

5. Sources to corroborate the impact (indicative maximum of 10 references)

External sources to corroborate underpinning work relative to case study:

Directorate General for Energy, DG (Ener) [formerly DG 12], Rue J-A Dermot, B-1040 Brussels: relative to Final Report of Demonstration Project SE-167/88-UK, 1994, cited as underpinning work relative to impacts of case study.

Prof. Fionn Stevenson, Sheffield School of Architecture, e-mail: f.stevenson@sheffield.ac.uk re above demonstration project and chapter cited below.

Nicolas A Mazzeo, Editor for underpinning work 'Sensing a historic low-CO_2 Future', 2011, Intech, Janeza Trdine 9, 51000 Rijeka, Croatia; noting that the chapter had been accessed on line 2,000 times by December 2012, this regarded by the publisher as achieving "impressive readership results" with "significant impact".

Lynne Sullivan, Sustainable by Design, Unit 5, Carlson Court, 116 Putney Bridge Road, London SW15 2NQ: re 'Sensing a historic low-CO_2 Future', 2011.

Dr Colin Hunter, RICH, Glasgow Caledonian University, Cowcaddens Rd, Glasgow re analysis of airborne mould spores cited as underpinning work relative to Case Study.

Dr Paul Strachan, ESRU, University of Strathclyde, Montrose St, Glasgow, e-mail: paul@esru.strath.ac.uk and Dr Paul Baker, RICH, Glasgow Caledonian University, Cowcaddens Rd, Glasgow re advanced modeling in conjunction with laboratory findings, both relative to the underpinning publications of the case study.

Sources to corroborate impact relative to case study

Lesley Booth, New Century PR, e-mail Lesley.booth@newcenturypr.com re media impact of Design Guide Launch, autumn 2012.

Dr Branka Dimitrijevic, CIC Start Online, Innovation Review, Issue 10, February 2012, pp 14-15 re 02/02/12 'Build Tight, Ventilate Right: Air Quality in Housing' Seminar cited, with full list of participants available; and Issue 11, June 2012 re article about nature of research involved in case study, pp 58-67; noting wide circulation reach of this online magazine.
Dr Paul Strachan, ESRU, University of Strathclyde, Montrose St, Glasgow, e-mail: paul@esru.strath.ac.uk re 30/11/11 Seminar disseminating results of the case study.