Assessing Thermal Performance in Traditional and Heritage Buildings

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Build Test Solutions
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  - The problem/challenge/opportunity!
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  - Modern tools and techniques
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Defining a Traditional Building

What do we mean by a traditional building?

- Buildings of architectural, historic or cultural significance
  - See BS 7913 and PAS2035 Table E.2
- Not always just based on being listed or located within conservation areas
- Typically older buildings, constructed with natural materials such as stone, brick, timber and lime…but not always!
- Upgrades must be sympathetic and ideally reversible

"A building's significance is the value it has for today and future generations. This might be due to the dwelling's design, construction and craftsmanship, or its association with an historical event or person, or cultural practices"

PAS2035:2023, Annex E

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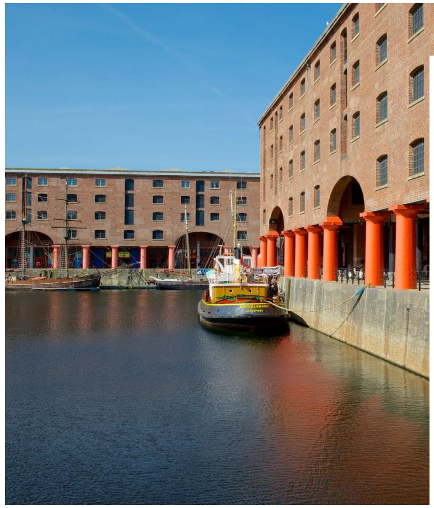

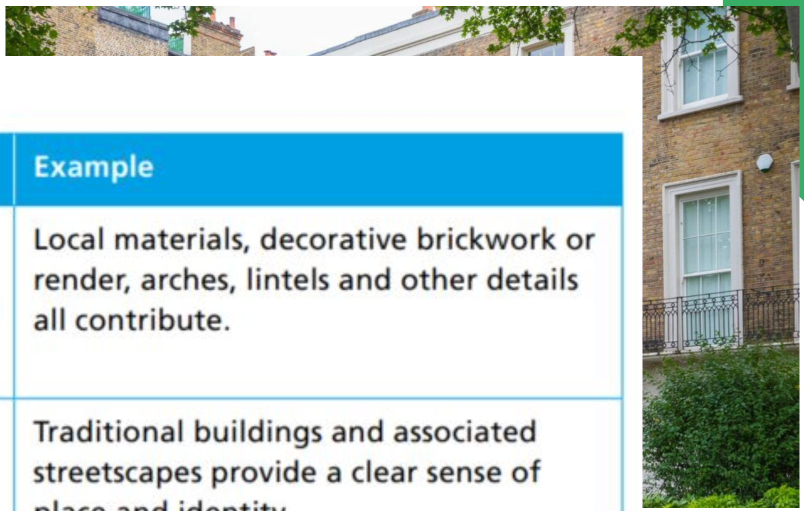

Table E.1 – *Key values of significance*

Values[A)]	Explanation	Example
Architectural and aesthetic	The quality of design, construction and craftsmanship of buildings and the character of their setting.	Local materials, decorative brickwork or render, arches, lintels and other details all contribute.
Communal	Many people value the appearance of older buildings.	Traditional buildings and associated streetscapes provide a clear sense of place and identity.
Evidential	Older buildings and their setting can inform us about how and why they were built, and how they were used.	Surviving original fabric provides valuable evidence.
Historical	Buildings may have associations with specific people or events or illustrate a past way of life.	The birthplace or residence of a historical figure, or an association with a particular industry.

[A)] Table E.1 draws on guidance from BS 7913 and is adapted for use in unprotected traditional buildings.

NOTE 2 Retrofit work can also provide an opportunity to reveal and enhance significance. For example, a new double-glazed timber sash window to the original pattern might replace a later replacement window that has diminished the significance of the dwelling.

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The Challenge/Opportunity

- By definition, traditional buildings are unique and require tailored solutions
- Limited documentation and unknown construction details
- Hard to model accurately with standard default performance parameters
- Balancing preservation and energy performance
- Moisture risk management is mission critical
- Over 30% of homes in the UK are older, traditional, heritage buildings - more than 7 million properties!

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Understanding Heritage Buildings

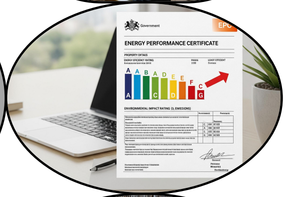
Modelling, Measurement & Monitoring

01

Survey (BaU)
Visual inspections & record keeping

02

Modelling (BaU)
EPCs - PHPP



03

Measurement (infrequent)
Onsite, in-situ

04

Monitoring (very infrequent!)
Ongoing management

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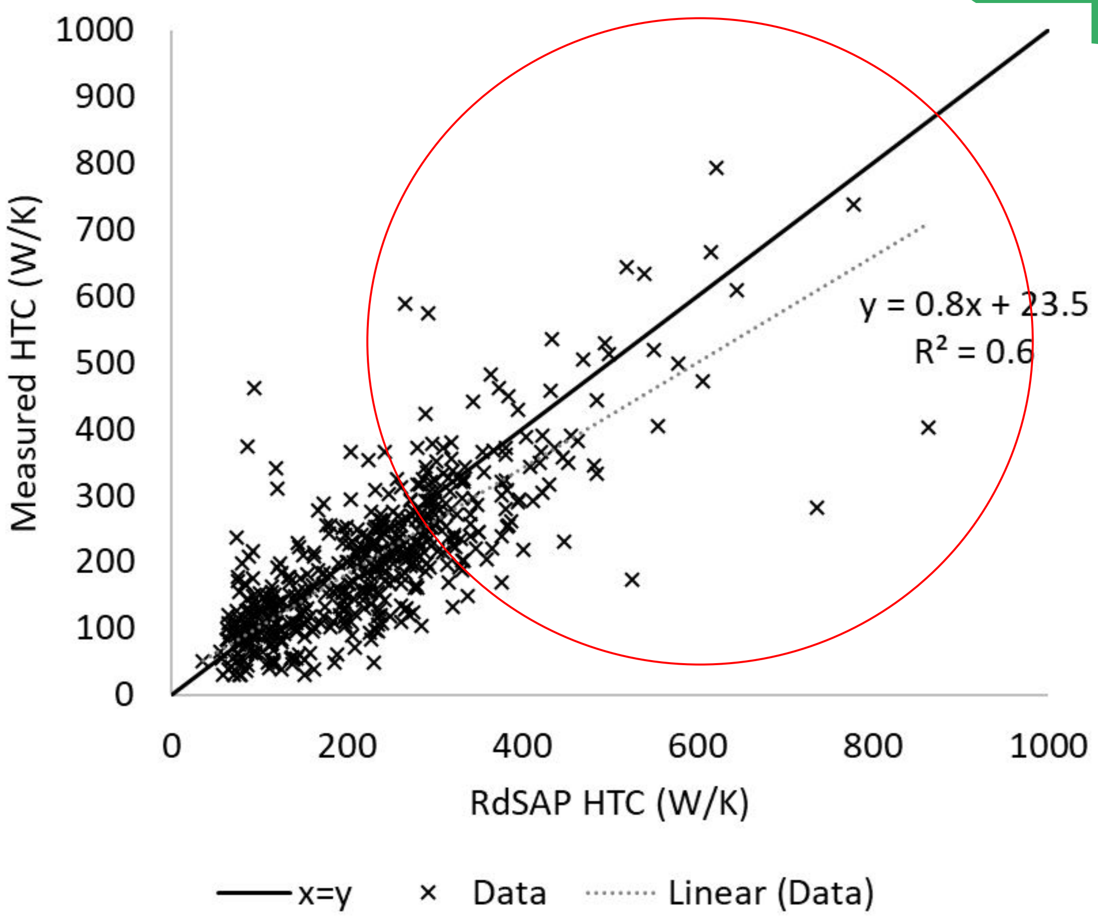
Why Measure?

*“The **performance gap** between the model of a traditional building and as-built reality **may be considerable, but it also could be the reverse of the performance gap that has been identified for new buildings** that do not achieve anything like their predicted design targets. **It would seem that, in practice, traditional buildings often perform much better than predicted owing to processes and interactions that are not well captured by models**”*

STBA Responsible Retrofit of Traditional Buildings, 2012



Energy Saving Trust and BTS on behalf of DESNZ, 587 dwellings

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Measurement-led insights: our toolkit

- To truly understand a traditional building, we must prioritise measurement over assumptions.

- BTS tools provide evidence-based insight into building performance:
    - SmartHTC & Mould Risk
    - Heat3D
    - Pulse and Leak Checker
    - Ventiflow / Flowfinder

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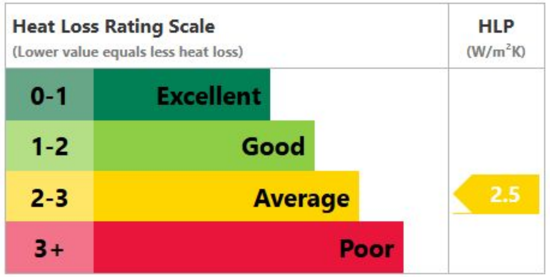
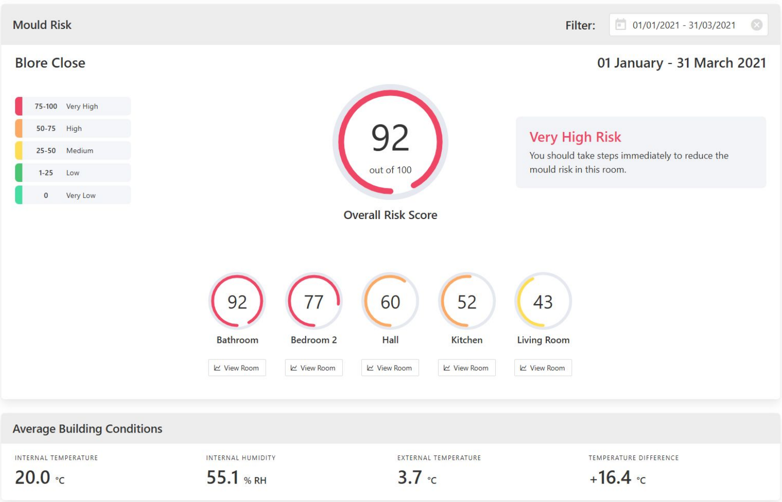
SmartHTC and Mould Risk Indicator

- Measures whole building heat loss rate and peak heat load
- Low cost pay per property. Independently tested and validated SMETER method.
- Mould risk indicator simultaneously predicts surface condensation potential
- Ideal for evaluating fabric upgrades and monitoring outcomes





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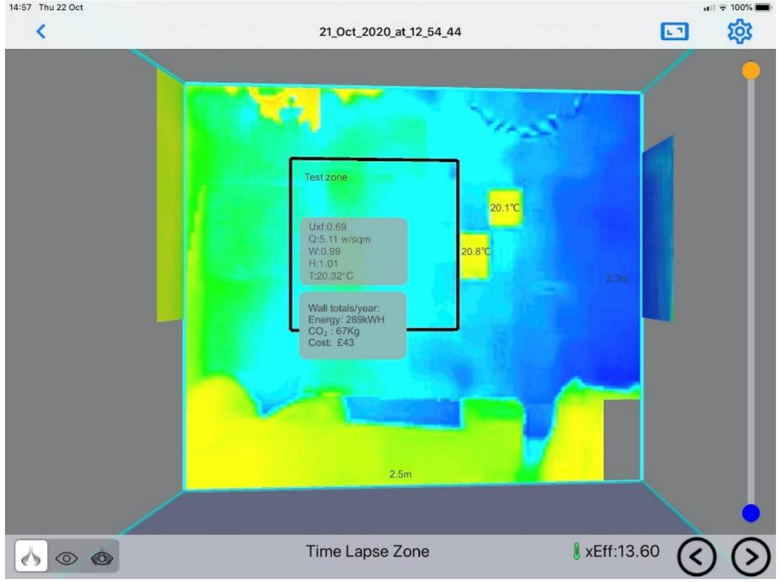
Heat3D In-situ U-values

Rapid U-value measurement solution

- Measure the thermal performance of entire wall elements
- U-value measurements within 1 hour
- Low cost hardware requirements (FLIR ONE Pro) and BTS supplied air targets and test controller
- Highly visual thermography based assessment. Reveals irregularities and hidden defects



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Wall U-values

NOTE 8 For traditionally constructed buildings, it might not be appropriate to accept the default U-values offered by RdSAP software; instead, it might be necessary to establish details of the construction in order to calculate or measure U-values.

Study	Element Type	Sample	Mean	StDev	CV	Lower Bound	Upper Bound	Pred Int %	RdSAP*
BRE 2016	Standard Solid Wall	50	1.74	0.18	10%	1.38	2.10	20%	1.7
Baker, 2011	Solid Wall, Non-Standard	46	1.27	0.47	37%	0.33	2.20	74%	1.67
Hulme & Doran, 2014	Solid Wall, Standard	85	1.57	0.32	20%	0.94	2.20	40%	2.1
Hulme & Doran, 2014	Solid Wall, Non-Standard	33	1.28	0.42	33%	0.44	2.12	65%	2.2
Hulme & Doran, 2014	Uninsulated cavity	50	1.38	0.3	22%	0.79	1.97	43%	1.5
Hulme & Doran, 2014	Insulated Cavity	109	0.67	0.23	34%	0.22	1.12	68%	0.7

Studies by BRE & Historic Scotland

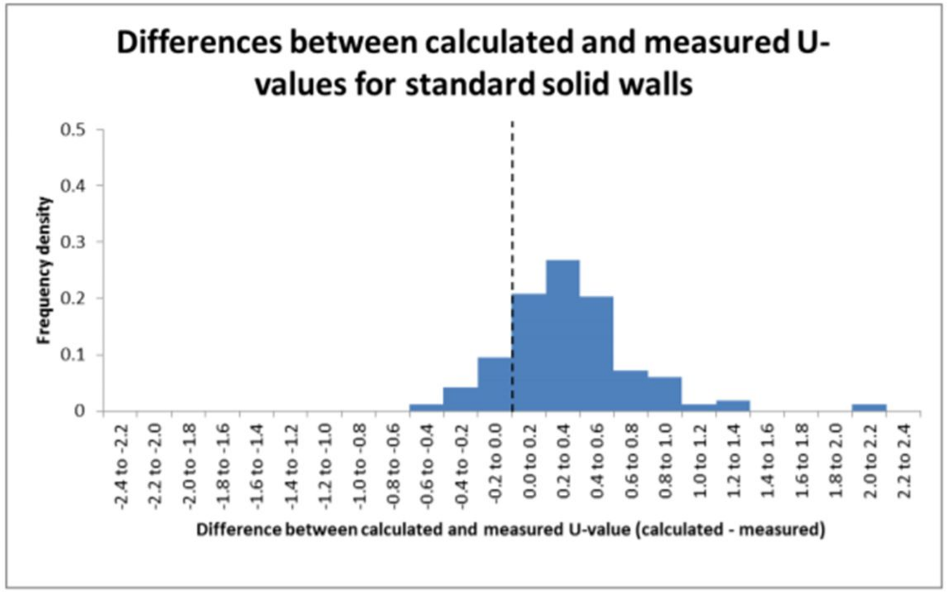

Figure from: BRE Report *In-situ measurements of wall U-values in English housing.* c.300 houses

Wall Type (study)	U-Value (W/m^2K)	EPC Rating	EPC Band	Annual Energy Cost
Solid (H&D)	0.94-2.2	68-62 (6)	D-D	£1,024-£1,230 (£229)
Sold, non-standard (B)	0.33-2.2	71-62 (9)	C-D	£898-£1,253 (£355)
Uninsulated cavity (H&D)	0.79-1.97	69-63 (6)	C-D	£994-£1,213 (£219)
Insulated cavity (H&D)	0.22-1.12	72-67 (5)	C-D	£874-£1,058 (£184)
H&D - Hulme & Doran, 2014; B - Baker, 2011				

Table showing the impact on EPC outputs given the uncertainty in the U-value input for various construction types, the difference between the upper and lower bounds is shown in brackets.

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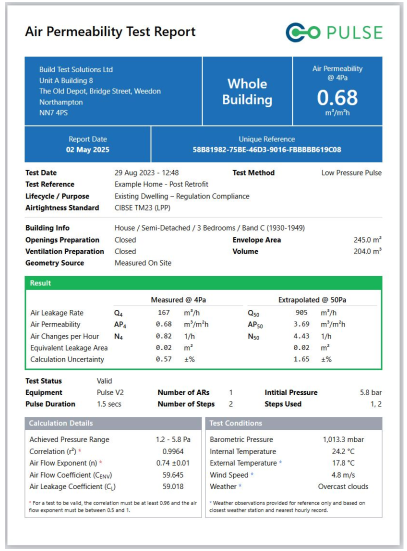
Pulse Air Leakage Testing

Air Leakage Measurement Device

- Low pressure rapid air leakage testing (4Pa)
- Measured air change rates that are representative of ambient occupied conditions
- Simple user operation
- Carry out low disruption tests in occupied homes
- Approved for new build and retrofit compliance testing in the UK

Example report:



Air Permeability Test Report — PULSE

Build Test Solutions Ltd Unit A Building 8 The Old Depot, Bridge Street, Weedon Northampton NN7 4PS	**Whole Building**	Air Permeability @ 4Pa **0.68** m^3/m^2h

Report Date	Unique Reference
02 May 2025	**58B81982-75BE-46D3-9016-FBBBBB619C08**

Test Date	29 Aug 2023 - 12:48	**Test Method**	Low Pressure Pulse
Test Reference	Example Home - Post Retrofit		
Lifecycle / Purpose	Existing Dwelling – Regulation Compliance		
Airtightness Standard	CIBSE TM23 (LPP)		
Building Info	House / Semi-Detached / 3 Bedrooms / Band C (1930-1949)		
Openings Preparation	Closed	**Envelope Area**	245.0 m^2
Ventilation Preparation	Closed	**Volume**	204.0 m^3
Geometry Source	Measured On Site		

Result

	Measured @ 4Pa			Extrapolated @ 50Pa		
Air Leakage Rate	Q_4	167	m^3/h	Q_{50}	905	m^3/h
Air Permeability	AP_4	0.68	m^3/m^2h	AP_{50}	3.69	m^3/m^2h
Air Changes per Hour	N_4	0.82	1/h	N_{50}	4.43	1/h
Equivalent Leakage Area		0.02	m^2		0.02	m^2
Calculation Uncertainty		0.57	±%		1.65	±%

Test Status	Valid				
Equipment	Pulse V2	**Number of ARs**	1	**Intitial Pressure**	5.8 bar
Pulse Duration	1.5 secs	**Number of Steps**	2	**Steps Used**	1, 2

Calculation Details	
Achieved Pressure Range	1.2 - 5.8 Pa
Correlation (r^2) *	0.9964
Air Flow Exponent (n) *	0.74 ±0.01
Air Flow Coefficient (C_{ENV})	59.645
Air Leakage Coefficient (C_L)	59.018

* For a test to be valid, the correlation must be at least 0.96 and the air flow exponent must be between 0.5 and 1.

Test Conditions	
Barometric Pressure	1,013.3 mbar
Internal Temperature	24.2 °C
External Temperature *	17.8 °C
Wind Speed *	4.8 m/s
Weather *	Overcast clouds

* Weather observations provided for reference only and based on closest weather station and nearest hourly record.

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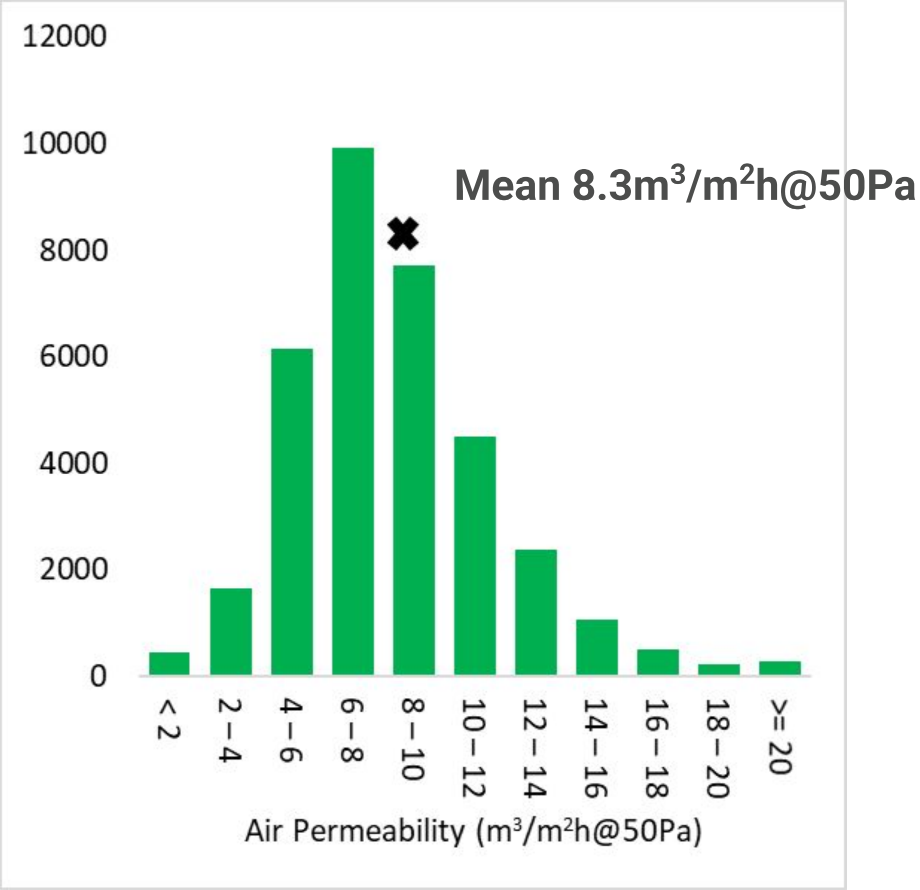
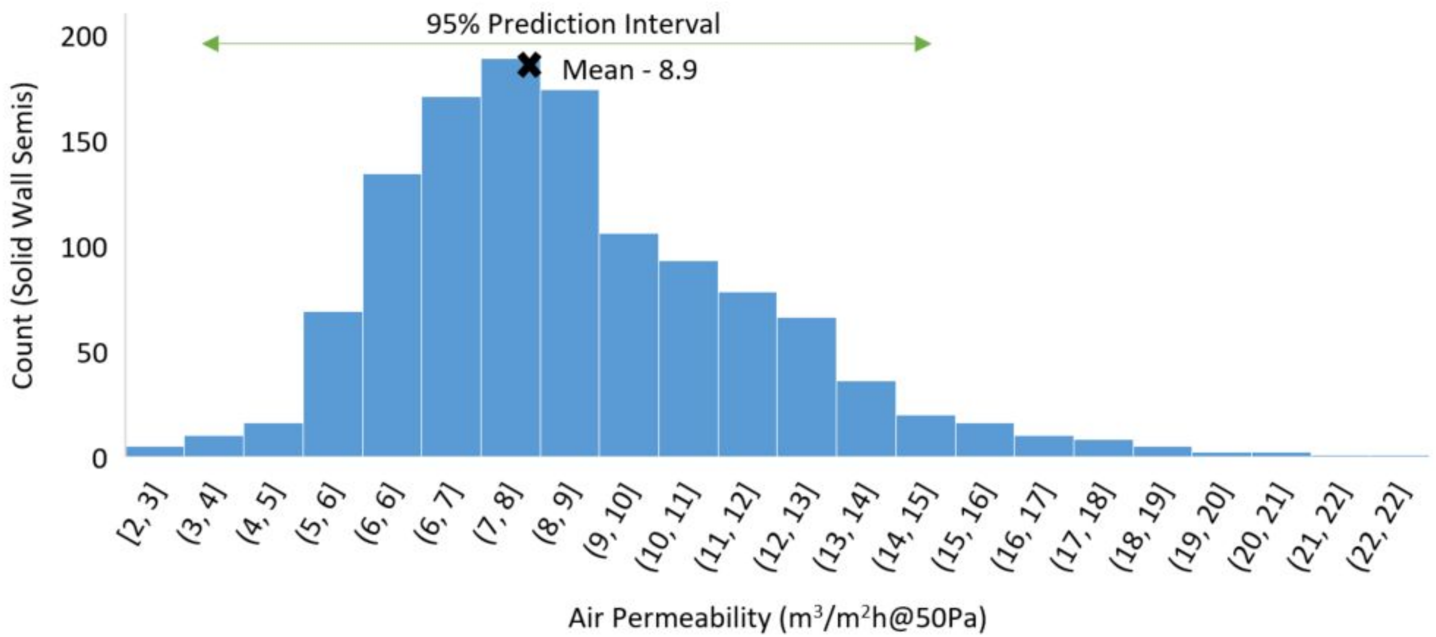
Unexpected Performance is Typical





Guess the Performance

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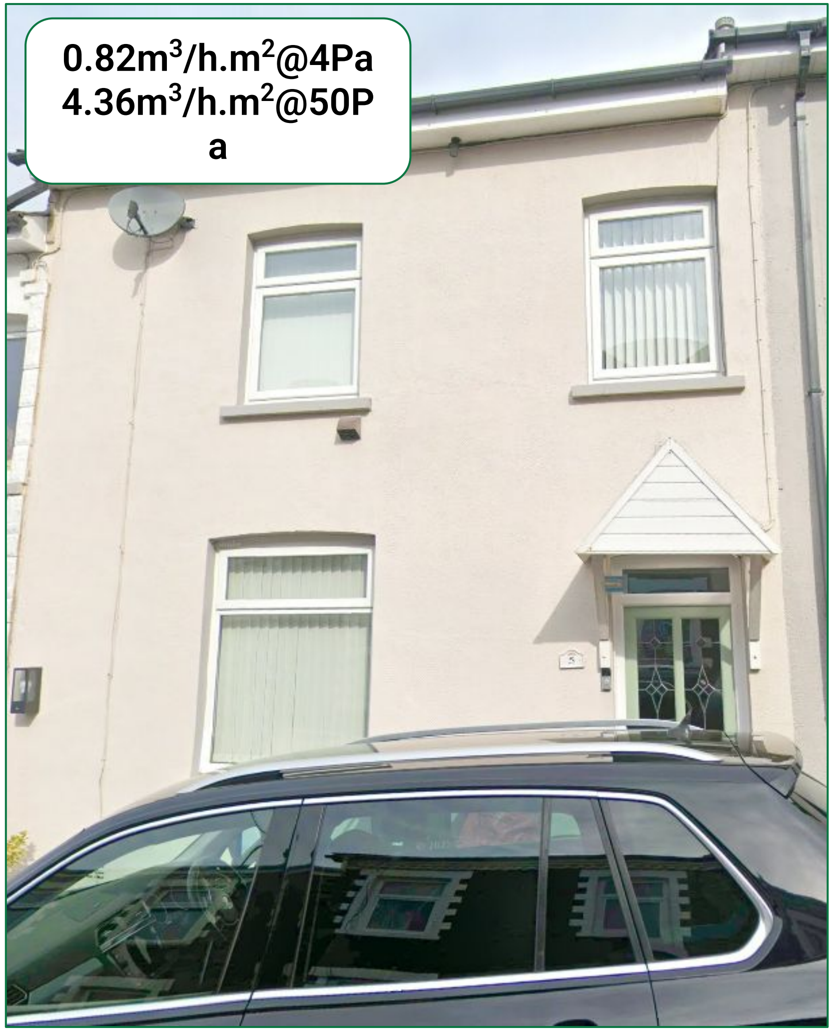
Guess the Performance



Guess the Performance

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Ventilation Flow Rate Measurement

- UK Supplier of ACIN VentiFlow and FlowFinder ventilation flow rate measurement equipment
- Accurately measure both supply and extract ventilation system air flows
- Supplied with UKAS certificate
- As required by Part F of the Building Regulations

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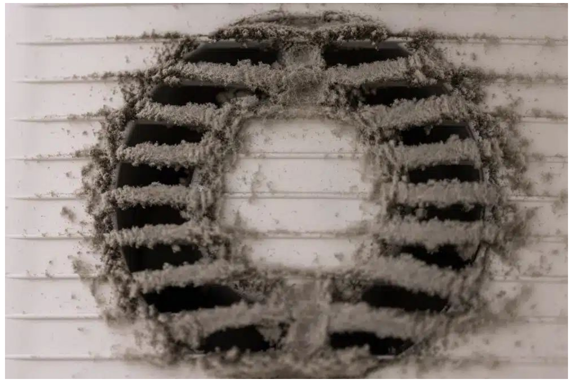
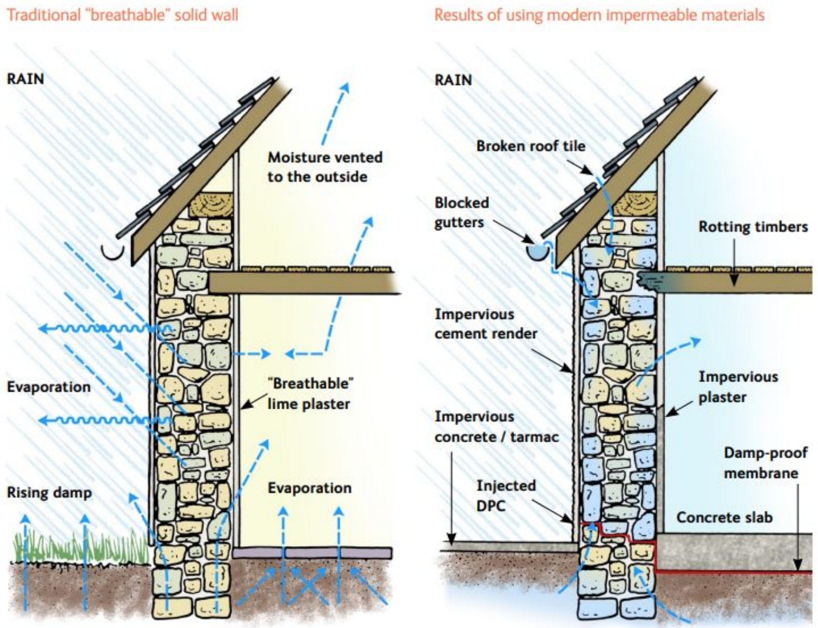
Airtightness and Ventilation

- Management of moisture risk is critical in all buildings but especially so in traditional buildings
- Sometimes a lack of ventilation is obvious
- More common however is to underestimate airtightness and misjudge ventilation needs
- Energy efficiency interventions can often tip the balance. **Build Tight, Ventilate Right!**
- ***Not to be confused with vapour permeability!***

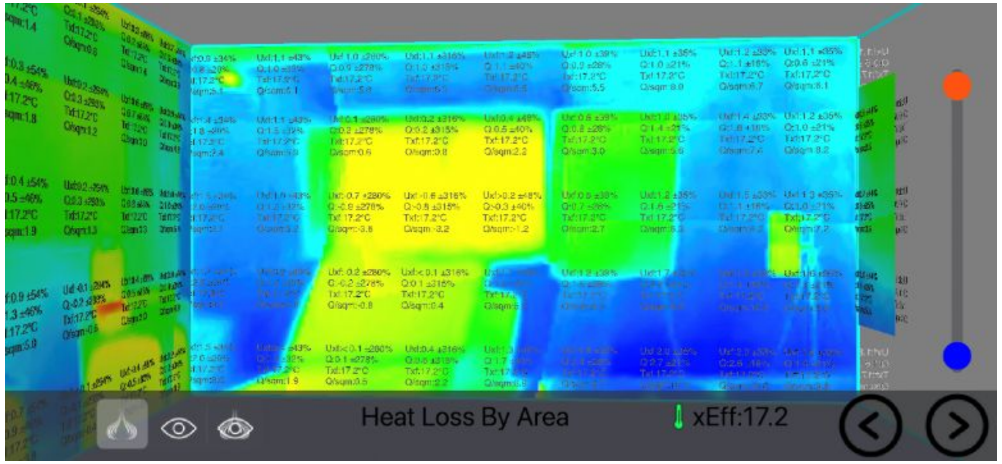




Case studies: Heritage in practice

Gressenhall Museum, Norfolk

- Walls typically present the largest overall heat loss surface area
- U-values can be hard to determine, particularly in older buildings
- Norfolk flint wall = 1.2 W/m^2K, half that of rdSAP assumed 2.4 W/m^2K
- Measure U-values and specify wall insulation upgrades accordingly



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The Deanery, Westminster Abbey

- Pulse and Ventiflow used to understand airtightness and ventilation - 10.46 m^3/m^2h @50Pa
- Low observed mould risk
- Lower than expected U-values of 0.91 W/m^2K and 0.75 W/m^2K
- Modelling calibrated to agree with the overall HTC, then used for detailed option appraisal




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Merseyside Maritime Museum, Albert Dock

- Non-invasive Heat3D testing gave surprising results that showed a large variation in how different parts of the buildings retained heat.
- Wall thickness from 450mm to 980mm
- rdSAP 10 assumes a U-value of $1.1 W/m^2K$
- Measured U-values ranges from $0.66 W/m^2K$ to $1.51 W/m^2K$, much lower than expected.
- Able to propose using much less insulation than modelling had suggested.

Feilden Clegg Bradley Studios

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University of Salford / National Trust

- 2023/2024 study across 9x solid wall pre-1919 homes
- 3x semi-detached, 6x detached. Floor area range of 72 to 245m^2
- Findings pointed to discrepancies of up to 47% for U-values, and 49% for airtightness. This leading to energy demand and running cost variances of up to 24%.
- Deviations from assumed values in rdSAP and SAP of ranging from 0.99W/m2K to 1.67W/m2K (12% to 47% better than assumed)
- Airtightness was more variable - 7 of the 9 properties outperforming the models, the overall range of difference extended from 51.7% better to 57.1% worse than assumed

National Trust

University of Salford MANCHESTER

"Together, these numbers help us to calculate whole-dwelling heat-loss figures. These also varied considerably when comparing in-situ measurements with assumed values, ranging from 12.1% to 46.7% better than assumed. This showed that the buildings in all cases lost less heat than had been modelled."

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Summary

How to Access The Tools Discussed

- 📋 Assessors: nationwide network, reduce visits and travel
- 🧰 Installers: some evidence their own work
- 🏠 In-house: Upskill your own team

BTS exist to help you specify, conduct or source measurements!

“Measure first, conserve better”

- Heritage buildings demand measurement before intervention
- Upgrade options and pathways are rarely what you might think
  - Prioritise the basics - address property condition and any defects
  - Airtightness and ventilation is the low hanging fruit
  - Fabric versus heating decarb, PV and storage
- Real data unlocks safe, effective retrofit strategies
- Build Test Solutions provides a host of tools for more confident, evidence based decision-making

Diary Dates

- **Next webinar:**
  Doctor, Doctor, Diagnose my Building!
  Combining multiple building performance measurements for maximum insight
  27th November 2025

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Thank you!

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