Scottish Housing Stock: Description and Examples of Flat, Terrace and Semi-Detached Dwelling Types, Technical Risks.

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1. Overview of Scottish Housing Stock

The breakdown of the Scottish Housing stock is shown in the following excerpts from the Scottish House Condition Survey [1]. Prior to 1982 there was no energy standard in building regulations, after 1982 there have been gradually improving energy standards to be met by new construction. Scotland's most common dwelling type is a flat, where 'tenement' refers to purpose built flats within a building greater than 2 storeys high. The breakdown of other flat types is given, with '4 in a block' the most common non-tenement flat configuration (2 storey flats in a block of 4). Terraced houses are the second most common type and semi-detached the third most common type requiring renovation if the recent boom in detached dwellings is excluded (due to higher energy performance standards for recent buildings). Most buildings (80%) are heated by gas, with electricity the next most common option (12%).

Table 1: Proportion of Occupied Dwellings by Age Band and Type, 2017 (Percentage of Whole Stock)

Age of dwelling	Type of Dwelling					
	Detached	Semi-detached	Terraced	Tenement	Other flats	Total
pre-1919	4%	3%	3%	7%	2%	**19%**
1919-1944	2%	3%	1%	2%	4%	**12%**
1945-1964	2%	6%	8%	4%	3%	**22%**
1965-1982	5%	4%	7%	3%	2%	**21%**
post-1982	10%	3%	3%	8%	2%	**26%**
Total	**22%**	**20%**	**22%**	**24%**	**13%**	**100%**
Sample size						*3,002*

Table 2: Number of Occupied Dwellings by Age Band and Type, 2017 (Thousands)

Age of dwelling	Type of Dwelling					
	Detached	Semi-detached	Terraced	Tenement	Other flats	Total
pre-1919	94	62	70	182	60	**467**
1919-1944	42	83	33	38	95	**291**
1945-1964	42	148	185	101	69	**544**
1965-1982	120	110	164	74	47	**515**
post-1982	256	79	83	189	39	**646**
Total	**554**	**481**	**534**	**584**	**311**	**2,464**
Sample size						*3,002*

19. The category 'other flats' includes houses that have been converted to flats (40,000), towers / slabs (64,000) and so-called "4-in-a-block" flats (207,000).

- "4-in-a-block" flats were commonly built as social housing between 1919 and 1965 (69% of all flats of this type fall in that age category).
- 85% of towers / slabs were built in the 1945 to 1982 period, again often as social housing.
- Converted flats are almost exclusively pre-1919 structures (92%), where a house has been divided into multiple residences.

Table 5: Primary Heating Fuel, Households (000s) and %, for All Stock and by Sector, 2017

	All Stock		Private		Social	
Primary Heating Fuel	**000s**	**%**	**000s**	**%**	**000s**	**%**
Mains gas	1,937	79%	1,449	79%	488	78%
Electricity	292	12%	195	11%	97	15%
Oil	143	6%	143	8%	*	*
Communal Heating	32	1%	3	0%	29	5%
LPG bulk or bottled	30	1%	25	1%	5	1%
Solid mineral fuel	16	1%	10	1%	6	1%
Biomass	13	1%	13	1%	0	0%
Sample size		*3,002*		*2,274*		*728*

* denotes cases where attributes appear too rarely to provide an adequate basis for reporting. See section 7.1.6 for table conventions.

2. Scottish Housing Descriptions

This section describes Scottish housing in some more detail.

2.1 Construction types: Cavity Wall Construction with Suspended Timber Floor

The most common construction type (74%) is brick or block cavity external wall construction where there are two wall layers separated by an air cavity. The cavity wall construction was designed to prevent moisture penetration by allowing moisture penetrating the outer leaf to drain to the outside. This construction type commonly has suspended timber floors above a ventilated sub-floor crawl space. Roofs are commonly timber framed with ventilated attics. Prior to the 1970s, the construction often included chimneys. Typically, the party wall between dwellings is single brick or block, windows were wood-framed, single glazed, and ventilation was 'natural' via infiltration and openable windows. Flat roofs became more common for flats from the 1960s but are less common than timber framed roofs.

2.2 Construction types: Solid Wall Construction

There are a number of solid (i.e. non-cavity) wall constructions (26%); these include: solid stone, stone and rubble, single brick or block, 'system built', or timber frame. System built refers to a range of systems based on variations of concrete technology sometimes with structural steel frames *etc*. Solid stone or stone and rubble solid wall construction is generally found in pre-1919 buildings.

The table below gives a breakdown of construction type and upgrades for the Scottish housing stock.

Table 13: Insulation by Wall Type and Tenure, 2017 and Insulation of all Wall Types by Tenure, 2016 and 2017[20]

Wall and Insulation Type	Private Sector			Social Sector			Total		
	000s	%type	%all	000s	%type	%all	000s	%type	%all
2017									
Cavity									
Un-insulated	334	26%	18%	123	23%	20%	457	25%	19%
- HTTC	116	9%	6%	50	9%	8%	165	9%	7%
- Standard	218	17%	12%	74	14%	12%	292	16%	12%
Insulated	953	74%	52%	411	77%	66%	1,363	75%	55%
- CWI	465	36%	25%	219	41%	35%	684	38%	28%
- Int/External	40	3%	2%	80	15%	13%	120	7%	5%
- As built	447	35%	24%	113	21%	18%	559	31%	23%
Total	1,286	100%	70%	534	100%	85%	1,821	100%	74%
Sample Size		*1,648*			*636*			*2,284*	
Solid/Other									
Un-insulated	478	87%	26%	51	56%	8%	529	82%	21%
- Pre-1919	394	71%	21%	28	31%	5%	422	66%	17%
- Post-1919	84	15%	5%	23	25%	4%	106	17%	4%
Insulated	74	13%	4%	41	44%	6%	115	18%	5%
- Retrofit	60	11%	3%	40	44%	6%	101	16%	4%
- As built	14	2%	1%	*	*	*	14	2%	1%
Total	552	100%	30%	92	100%	15%	643	100%	26%
Sample Size		*626*			*92*			*718*	
All Wall Types									
Un-insulated	811		44%	174		28%	986		40%
Insulated	1,026		56%	451		72%	1,478		60%
Total	1,838		100%	626		100%	2,464		100%
Sample Size			*2,274*			*728*			*3,002*
2016: All Wall Types									
Un-insulated	856		47%	180		29%	1,035		42%
Insulated	974		53%	443		71%	1,417		58%
Total	1,829		100%	622		100%	2,452		100%
Sample Size			*2,134*			*716*			*2,850*

2.3 U-values: As-built and with Upgrades

Some energy efficiency actions have implemented glazing and insulation upgrades, the latter directed at both cavity and solid wall cases. The proportion of properties with cavity walls that have been insulated is 75%, mostly by cavity infill. The proportion of properties with solid walls that have been insulated is 18%, by application of internal or external insulation systems. Few of the dwellings with cavity wall construction have had internal or external insulation applied.

Most properties have added double glazing and loft insulation. The tables below give the assumed thermal performance for the different wall construction types as built and with wall upgrades applied.

Age band	England & Wales	Scotland
A	before 1900	before 1919
B	1900-1929	1919-1929
C	1930-1949	1930-1949
D	1950-1966	1950-1964
E	1967-1975	1965-1975
F	1976-1982	1976-1983
G	1983-1990	1984-1991

Table S7 : Wall U-values – Scotland

Age band	A	B	C	D	E	F	G
Wall type							
Stone: granite or whinstone as built	a	a	a	a	1.7 b	1.0	0.60
Stone: sandstone or limestone as built	a	a	a	a	1.5 b	1.0	0.60
Solid brick as built	2.1	2.1	2.1	2.1	1.7	1.0	0.60
Stone/solid brick with 50 mm external or internal insulation	0.60	0.60	0.60	0.60	0.55	0.45*	0.35*
Stone/solid brick with 100 mm external or internal insulation	0.35	0.35	0.35	0.35	0.35	0.32*	0.24*
Stone/solid brick with 150 mm external or internal insulation	0.25	0.25	0.25	0.25	0.25	0.21*	0.18*
Stone/solid brick with 200 mm external or internal insulation	0.18	0.18	0.18	0.18	0.18	0.17*	0.15*
Cob as built	0.80	0.80	0.80	0.80	0.80	0.80	0.60
Cob with 50 mm external or internal insulation	0.40	0.40	0.40	0.40	0.40	0.40	0.35*
Cob with 100 mm external or internal insulation	0.26	0.26	0.26	0.26	0.26	0.26	0.24*
Cob with 150 mm external or internal insulation	0.20	0.20	0.20	0.20	0.20	0.20	0.18*
Cob with 200 mm external or internal insulation	0.16	0.16	0.16	0.16	0.16	0.16	0.15*
Cavity as built	2.1	1.6	1.6	1.6	1.6	1.0	0.60
Unfilled cavity with 50 mm external or internal insulation	0.60	0.53	0.53	0.53	0.53	0.45	0.35*
Unfilled cavity with 100 mm external or internal insulation	0.35	0.32	0.32	0.32	0.32	0.30	0.24*
Unfilled cavity with 150 mm external or internal insulation	0.25	0.23	0.23	0.23	0.23	0.21	0.18*
Unfilled cavity with 200 mm external or internal insulation	0.18	0.18	0.18	0.18	0.18	0.17*	0.15*
Filled cavity	0.50	0.50	0.50	0.50	0.50	0.40	0.35
Filled cavity with 50 mm external or internal insulation	0.31	0.31	0.31	0.31	0.31	0.27	0.25*
Filled cavity with 100 mm external or internal insulation	0.22	0.22	0.22	0.22	0.22	0.20	0.19*
Filled cavity with 150 mm external or internal insulation	0.17	0.17	0.17	0.17	0.17	0.16	0.15*
Filled cavity with 200 mm external or internal insulation	0.14	0.14	0.14	0.14	0.14	0.13	0.13*
Timber frame as built	2.5	1.9	1.9	1.0	0.80	0.45	0.40
Timber frame with internal insulation	0.60	0.55	0.55	0.40	0.40	0.40	0.40†
System build as built	2.0	2.0	2.0	2.0	1.7	1.0	0.60
System build with 50 mm external or internal insulation	0.60	0.60	0.60	0.60	0.55	0.45	0.35*
System build with 100 mm external or internal insulation	0.35	0.35	0.35	0.35	0.35	0.32*	0.24*
System build with 150 mm external or internal insulation	0.25	0.25	0.25	0.25	0.25	0.21*	0.18*
System build with 200 mm external or internal insulation	0.18	0.18	0.18	0.18	0.18	0.17*	0.15*

2.4 Examples of Scottish House Types

Flats, low rise

Flats, 4-in-a-block

Flats, tenement

Flats, high rise

Terrace

Semi – detached

3. Technical Risks

Upgrading of dwellings for energy efficiency in Scotland has in the past been associated with building performance failures related to health issues for occupants.

There exists a performance gap between intended performance and achieved performance in upgrades, with actual energy use typically being around twice the design intent.

It is critical that any future upgrade programme takes known risks into account and has robust process in place so that failures are avoided and intended performance is delivered.

A particular issue in the Scottish climate is moisture in buildings due to external factors such as high external rainfall and humidity, high water table, and wind driven rain; but also due to internal factors such as high occupant density, cooking, clothes drying and showering. The high moisture production per unit volume and prevailing outside conditions makes ventilation and thermal bridge mitigation particularly critical in order to keep humidity within a healthy range and avoid condensation and high humidity at locations where dust mites and mould can proliferate.

The cavity wall construction with ventilated sub-floors and attics and chimneys in the majority of dwellings provide particular issues with retrofit, including thermal bypass where air paths exist which can negate the effect of applied external insulation. Cavity walls between dwellings and continuous cavities across multiple dwellings may be problematic.

External insulation completeness, thermal bridging and thermal bypass (and also water leakage) between external insulation and original walls and at junctions between insulation elements and between insulation elements and ground have also been problematic.

4. References

https://www.gov.scot/publications/scottish-house-condition-survey-2017-key-findings/

https://www.bre.co.uk/filelibrary/SAP/2012/SAP-2012_9-92.pdf

https://www.google.com/maps

Retrofit for the Future final report. UK Gov.


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