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The Economic and Environmental Impact of Communal Laundry Spaces in High Density Housing in the UK

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Abstract: The paper supplements data obtained in the course of a collaborative, EPSRC-funded research project ('Environmental Assessment of Domestic Laundering' led by the Mackintosh School of Architecture with Glasgow Caledonian University and the University of Strathclyde). The aim of the paper is to compare energy and related impacts from individual domestic washing and drying appliances with those for communal laundry facilities. Having set the historical context, including a rather unsatisfactory status quo with respect to standards and regulation, the methodology and data-acquisition for analysis is outlined. This involved face-to-face questionnaires and spot measurements with 100 representative households in Glasgow's public sector (range of low-, medium- and high-rise) and longer-term measurements and diaries associated with 20 of these. Further questionnaire data from 36 housing providers with regard to communal facilities augmented extrapolations from short-term metrics in a specific shared laundry facility at the base of a 1960s tower block. Although further detailed work is suggested, the findings indicate distinct advantages for communal facilities of this nature, in particular with respect to the drying process. In this regard, not only are the energy loads much higher than those for washing, but also the negative consequences of various methods used in the home are potentially serious in terms of health and wellbeing. Concluding comments also recognize that a degree of flexibility and choice is desirable in terms of individual and shared approaches, and hence makes suggestions for a range of measures that might be incorporated in improved statutory and 'best practice' standards.

Keywords: Environmental Benefit, Energy efficiency, Communal laundry, Domestic Laundry

Introduction–Historical Overview and Aim

DURING THE MID 19th Century, fast growing populations with poor levels of sanitation caused epidemics of cholera to sweep through many towns and cities in the UK. Control of the disease depended on the development of a higher standard of living together with clean water supplies and improved sanitation. The Baths and Wash Houses Act of 1846 enabled local authorities to provide public baths and washhouses (Images 1 and 2) in the most deprived and densely populated areas for the many residents without hot running water in their homes. These new washhouses provided large volumes of hot water and steam and promoted health and hygiene through the provision of hot tubs for washing clothes, and large mangles and dryers. In Glasgow, the Corporation (as the city council was known) built many public baths, pools and washhouses which were well used up until the mid 20th Century. The post-WW2 housing boom together with increasing availability and improvement of individual domestic appliances was one reason for their demise, and commercial laundrettes another. However, some publicly provided shared

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laundries were located within high density social housing in the 1960s, and survive to this day.

Image 1-Traditional Municipal Wash House in Whiteinch, Glasgow, 1912

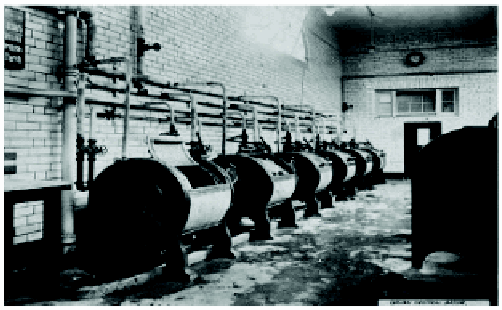

Image 2-Large format washing machine in Govan Public Baths and Wash House, Harhill Street, Govan, Glasgow, 1925

This paper seeks to evaluate the economic and environmental impact of an existing communal laundry in a typical 1960s tower block in Glasgow, with particular emphasis on drying, and comparing this data with that for individual domestic appliances. This is in order to assess whether a revival of communal practice could be achievable in the UK in an attempt to reduce domestic energy consumption, particularly the use of tumble dryers, and also to improve internal air quality within homes. The results of the energy analysis is discussed in the context of management, maintenance and other associated running costs of the laundry, which then opens up discussions for enhanced environmental strategies that could be adopted within a centralised facility such as this.

The opportunity for this appraisal occurred during the data-acquisition phase of a project by the Mackintosh Environmental Architecture Research Unit (see next section), some of the participating households being located on an estate with four such laundries.

Current Context, Scope and Outline Methodology

The trend towards individual, energy-intensive, domestic washing and drying appliances in dwellings is well documented, with a recent survey indicating that 90% of home owners now own a washing machine and 59% own a tumble dryer within their home (1). Drying of domestic laundry represents a significant amount of electricity use in the UK, reportedly accounting for 4.3% of the total domestic energy consumption (2) (see below under Discussion of Data for comparison with EPSRC-funded monitoring in Glasgow). Electrically-heated tumble dryers make up over 95% of the tumble dryer market with condenser dryers being the most popular options. The vented dryers are more energy efficient and more cost effective to purchase; but, given the requirement to be vented to the exterior, these give the purchaser less flexibility in their choice of location.

It has become customary for social housing providers to supply a condenser washer/dryer or to designate a 600 x 600 mm space with associated plumbing in the kitchen to allow the resident to install their own washer/dryer appliance. In the majority of new-build social housing situations there are no alternative drying spaces provided in the form of an airing cupboard, utility room or communal drying space (either externally or internally). There are currently weak statutory regulations in the Domestic Technical Handbook 2009 (DTH09) (3), which is identical to that of 2007 in terms of conformity with the Building (Scotland) Regulations 2004, and enforce provision of dedicated drying spaces in dwellings. DTH09, 3.11(b), section 3.11.6 requires 1 m^3 with no dimension less than 700 mm, minimum 1.7 m linear hanging, and refers to 3.14 for ventilation. This is not particularly onerous, but does go some way to reinstating the requirement in the Building Regulations from 1963-86.

The environmental performance rating system Ecohomes assessment (4), administered by the BRE (Building Research Establishment), acknowledges that drying clothes does have an environmental impact in terms of both air quality and energy consumption. As part of a points based scheme, section ENE 3 awards 3 credits for a 6 m clothesline either internal (in a ventilated space) or external. Internally this could take the form of a retractable clothesline over a bath (as allowed in 3.11.6 of DTH09). As an environmental advisory scheme, this falls short of providing a satisfactory solution to an issue which has been identified as critical to energy performance within homes. Moreover, the Ecohomes rating system is currently purely consultative and is not an obligatory part of the design process. The equivalent rating scheme in England is the Code for Sustainable Homes (CSH). Unlike the Scottish system, CSH is now mandatory, but has similar weak guidelines to tackling the issue of domestic laundering. Under Section ENE 4 of the Code (5), the issue of drying space is tackled by awarding credits based on the provision of adequate secure drying space. However, no further detail is provided and reference is made to recommendations of the Energy Savings Trust (EST). The EST states that a ventilated space for drying clothes should be provided within the house either as an unheated space with good ventilation, or a heated space with adequate, controlled ventilation. For a mandatory code, these guidelines could go further in specifying designated spaces for effective clothes drying that is energy-efficient and does not compromise internal humidity.

The need to ventilate drying spaces is critical to the indoor air quality within homes and, with increasing pressure for airtight homes (both in retrofit of existing buildings and in new building regulations) to meet energy conservation targets, there is the potential for poor air quality and an increase in moisture levels. This problem is exacerbated when residents choose indoor drying methods such as radiator racks or airers in order to reduce use of energy-intensive tumble dryers. Evidence is provided under Discussion of Data below.

Both the Ecohomes and CSH environmental performance schemes apply to new-build housing only. Whilst the issue can be resolved in new-build homes, the majority of social housing stock is in existence (the buildings that exist today in the UK will account for over 70 % of the UK's total building stock by the year 2050). Also, in many 1960s housing blocks, the landlords or residents have compromised designed ventilation systems. Consequent lack of ventilation leads to poor indoor air quality, which is further hampered by residents drying laundry in inadequately ventilated spaces – again evidenced below.

In order to meet the aim of this paper in comparing economic, environmental and energy impacts of communal with domestic laundering, especially drying, the methodology is effectively borrowed from that used in the process of fulfilling part of the EPSRC-funded project 'Environmental Assessment of Domestic Laundering' (6). An initial survey of 100 households by the Mackintosh Environmental Architecture Research Unit was undertaken during 2009. The survey sample was from a wide demographic mix of residents within Glasgow's social housing stock (various building typologies), including that with communal laundries (Wyndford estate owned by Cube Housing Association). This survey took the form of face-to-face interviews undertaken in the resident's home with a questionnaire detailing laundry habits, fuel bills, heating and ventilation regimes and included spot measurements of temperature, CO2 and humidity. Since the entire cohort volunteered, there was effectively a 100% response, but of course this only represented a very small proportion of the total population of all the schemes involved. During a further, more detailed monitoring phase, a selection of 20 residents (from the initial 100 surveyed, and again based on a variety of dwelling types, orientation and demographic mix) were asked to keep a diary of their laundry habits over a 2-week period. This second phase of monitoring was undertaken during the heating season (October to April). Durational temperature, CO2 and humidity readings were logged for the 2-week monitoring period in 5 rooms within the dwelling, and the electricity consumed by washing machines and tumble dryers was also measured.

A further survey of 50 social housing providers in the Glasgow area was undertaken to provide an insight into management attitudes towards communal laundry spaces within their housing stock. This survey took the form of a postal questionnaire and yielded a 72% response rate (i.e. 36 ex 50). In addition, specific data were gathered for the ground floor laundry facility of 1960s tower blocks in the Wyndford estate. Resident usage was documented over a 2-week monitoring period and supporting energy consumption data for each machine was taken from manufacturers' data for a typical wash or dry cycle. This yielded estimated energy consumption for washing and drying per unit mass of laundry for both individual and communal situations. Accepting the limitations of the respective values (i.e. measurements for small sample supported by manufacturers' power ratings), the analysis can only be said to be indicative at this stage.

Discussion of Data

Analysis of the data from the 100 households indicated that 72% residents dry clothes within the home without the use of a tumble dryer. However, this proportion is not representative of the 41% value UK population as a whole (1), and, in any case, the use of tumble dryers is known to be increasing. These other methods of drying included using clothes airers and pulleys, drying racks on or next to radiators (Image 3) and a very small percentage within an airing cupboard. Of the homes of residents who dry passively, and exclusively at home, 37% showed signs of mould within the rooms associated with drying (Image 4). Within the social housing stock in Glasgow there has been a history of dampness and condensation, particularly in high-rise housing, many of which have lead to residents experiencing health problems and respiratory illnesses such as asthma. Whilst this survey cannot confirm that the laundry drying was the sole cause of mould growth, it is reasonable to assume that the increased moisture levels are an associated or contributory factor. In support of this contention, fairly high moisture levels (relative humidity) were recorded in the rooms in which clothes drying took place, and this appears to be associated with the evidence of dampness and mould growth in some instances.

Image 3- Laundry drying in front of radiator in resident's home.

Image 4- Evidence of mould growth within room used for clothes drying in resident's home.

During the detailed monitoring survey phase, it was also noted that one fifth of those drying clothes on, or adjacent to, radiators turned up their heating in response to the wet clothes. This trend is concerning, especially in light of recent fuel poverty statistics indicating that many Scottish families are struggling to heat their home properly with almost 1 in 4 of households in fuel poverty (7). Fuel poverty is defined as 'the inability to afford adequate warmth in the home, usually defined as having to spend 10% or more of income to meet recognized heating standards' (8). These figures indicate that current practices of clothes drying within the home are making a significant impact on domestic fuel bills at a time when many efforts are being made to lift residents out of fuel poverty.

Of those 20 dwellings subject to 2-week durational monitoring, those who did use a washing machine (and tumble dryer if present) had the energy consumption of the appliance recorded via an electrical current monitor, which was logged remotely. An example of individual data recorded (Tables 2 and 3) is shown below for comparison with the Table 1 values for domestic appliances supported by manufacturers' power ratings:

Table 1: Energy Consumption of Typical Domestic Laundry Appliance (kWh)

Data ref. RES01	Full Load Capacity	Energy consumption per full load cycle - kWh (Manufacturers data)	Energy Consumption per full load cycle - kWh (monitored data)
Washing machine	6 kg	0.8 kWh (per 40^{o}C wash cycle)	0.9 kWh (per 40^{o}C wash cycle)
Tumble Dryer (condenser)	7 kg	4.8 kWh	5.1 kWh

Table 2: Energy Consumption for Washing Per Person Annually (from monitored data of 20 residents over 2 week period)

Average no of washes per week (average over 2 weeks)	Energy per wash	Number of people in house	Energy consumption per person per week	Energy consumption per person annually
5.5	0.9 kWh	2.1	2.36 kWh	122.72 kWh

Table 3: Energy Consumption for Drying Per Person Annually (from monitored data of 4 residents over 2 week period)

Average no of drying cycles per week (average over 2 weeks)	Energy per drying cycle	Number of people in house	Energy consumption per person per week	Energy consumption per person annually
5.2	5.1 kWh	2.3	11.53 kWh	599.56 kWh

Extrapolating linearly from the monitored data indicates that the total energy consumption per person for both washing and drying in the home is just over 722 kWh per year. Assuming a family home with 3 residents this then equates to 2,166 kWh annually. This is approximately 9% of a household's energy consumption based on an average given by National Statistics Office of 24,000 kWh (9). The annual cost (using an average unit price of electricity as 10p) for domestic laundry would then be in the order of £217. The figure for drying alone is 1799 kWh or 7.5% of average annual household energy consumption. It may be noted that this is significantly higher than the 4.3% figure quoted earlier (2), although, since it is based on a small sample, it should be treated with some caution.

As yet there are very few tumble dryers with a low energy rating. The EU energy label has helped to drive some improvements in energy efficiency in electrically-heated dryers. Currently the majority of tumble dryers are rated 'C' for energy efficiency, and so some incentive still exists for improving performance. Domestic tumble dryers in the UK are currently (2007) consuming an estimated 4.25 TWh electricity annually (2). In line with the increase in the number of homes and tumble dryer ownership expected by 2020, clothes dryer energy consumption is expected to increase to 4.53 TWh unless consumers start to use dryers that are more efficient or use more efficient means of drying.

Of course the individual process is convenient and it gives the resident flexibility – most appliances can be programmed to commence at certain times to suit occupancy patterns, and residents are not limited to opening hours as in the case of a communal laundry.

But apart from their intensive energy use, vented tumble dryers also risk misuse, with acute warm moisture peaks dispersing inside the dwelling. The condensing type with removable reservoirs may also evaporate their condensate into occupied spaces, if less suddenly, and alternative passive drying similarly adds humidity. Thus drying solutions outside the home are supported by an environmental incentive to reduce the domestic moisture load, in tandem with a careful ventilation regime. Indeed, the model of shared laundry spaces is used extensively in many countries, including Denmark (10), in both private and public housing sectors.

The further survey of 50 social housing providers in the Glasgow area should be viewed in light of these findings and current pressures to reduce fuel poverty. 60% of respondents confirmed that they have no communal laundry in any of their housing stock, instead preferring to provide residents with a washer-dryer appliance. Half of the 60% cohort has communal external drying facilities in the form of a single drying line in a backcourt drying area. However, during face-to-face surveys, residents noted general concerns regarding access and security of such facilities. Exterior drying spaces have also proved unsuccessful in Glasgow partly due to its climatic conditions and limited exposure to dry windy days. Indeed climate change predictions indicate that the West coast of Scotland shall see an increase in precipitation over the next 70 years (11). Already external humidity levels are increasingly higher in the summer drying months over the last 5 years in Scotland (12); and if this trend continues, opportunities for outdoor drying even in this period will be severely limited. Given Glasgow's current climate and increasing rain predictions, exterior drying is not a feasible solution unless it is adequately designed to prevent ingress of rain whilst maximising wind exposure and direct sunshine.

Disappointingly, 20% of the providers did not allow residents to dry clothes on their balconies, which provide a secure, easily accessible and covered method of drying (Image 5). This reluctance to allow drying on balconies historically relates to outdated tenancy agreements that prohibit the activity because it was considered unsightly and formed part of a set of rules that aimed to maintain the aesthetics of housing blocks. Of course, drying externally in this manner is a pragmatic, utilitarian practice, especially as it is a covered secure space easily accessible from the apartment. Moreover, high-rise blocks enjoy a good wind resource which can aid the drying process, and some are designed with covered rooftop drying areas (Image 6). But many of these are now virtually redundant, while covered, semi-outdoor shared drying spaces in low-rise blocks tend to be rather better used.

	
Image 5: Balcony drying space, 15 storey tower block, Wyndford Road, Maryhill, Glasgow	Image 6: Rooftop communal drying space- (now redundant), Curle St tower block, Scotstoun and Whiteinch Housing Association, Glasgow

Whilst the mixed tenure arrangement within many social housing projects today limits the introduction of communal facilities, it was noted that several housing associations operated very successful, well-used laundry facilities. Of those providers who responded to our survey, 20% confirmed they had a communal laundry facility, which either provided both washing and drying machines or a drying facility only. Many of these laundry spaces are located on the ground floor within high rise tower blocks, which were part of the original design and are still in operation today. Of those with laundry facilities, 75% of them charge residents for the facility within their rent payment. However none of the respondents were able to confirm the exact breakdown of the monthly charge to residents and many noted that, due to fixed rental agreements, there was no opportunity to add laundry costs to monthly bills.

Image 7- 1 of 3 rooms within communal laundry 15 Wyndford Road, Wyndford Estate, CUBE Housing Association, Glasgow.

Image 8- Residents drying room, Westercommon Road, Queens Cross Housing Association, Glasgow.

Unfortunately, no respondents were able to confirm the exact annual energy consumption of their laundry facility, given that the housing association does not meter either the machines or the laundry room separately. However, in the case of the 3-washer and 2-dryer laundry facility on the ground floor of a 15 storey tower in the Wyndford Estate, Glasgow (Image 7), an estimate of consumption can be derived; this by taking an average number of washes and drying cycles over a one week monitored period, and working from manufacturer's energy value per cycle. Extrapolating on this basis, it is estimated that the energy consumption within this communal laundry is 33,997kwh or circa £3,400 a year (using an average unit price of electricity as 10p), Table 4.

Table 4: Energy Consumption for Communal Laundry Facility (monitored for 1 week)

	Load Capacity	Energy consumption per cycle	Number of cycles per week	Total weekly energy consumption	Extrapolated annual energy consumption
Washing (hot feed)	7.5Kg	0.7kWh	84	58.8kWh	3,057kWh
Drying(vented)	16Kg	8.5 kWh	70	595kWh	30,940kWh
Total					**33,997kWh**

This laundry serves 56 dwellings in the block (all 2 bedroom flats) and is typical of the laundry provisions within the estate. The laundry is accessed via a resident's key and the management operate a rota system. The concierge manages the facility itself, and is responsible for locking-up at night, maintenance and associated cleaning regimes.

Approximately £2,000 a year is spent on the maintenance, cleaning, decoration and lighting, which, together with an estimated energy bill of £3,400, brings the running cost to £5,400 annually (although it should be noted that not all residents within the block choose to use the facility). Divided between 56 apartments the running cost is less than £100 per dwelling per year, which compared to £245 a year for a household to undertake laundry in the home is a significant reduction. However, the probability is that many people would choose to make use of both facilities, hence challenging such simple comparison. Despite this, the order of magnitude of the difference does support the case for communal facilities, especially taken together with the associated environmental benefits – reduced moisture and reduced heat demand in the home (the latter based on the survey evidence that heating is often stepped up to speed up drying).

The relative efficiencies of communal versus individual washing and drying become clear when reduced to kWh/kg: From Table 1, individual washing is 0.15 kWh/kg (0.9/6.0), 60% greater than the communal load of 0.09 kWh/kg from Table 4 (0.7/7.5); and individual drying is 0.73 kWh/kg (5.1/7.0), 38% more than the communal estimate of 0.53 kWh/kg (8.5/16.0). In the case of washing, it is probably the difference in hot water storage capacity, rather than appliance capacity, that results in the large difference. In the case of the drying process, it is likely that the large capacity machines (16kg load) consume considerably less energy proportionally than a domestic dryer. In addition, the designated laundry room allows the ventilation required for dryers to be the more efficient vented models. Social habit may also be significant in the energy comparison of communal and domestic laundering practises. Our research has also indicated that users of a communal laundry tend to save up laundry for a particular day of the week thereby avoiding the temptation to run an energy intensive reduced load in a domestic appliance. Previous research indicates that the average load in houses with one or two people is 2.75 kg, despite the predominance of larger capacity machines (13). It is also noteworthy that some housing associations provide drying facilities only (Image 8), which allows the main bulk of the moisture load and energy burden to be removed from the home.

Concluding Comments

Acknowledging the methodological constraints, this study nevertheless demonstrates that a communal laundry can provide a more energy efficient (60% for washing; 38% for drying) and cost effective solution (saving over £100 annually per household) compared to the domestic laundry process. In particular, drying clothes in a communal laundry as opposed to using a domestic tumble dryer could reduce annual energy bills substantially with associated CO2 reductions. One must also bear in mind that, although the individual to communal percentage energy saving is less for drying than washing, the predicted 'active' drying loads are some five to six times greater than those for washing per kilogram (0.73/0.15 = 4.9 individual; 0.53/0.09 = 5.9 communal); and the annual total prediction for drying is more than ten times that for washing (weekly kWh loads of 595/58.8 = 10.1). These findings suggest further work to verify communal consumption in practice over longer periods and less reliance on supporting data from manufacturers, in parallel with more substantial monitoring of corresponding domestic appliances.

The communal laundry facility itself could become more efficient in order to reduce the cost burden on a housing association or other provider, and a system to meter the power consumed in the laundry directly would allow a more accurate billing process. Energy savings through economies of scale could be made together with the introduction of more energy efficient large scale washers/dryers through the use of primary fuel (gas) dryers or heat pump tumble dryers. There is even the potential to recycle some of the energy of the hot vented air back into the housing block – for example, to heat communal spaces in order to further reduce the communal energy load of the building. If a strong case could be argued for energy reduction, the government may step in to subsidise installation costs of gas-heated tumble dryers or the creation of more communal laundries as part of their commitment to tacking fuel poverty and to meeting climate change obligations.

Whilst this paper focuses on the comparison between domestic tumble drying and that in shared laundry spaces, the research verifies that a significant number of residents dry clothes within the home without a drying appliance. Therefore, improved energy efficiency and cost savings are not the only benefits. The communal laundry provides a method of reducing the moisture load in dwellings when it displaces alternative passive drying means within homes; noting that the survey found evidence of associated increases in humidity. Lower humidity for a given rate of ventilation should in turn reduce incidence of mould and, potentially, numbers of dust mites, hence making homes healthier. Moreover, whilst running costs could be perceived to be high for the social housing provider, a communal laundry could reduce recurring housing costs for anti-fungal treatment and redecoration incurred by condensation and mould growth. Even the option of a covered, and potentially sunny, shared drying space, rather than a full laundry, could lower the impact of people drying clothes on or near heaters (as evidenced in the survey); and the consequent drop in energy demand should in turn help to lower rates of fuel poverty.

Although in theory communal laundries are an excellent facility and many residents indicated these are well used and effectively managed, there were also expressions of reluctance, perhaps indicating an unwillingness to interact with neighbours as well as the organisational issue. The use of shared drying spaces also raised concerns regarding the security of clothes. This indicates that a culture change is required if communal facilities are to be successful in the UK. This culture change includes a practice of saving clothes for wash day and allowing flexibility of timing to do laundry. These aspects have not been problematic in many countries in Europe, where communal laundries are mainstream practice. The shared laundry not only provides the functional washing facility but also offers an area for social interaction. Initiatives that aim to build communities consider innovative schemes to encourage social cohesion; but it is the small moves that historically have brought people back together, and previously the laundrette or wash-house ('the steamie' in Glasgow) was well known as a place for social interaction.

Broadly, whilst this paper concludes that communal laundries provide an attractive alternative to individual domestic washing and drying in terms of energy efficiency and environmental efficiency, the research suggests a parallel case for alternative passive solutions. These could occur both in the home and/or as secure shared facilities. Essentially the findings supported diversity and choice for residents, uptake varying with circumstances – including demography, work patterns and weather. In pursuit of such choices, and respective benefits as indicated above, this paper supports the case for a change to statutory building regulations and amendment to environmental assessment schemes such as CSH to tackle the domestic laundry issue – i.e. more rigorous design parameters with regard to communal laundries and shared drying spaces in large scale housing developments, as well as strengthening passive drying facilities inside homes.

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Ms Rosalie Menon BSc (hons), MArch, RIBA, ARIAS has been a lecturer of Architectural Technology at the Mackintosh School of Architecture in Glasgow since 2005. She is also a key member of the research unit MEARU (Mackintosh Environmental Architectural Research Unit). Before taking up her post at the Mackintosh School of Architecture, she was Design Studio tutor at Strathclyde University Architecture Department for 5 years and was a practising architect with the international multidisciplinary firm RMJM. The Mackintosh Environmental Architecture Research Unit has been in operation for over 12 years and has an established track record of high quality research into environmental architecture. The unit undertakes both research and consultancy, with corporate clients well as commercial and public organisations including housing associations and architects. Rosalie's research interests, which relate closely to her practice and teaching, include sustainable initiatives in residential developments; the use of indigenous building materials and techniques in contemporary construction and the integration of technical knowledge in the creative design process. She is currently an investigator in the EPSRC funded project to assess the environmental impact of domestic laundering in the UK context.

Prof. Colin Porteous
Prof. Colin Porteous inaugurated MEARU (Mackintosh Environmental Architecture Research Unit) in 1993, having spent some years in general architectural practice (1964-81), postgraduate studies (1981-84) and community practice (1984-86); thereafter commencing full-time research and teaching at the Mackintosh School of Architecture in 1986, and appointed Senior Lecturer in charge of Architectural Science, 1991 (PhD also 1991). He later took on the role of Senior Research Fellow, August 2003-06 (Part-time 2006-) and was appointed Professor of Architectural Science, February 2004. Ongoing internationally disseminated research is mainly in the field of solar energy, applied within architectural practice and includes two books - THE NEW eco-ARCHITECTURE, Alternatives from the modern movement, Spon Press, 2002; and Solar Architecture in Cool Climates, Earthscan, 2005. He remains active on the Board of ISES-Europe and on several international/scientific committees of solar/environmental conferences etc.

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Dr Haruna Musa studied at the Federal University of Technology, Yola-Nigeria graduated with B.Tech (Hons) in Urban and Regional Planning (Environmental Assessment) in 2001. He was awarded an overseas scholarship from the Petroleum Technology Development Fund (PTDF) Nigeria in 2003, to study MSc Instrumental Analytical Sciences (Environmental Analysis) at The Robert Gordon University. Thereafter he secured a PhD studentship from Glasgow Caledonian University, at the Centre for Research in Indoor Climate and Health (RICH) within the university. His research examined the metabolites production and potential health effects of mould growth associated with buildings. Haruna currently holds the post of senior research assistant at the Mackintsoh Environmental Research Architecture Unit, at Glasgow School of Art, involved with ESPRC funded project: Environmental assessment of domestic laundering. He belongs to the Institute of Environmental Assessment and Management (IEMA), Society for Applied Microbiology (SFAM), British Occupational Hygiene Society (BOHS)and remains active in the area of environmental assesment, indoor air qaulity and human comfort in enclosed buildings.

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