

Crest Nicholson Operations Ltd and Defence Infrastructure Organisation

Energy and Sustainability Statement

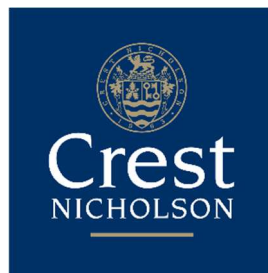
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This energy statement has been commissioned by Crest Nicholson Operations Ltd and Defence Infrastructure Organisation to detail the proposed retrofit approach to the conversion of the Grade II listed Moat House building into 4 residential apartments. It should be noted that the details presented, including the proposed specifications, are subject to change as the detailed design of the dwellings progresses, whilst ensuring that the overall commitments will be achieved.

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1. Introduction

- 1.1. Written by AES Sustainability Consultants on behalf of Crest Nicholson Operations Ltd and Defence Infrastructure Organisation, this Energy Statement has been prepared in support of the “Full Planning Permission and Listed Building Consent for the Change of Use of the Moat House from office (Use Class E) to residential (Use Class C3) to provide 4 residential dwellings and associated internal roads, parking, landscaping, drainage, plant, bin and cycle storage”.

Development Description

- 1.2. The development site is located approximately 4 miles west of Wokingham and 4.5 miles south east of Reading in the village of Arborfield, within the boundary of Wokingham Borough Council. The development detailed in this report is one phase of planning application O/2014/2280 for up to 2,000 new dwellings.
- 1.3. The Moat House conversion proposal situated in The Moat House Area would deliver 4 apartments comprising of 2 two bed apartments and 2 one bed apartments. The proposed site layout is shown in Figure 1.
- 1.4. The Moat House is a Grade II listed building, characterised by its historical and architectural significance. Constructed in 1906 it features a “loose Jacobean style, unusual for the military, that alludes to the style of the main house on the estate, by Robert Kerr”. The brickwork is of good quality, the storey band and cornice are crisply executed and the aedicular doorcase is a restrained but striking inclusion.
- 1.5. The building has undergone very little alteration, retaining most of its original fixtures and fittings.” The building, which is currently used as office space, is also of historic interest and significance. “Arborfield’s significance as one of a very limited number of remount depots is clear; it played a crucial role in mobilising the cavalry in WWI and the Moat House is one of its few surviving buildings. With the scheduled moated site, it overlooks and from which it takes its name, forming the focus of the historic site.”¹

Purpose and Scope of the Statement

- 1.6. This statement has been prepared to address relevant national and local policies relating to the sustainable design and construction of dwellings and will address relevant planning conditions contained within national and local policies relating to sustainable development, including policies within the Wokingham Borough Core Strategy.
- 1.7. This statement will detail the approach for ensuring compliance with Part L1 for the conversion, within the constraints a Grade II listed historic property, into four residential apartments using a balanced approach to improving energy efficiency with the preservation of the building’s heritage features, as mandated by its listed status.

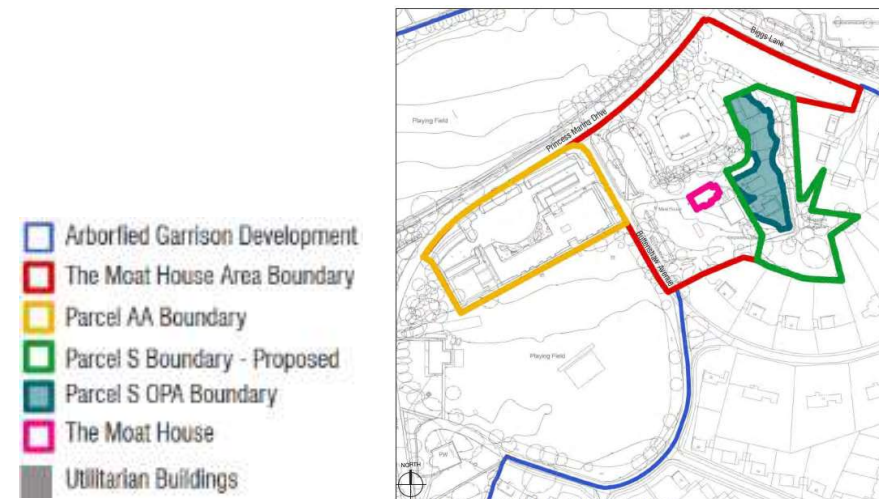


Figure 1: The Moat House, Arborfield Site Plan

A Grade II Listed Building in Arborfield Garrison, Wokingham britishlistedbuildings.co.uk/101419613

2. Planning Policy

Local Planning Policy

2.1. This Energy Statement addresses local planning policy relating to sustainable design and construction, principally contained within the Wokingham Borough Local Development Framework Core Strategy, adopted in January 2010 and the associated Design and Sustainability Supplementary Planning Document (SPD). For the conversion of a historic Grade II listed building, the relevant extracts from the Local Development Framework Core Strategy, particularly CP1, CP3 and TB24, provide guidance on sustainable development, general principles for development and considerations for heritage assets.

2.2. Core Strategy Policy CP1: Sustainable Development

CP1 aims to ensure that development contributes to sustainable development by:

1. Meeting the needs of the community: The development should provide for a mix of housing types, tenures and sizes to meet the identified needs of the community, ensuring an inclusive approach.
2. Efficient Use of Resources: The development should make efficient use of resources, including land, water and energy and minimize waste and pollution. This includes:
 - Incorporating energy-efficient design and construction techniques.
 - Using renewable energy sources where feasible.
 - Ensuring water efficiency and sustainable drainage systems.
3. Protecting and Enhancing the Environment: Development should protect and enhance the natural, built and historic environment. This includes:
 - Retaining and enhancing important landscapes, wildlife habitats and natural features.
 - Conserving and enhancing heritage assets and their settings.
 - Mitigating and adapting to climate change.

2.3. Core Strategy Policy CP3: General Principles for Development

CP3 outlines the general principles that all development should adhere to:

1. High-Quality Design: The development should achieve high-quality design that respects and enhances the character and appearance of the area. This includes:
 - Ensuring new buildings and spaces are well-designed and respect the scale, form and materials of surrounding buildings.
 - Retaining and integrating existing landscape features, including trees and hedgerows.
2. Accessibility and Transport: Development should be located and designed to be accessible by various modes of transport, promoting sustainable transport choices.
3. Impact on Amenity: Development should not result in significant adverse impacts on the amenities of existing or future occupants of adjacent properties. This includes considerations of privacy, overshadowing and noise.
4. Provision of Infrastructure: Development should provide or contribute to the necessary infrastructure to support it, ensuring that it does not place undue strain on existing services and facilities.

2.4. Managing Development Delivery (MDD) Local Plan Policy TB24: Heritage Assets

TB24 provides specific guidance on developments affecting heritage assets:

1. Conservation and Enhancement: Development proposals should conserve and enhance the significance of heritage assets and their settings. This includes:
 - Using materials and methods that are appropriate to the age, style and character of the building.
 - Ensuring any alterations or extensions are sympathetic to the building's architectural and historic interest.
2. Sustainable Use: Encouraging the sustainable use and re-use of heritage assets, where appropriate, to ensure their long-term conservation.
3. Assessment of Impact: Proposals affecting heritage assets should be accompanied by an assessment of the asset's significance and the impact of the proposed development on that significance. This might include:
 - Heritage Impact Assessments.
 - Statements of Significance.
 - Conservation Management Plans.
4. Mitigation of Harm: Where development would cause harm to the significance of a heritage asset, this harm must be clearly justified and substantial public benefits that outweigh the harm must be demonstrated. Measures to mitigate harm should also be included.

Application to the Moat House Conversion Project

- 2.5. For the conversion of the Grade II listed building into residential apartments, the following considerations should be made based on the relevant policies:
- 2.6. **Sustainable Development (CP1):** The conversion should aim to meet local housing needs while incorporating energy-efficient measures and protecting the historic fabric of the building.
- 2.7. **High-Quality Design (CP3):** Any alterations should respect the building's original character, using appropriate materials and design approaches that enhance its historic value.
- 2.8. **Heritage Considerations (TB24):** A detailed assessment of the building's significance and the impact of the conversion should be conducted. Proposals should demonstrate how the development will conserve and enhance the building's historic features and any harm should be justified with public benefits.
- 2.9. By adhering to these policies, the conversion project can achieve a balance between preserving the heritage significance of the Grade II listed building and providing modern, sustainable residential accommodation.

Proposed Strategy

- 2.10. This statement is intended to establish the proposed approach to sustainable construction/refurbishment and energy demand reduction to be delivered at the development.
- 2.11. It is proposed that the dwellings will be renovated following a fabric first approach to meet and exceed where possible, the current Building Regulations, with insulation standards, minimising thermal bridging and undesigned air leakage and where possible improved beyond the minimum compliance levels.
- 2.12. The following sections of this statement set out the sustainable design considerations which will be applied to the dwellings in order to deliver low energy, comfortable and affordable dwellings.

3. Energy Consumption and CO₂ Emissions

- 3.1. As one of the key areas of ongoing impact of any development, the energy demand of the dwellings to be constructed is a key consideration in the overall sustainability strategy.
- 3.2. Part L of the Building Regulations in the UK focuses on the conservation of fuel and power, setting standards for energy performance in buildings to reduce energy demand and carbon emissions.
- 3.3. When applied to the change of use of an existing building, Part L ensures energy efficiency and sustainability through several technical mechanisms.
- 3.4. Part L in relation to existing buildings and the change of use thereof, stipulates specific U-values (a measure of heat transfer) that building elements must achieve. As shown in Figure 2, there are backstops for existing fabric and upgraded elements. Any elements of new construction needed as part of the scheme will need to adhere to fabric U-value backstops in Part L similar to those found in new constructed dwellings.
- 3.5. Part L recommends the upgrading or installing of new energy-efficient building services and controls and ensuring that heating systems are efficient and appropriately sized for the building's needs.
- 3.6. Installing energy-efficient lighting systems, such as LED lighting and considering controls like occupancy sensors and daylight sensors should be considered.
- 3.7. Implementing efficient ventilation strategies, considering systems with heat recovery where applicable and ensuring cooling systems are energy efficient.
- 3.8. Finally, integration of renewable energy sources and low carbon technologies, such as solar panels to generate electricity or considering air-source or ground-source heat pumps for heating and hot water.

Element	U-value ⁽¹⁾ W/(m ² ·K)	
	(a) Threshold	(b) Improved
Roof ⁽²⁾⁽³⁾	0.35	0.36
Wall – cavity insulation ⁽²⁾⁽⁴⁾	0.70	0.55
Wall – internal or external insulation ⁽²⁾⁽⁵⁾	0.70	0.30
Floor ⁽²⁾⁽⁶⁾	0.70	0.25

NOTES:

1. Area-weighted average values.
2. For dormer windows, 'roof' includes the roof parts of the windows and 'wall' includes the wall parts (cheeks).
3. If meeting such a standard would limit head room, a lesser standard may be appropriate. In such cases, both of the following should be achieved.
 - a. The depth of the insulation plus any required air gap should be at least to the depth of the rafters.
 - b. The insulant should be chosen to achieve the lowest practicable U-value.
4. If there are problems with the load-bearing capacity of the frame or height of the upstand, for a flat roof or roof with integral insulation, a lesser standard may be appropriate.
5. This applies only to a wall that is suitable for cavity insulation. Where this is not the case, it should be treated as 'wall – internal or external insulation'.
6. If meeting such a standard would reduce the internal floor area of the room bounded by the wall by more than 5%, a lesser standard may be appropriate.
7. The U-value of the floor of an extension may be calculated using the exposed perimeter and floor area of the whole enlarged dwelling.
8. If meeting such a standard would create significant problems in relation to adjoining floor levels, a lesser standard may be appropriate.

Figure 2: Limiting U-values for existing elements in existing dwellings as set out in Part L2021

Energy Reduction Strategy – Fabric First

- 3.9. The proposed upgrade specification and sustainable design principles to be applied to the development will ensure that each dwelling meets, where possible, backstop U-values mandated by Part L1 of the Building Regulations.
- 3.10. In committing to this, it is proposed that the energy demand reduction strategy for the development also concentrates finance and efforts on reducing energy demand as the first stage of the Energy Hierarchy.
- 3.11. Where a listed building is concerned, available options are often restricted as the following considerations will rule out potential improvement options:
- Options which would not preserve the features and character protected by the listing,
 - Measures that could be detrimental to the preservation of the building fabric,
 - Upgrades which are not expected to provide a realistic financial payback (through cheaper fuel bills),
 - Impractical design solutions,
 - Where improvements would impact useable floor space, create uneven floors, or restrict head room



Figure 3: The Energy Hierarchy

Be Lean – reduce energy demand

- 3.12. The design of a development - from the masterplan to individual building design - will assist in reducing energy demand in a variety of ways, with a focus on minimising heating, cooling and lighting loads. Key considerations include:
- Building orientation – maximise passive solar gain and daylight
 - Building placement – control overshading and wind sheltering
 - Landscaping – control daylight, glare and mitigate heat island effects
 - Building design – minimise energy demand through fabric specification

Building design – minimise energy demand through fabric specification

Be Clean – supply energy efficiently

- 3.13. The design and specification of building services to utilise energy efficiently is the next stage of the hierarchy, taking into account:
- High efficiency heating and cooling systems
 - Ventilation systems (with heat recovery where applicable)
 - Low energy lighting
 - High efficiency appliances and ancillary equipment

Be Green – use low carbon/renewable energy

- 3.14. Low carbon and renewable energy systems form the final stage of the energy hierarchy and can be used to directly supply energy to buildings, or offset energy carbon emissions arising from unavoidable demand. This may be in the form of:
- Low carbon fuel sources – e.g., biomass
 - Heat pump technologies
 - Building scale renewable energy systems
 - Small-scale heat networks
 - Development-scale heat networks

- 3.15. As this hierarchy demonstrates, designing out energy use is weighted more highly than the generation of low-carbon or renewable energy to offset unnecessary demand. Applied to the development, this approach is referred to as 'fabric first' and concentrates finance and efforts on improving U-values, reducing thermal bridging, improving airtightness and installing energy efficient ventilation and heating services.
- 3.16. This approach has been widely supported by industry and government for some time, particularly in the residential sector, with the Zero Carbon Hub¹ and the Energy Savings Trust² having both stressed the importance of prioritising energy demand as a key factor in delivering resilient, low energy buildings.
- 3.17. The benefits to prospective homeowners of following the Fabric First approach are summarised in Table 1.

Table 1: Benefits of the Fabric First Approach

	Fabric energy efficiency measures	Bolt-on renewable energy technologies
Energy/CO ₂ /fuel bill savings applied to all dwellings	✓	✗
Savings built-in for life of dwelling	✓	✗
Highly cost-effective	✓	✗
Increases thermal comfort	✓	✗
Potential to promote energy conservation	✓	✓
Minimal ongoing maintenance / replacement costs	✓	✗
Significant disruption to retrofit post occupation	✓	✗

¹ Zero Carbon Hub, Zero Carbon Strategies for tomorrow's new homes, Feb 2013

² Energy Savings Trust, Fabric first: Focus on fabric and services improvements to increase energy performance in new homes, 2010

Proposed Fabric Specification

- 3.18. In order to reduce the energy demand of the development, the conversion and retrofit of dwellings should be designed to minimise heat loss through the fabric wherever possible. Table 2 details the proposed fabric specification of the major building elements, with the first column in this table giving the current baseline performance and the second setting out the Part L1 limiting fabric parameters for existing building elements.
- 3.19. If the existing U-value (calculated where possible, taken from Appendix S where assumed) does not meet the backstop, column three sets out the target for the improvement. Column four is the proposed specification after considering targets against listed building restrictions, on site constraints and exceptions permissible as detailed in the Notes for Table 2.

Table 2: Proposed construction specification - main elements

	Existing	Part L1 Limiting Existing Fabric Parameters	Part L1 Limiting Improved Fabric Parameters	Proposed Specification
External wall + Corridor ^{2,5}	1.30 W/m ² K	0.70 W/m ² K	0.30 W/m ² K	To be improved where viable
Party wall	-	0.20 W/m ² K	-	0.00 W/m ² K
Dormer Cheek ^{2,5}	2.50 W/m ² K	0.70 W/m ² K	0.30 W/m ² K	To be improved where viable
Roof insulation at joist ^{2,3,4}	2.30 W/m ² K	0.35 W/m ² K	0.16 W/m ² K	0.11 W/m ² K
Roof insulation at rafter ^{2,3,4}	2.30 W/m ² K	0.35 W/m ² K	0.16 W/m ² K	To be improved where viable
Dormer Roof ^{2,3,4}	2.30 W/m ² K	0.35 W/m ² K	0.16 W/m ² K	To be improved where viable
Ground floor ^{7,8}	0.74 W/m ² K	0.70 W/m ² K	0.25 W/m ² K	To be improved where viable
Windows	4.80 W/m ² K	-	1.40 W/m ² K / Secondary	Secondary Glazing
Doors to corridor	3.00 W/m ² K	-	1.40 W/m ² K	1.40 W/m ² K

Notes for Table 2

- Area-weighted average values.
- For dormer windows, 'roof' includes the roof parts of the windows and 'wall' includes the wall parts (cheeks).
- If meeting such a standard would limit head room, a lesser standard may be appropriate. In such cases, both of the following should be achieved.
 - The depth of the insulation plus any required air gap should be at least to the depth of the rafters.
 - The insulant should be chosen to achieve the lowest practicable U-value.

This applies to the dormer roofs and sloping ceiling elements in the top floor apartments. See Figure 4 Internal photos that show limited scope to insulate under the rafters and reduce head height.

- If there are problems with the load-bearing capacity of the frame or height of the upstand, for a flat roof or roof with integral insulation, a lesser standard may be appropriate.
- This applies only to a wall that is suitable for cavity insulation. Where this is not the case, it should be treated as 'wall - internal or external insulation'.
- If meeting such a standard would reduce the internal floor area of the room bounded by the wall by more than 5%, a lesser standard may be appropriate.

This applies to all rooms and apartments. Measurements taken from sample rooms and whole apartments suggest that a typical IWI system of 100mm would reduced the useful floor areas by between 8% and 15%.

- The U-value of the floor of an extension may be calculated using the exposed perimeter and floor area of the whole enlarged dwelling.
- If meeting such a standard would create significant problems in relation to adjoining floor levels, a lesser standard may be appropriate.



Figure 4: Internal photos showing limited scope to insulate below rafter levels in dormers and sloping ceilings due to potential to limit head room

Meeting Part L Backstops and Areas of Limitation

- 3.20. The proposed specification U-values highlighted green in Table 2 are elements where the possibility to meet or exceed Part L targets can be achieved if space in the roof void allows and if secondary glazing and replacement apartment door to corridors are permitted by planning.
- 3.21. For other items listed in Table 2, the viability of upgrading elements in line with Approved Document L requirements cannot be achieved due to restrictions and exemptions. Where this is the case, the aim is to improve the fabric as much as is viably possible, considering practical limitations, and the building's Grade II protection status.
- 3.22. Replacement windows, external doors and external wall insulation are not feasible under the restrictions in altering the buildings appearance and character mandated by its listing.
- 3.23. The historic single glazing can be treated and draughtproofed by installing secondary glazing throughout and apartment doors to corridors replaced with units achieving a U-value of 1.40 W/m²K if permissible by the conservation officer.
- 3.24. Improving the walls with internal wall insulation of more than 50mm would reduce the useful floor area by more than 5%. A 50mm natural fibre insulated panel can achieve the 0.70 W/m²K backstop target U-value.
- 3.25. Improving the ceilings at rafter and dormer insulating between and below rafters would reduce internal head room. Natural fibre insulation can be installed in between rafters and leaving the minimum required air gap, aim to get as low as the target 0.35 W/m²K backstop U-value.
- 3.26. Improving the plane ceiling by installing 400mm of mineral wool in the roof void would achieve a U-value of 0.11 W/m²K. A technical survey should be carried out prior to installation to advise on suitability.
- 3.27. The current U-value generated for the suspended/semi exposed timber floor is estimated to be 0.74 W/m²K based on the perimeter/area ratio of the apartments, which gets close to the backstop target U-value 0.70 W/m²K. Full access to the floor void may not be possible and removing the suspended ground floor prove too costly considering the high skirting boards and architraves are noted in the listing making a simple 15-year payback unachievable. This needs further investigation as the design progresses, all attempts to insulate the suspended ground floor without risking damage to the building fabric and preserving the features in the listing should be made.
- 3.28. All U-value assumptions, calculations and literature can be found in Appendix A at the end of this report.

Material Considerations for insulating a Heritage Building

- 3.29. Heritage buildings often feature solid masonry or stone walls that were originally designed to breathe. This means they naturally absorb and release moisture to regulate indoor humidity and temperature. Vapour-open insulation like wood fibre, hemp, straw, cellulose, wool, cotton and flax are highly compatible with these types of walls because they allow for the passage of moisture vapour through the insulation layer without trapping it. This minimizes the risk of moisture build-up within the wall structure, which could otherwise lead to issues such as dampness, mould growth and deterioration of the building fabric.
- 3.30. Moisture management: Natural fibre insulation has the ability to absorb and release moisture, effectively buffering against sudden changes in humidity. This is crucial in heritage buildings where maintaining the integrity of the original materials is essential. By preventing condensation within the wall structure, vapour-open insulation protects the building from damage that could be caused by trapped moisture, such as rot in timber elements or spalling in masonry.
- 3.31. Thermal Performance: While allowing moisture to pass through, vapour-open insulation still provides effective thermal resistance. Natural fibre insulation, for instance, has a lower thermal conductivity, which means it effectively reduces heat loss through the walls while maintaining the breathability of the building fabric. This balance between insulation and breathability is essential in heritage buildings where altering the thermal dynamics too drastically can cause damage.
- 3.32. Preservation of Building Fabric: Heritage buildings often have decorative elements and finishes that are sensitive to changes in internal humidity and temperature. Vapour-open insulation helps to maintain a stable internal environment, reducing the stress on these historical elements. This approach helps in preserving the original character and integrity of the building, a key concern in conservation efforts.
- 3.33. Low Embodied Energy: Natural insulation materials generally have lower embodied energy compared to synthetic alternatives such as foam boards or mineral wool. Embodied energy refers to the total energy required to produce, transport and install the material. Natural fibre, being derived from sustainably managed sources, often require less energy-intensive processes and can be produced with minimal carbon emissions, contributing to a lower overall carbon footprint.
- 3.34. Carbon Sequestration: Natural fibre insulation not only requires less energy to produce, but it also acts as a carbon sink. During its growth, materials such as wood, hemp, straw and flax absorb carbon dioxide from the atmosphere and this carbon remains locked within the material throughout its lifespan. Using natural fibre insulation can therefore contribute to reducing atmospheric carbon levels, which is a significant advantage in combating climate change.
- 3.35. Biodegradability and End-of-Life Disposal: Unlike synthetic insulation materials, natural materials are generally biodegradable and do not contribute to long-term environmental pollution. At the end of their life, they can be composted or disposed of without the risk of releasing harmful substances into the environment. This reduces the environmental impact associated with the disposal of building materials and contributes to a more circular economy.
- 3.36. Indoor Air Quality: Natural insulation materials are often free from harmful chemicals and volatile organic compounds (VOCs) that are commonly found in synthetic insulation products. This results in better indoor air quality, which is particularly important in heritage buildings where the health and safety of occupants need to be preserved along with the building fabric.

Wider Sustainability Benefits of Using Natural Insulation Materials

4. Low Carbon and Renewable Energy Systems

- 4.1. A range of technologies have been assessed for potential incorporation into the scheme in accordance with Regulation 25A of the Building Regulations (2013) and with the intent of delivering compliance with the carbon reduction targets contained within Part L 2021.

Combined Heat and Power (CHP) and District Energy Networks

- 4.2. A CHP unit is capable of generating heat and electricity from a single fuel source. The electricity generated by the CHP unit is used to displace electricity that would otherwise be supplied from the national grid, with the heat generated as effectively a by-product utilised for space and water heating.
- 4.3. The economic and technical viability of a CHP system is largely reliant on a consistent demand for heat throughout the day to ensure that it operates for over 5000 hours per year. Heat demand from mainly residential schemes is not conducive to efficient system operation, with a defined heating season and intermittent daily profile, with peaks in the morning and the evening. For this reason, the use of a CHP system is considered unfeasible for this development.
- 4.4. There are currently no heat networks which extend near the proposed development. High network heat losses associated with distribution to individual houses, as opposed to large high-rise apartment blocks and commercial developments mean that a new heat network to serve the area is not considered viable or an environmentally preferred option. Due to these reasons, the provision for future connection to a district heating system is also not proposed.

Wind Power

- 4.5. Locating wind turbines adjacent to areas with buildings presents a number of potential obstacles to deployment. These include the area of land onsite required for effective operation, installation and maintenance access, environmental impact from noise and vibration, visual impact on landscape amenity and potential turbulence caused by adjacent obstacles, including the significant amount of woodland on and around the development.
- 4.6. A preliminary examination of the BERR wind speed database indicates that average wind speeds at 10m above ground level are around 5.1m/s³. Wind turbines at this site are therefore unlikely to generate sufficient quantities of electrical energy to be cost effective⁴. For these reasons wind power is not considered feasible.

³ NOABL Wind Map (<http://www.rensmart.com/Weather/BERR>)

Provisions for Energy-Efficient Operation of the Dwelling

- 4.7. The occupant of the dwelling should be provided with all necessary literature and guidance relating to the energy efficient operation of fixed building services. Currently it is assumed that all dwellings will be provided with the most appropriate heating systems, fully insulated primary pipework and controls including programmers, thermostats and room temperature controls to avoid unnecessary heating of spaces when not required.

Building Scale Systems

- 4.8. The remaining renewable or low carbon energy systems considered potentially feasible are at a building scale. These are as follows;
- Individual biomass heating
 - Solar thermal
 - Solar photo-voltaic (PV)
 - Air Source Heat Pumps (ASHPs)
 - Ground Source Heat Pump (GSHPs)
 - Hot water heat pumps
- 4.9. The advantages and disadvantages of these technologies are evaluated in Table 3, Table 4, Table 5, Table 6, Table 7 and Table 8.

⁴ CIBSE TM38:2006. Renewable energy sources for buildings.

Table 3: Individual Biomass Heating feasibility appraisal

Potential Advantages	Risks & Disadvantages
- Potential to significantly reduce CO₂ emissions as the majority of space and water heating will be supplied by a renewable fuel - Decreased dependence on fossil fuel supply	- A local fuel supply is required to avoid increased transport emissions - Fuel delivery, management and security of supply are critical - Space is required to store fuel, a thermal store and plant - A maintenance regime would be required even though modern systems are relatively low maintenance - Building users or a management company must be able to ensure fuel is supplied to the boiler as required. - Local environmental impacts potentially include increased NO_x and particulate emissions
Estimated costs and benefits	
Cost £2,000 upwards for a wood-pellet boiler, not including cost of fuel	
Conclusions	
Biomass heating is considered not technically feasible given the limited space available and requirement for ongoing fuel deliveries, maintenance and management required.	

Table 4: Solar Thermal systems feasibility appraisal

Potential Advantages	Risks & Disadvantages
- Mature and reliable technology offsetting the fuel required for heating water (typically gas) - Solar thermal systems require relatively low maintenance - Typically, ~50% of hot water demand in dwellings can be met annually	- Installation is restricted to favourable orientations on an individual building basis - The benefit of installation is limited to the water heating demand of the building - Safe access must be considered for maintenance and service checks - Buildings need to be able to accommodate a large solar hot water cylinder - Distribution losses can be high if long runs of hot water pipes are required - Visual impact may be a concern in special landscape designations (e.g. AONB)
Estimated costs and benefits	
- Cost £2,000 - 5,000 for standard installation - Ongoing offset of heating fuel, minimal maintenance requirements	
Conclusions	
Solar thermal systems are considered not feasible on account of their visual impact on the Grade II listed dwelling.	

Table 5: Solar Photovoltaic systems feasibility appraisal

Potential Advantages	Risks & Disadvantages
- The technology offsets grid supplied electricity used for lighting, pumps and fans, appliances and equipment - Mature and well proven technology that is relatively easily integrated into building fabric - Adaptable to future system expansion - Solar resource is not limited by energy loads of the dwelling as any excess generation can be transferred to the national grid - PV systems generally require very little maintenance - Service and maintenance requirement minimal and 2-3 storey buildings should not require significant additional safety measures (mansafe systems etc) for roof access	- Poor design and installation can lead to lower than expected yields (e.g. from shaded locations) - Installation is restricted to favourable orientations - Feed in Tariff support mechanism has been discontinued - Safe access must be considered for maintenance and service checks - Visual impact may be a concern in special landscape designations (e.g. AONB) or conservation areas - Reflected light may be a concern in some locations
Estimated costs and benefits	
- Cost £1,300 upwards (1kWp+) and scalable - Ongoing offset of electricity fuel costs, minimal maintenance requirements	
Conclusions	
Solar PV systems are considered not feasible on account of their visual impact on the Grade II listed dwelling.	

Table 6: Air Source Heat Pump systems feasibility appraisal

Potential Advantages	Risks & Disadvantages
- Heat pumps are relatively mature technology providing heat using the reverse vapor compression refrigeration cycle - Heat pumps are a highly efficient way of providing heat using electricity, with manufacturers reporting efficiencies from 250% - Can be of increased benefit where cooling is also required, therefore particularly relevant to commercial buildings - Very low carbon heating source based on Part L 2021 carbon factor of 0.136kgCO₂/kWh	- Air source heat pumps are powered by electricity, potentially increasing fuel bills for residents compared with gas heating systems - It is critical that heat pump systems are designed and installed correctly to ensure efficient operation can be achieved. Users must be educated in how heat pump systems should be operated for optimal efficiency - Air source heat pump plant should be integrated into the building design to mitigate concerns regarding the visual impact of bolt-on technology - Noise in operation may be an issue particularly when operating at high output
Estimated costs and benefits	
Cost £5,000 - £7,000 for standard installation (with an existing wet system present)	
Conclusions	
Air source heat pumps are considered not feasible for this scheme due to visual impact of the external condenser units, as this will impact the appearance of the building. Individual hot water cylinders would also be required in each apartment, restricting storage space. As a result, they are not considered a preferred option at this stage.	

Table 7: Ground Source Heat Pump systems feasibility appraisal

Potential Advantages	Risks & Disadvantages
- Heat pumps are relatively mature technology providing heat using the reverse vapor compression refrigeration cycle - Heat pumps are a highly efficient way of providing heat using electricity, with manufacturers reporting efficiencies from 320% - Can be of increased benefit where cooling is also required, therefore particularly relevant to commercial buildings - Very low carbon heating source based on Part L 2021 carbon factor of 0.136kgCO₂/kWh	- Low temperature heating circuits (underfloor heating) would be required to maximise the efficiency of heat pumps - A hot water cylinder would also be required for both space and water heating - Ground source heat pumps are powered by electricity, potentially increasing fuel bills for residents compared with gas heating systems - It is critical that heat pump systems are designed and installed correctly to ensure efficient operation can be achieved - Ground source heat pumps either require significant land to incorporate a horizontal looped system or significant expense to drill a bore hole for a vertical looped system
Estimated costs and benefits	
- Cost circa £10,000+ - Shared ground loop approach eligible for non-domestic RHI. Estimated simple payback at circa 18 years (systems only) - Running cost linked to COP of heat pump, however likely to be higher than mains gas - Additional costs to upgrade electricity infrastructure currently unknown	
Conclusions	
Ground source heat pumps are not considered technically feasible for this scheme. The cost, disruption and difficulty associated with vertical boreholes at this site means that they are not considered a preferred low carbon technology at this stage.	

Table 8: Hot Water Heat Pump feasibility appraisal

Potential Advantages	Risks & Disadvantages
- Hot water demand met through grid electricity with low effective emissions factor - Heat pump element increases efficiency over immersion heater, circa 200%+ - No external heat exchanger requirement, only intake and exhaust duct runs - Low noise levels - Compact solution in same footprint as hot water cylinder	- Maximum length of duct runs means that cylinder positioning needs to be considered within the dwelling - Less appropriate for larger dwellings with higher hot water demands due to potentially slower recharge rate - Some noise, however likely to be easily suppressed with appropriate cylinder location - Space heating must be met through separate system
Conclusions	
Hot water heat pumps are not considered feasible for dwellings as duct runs to building façade would not be permissible under it's listed status.	

Summary

4.10. Following this feasibility assessment, it is considered that there are a range of technically feasible low carbon or renewable energy systems, however a number of these may be discounted on the grounds of increased running costs for residents or other adverse effects:

- Biomass heating systems would require significant storage space for fuel as well as regular deliveries at different times to all dwellings. Local NO_x and particulate pollution is also an increasing concern and therefore they are not appropriate for this development.
- Ground source heat pump systems are not considered feasible due to the initial cost of installation. The limited area of available ground means a horizontal coil system is not practical and a borehole installation is not expected to be economically viable.
- For air source heat pumps, external condenser units will be required which will not align with the building's Grade II protection. Also, large hot water cylinders and associated plumbing works will be required in each apartment which would restrict usable floor space. For this reason, they are not considered appropriate.

4.11. Therefore, high efficiency gas combis or all electric heating and hot water with a dual rate electric meter are considered the options with the most potential for the development.

4.12. Incorporating high heat retention modern electric storage heaters and immersion hot water cylinders to supply the apartments with heating and hot water running dual tariff electricity meters, minimises façade penetrations and internal impact on features protected by the listing. An all-electric strategy is in line with current national, local planning and net zero policies by benefitting from the decarbonization of the national grid.

4.13. Adopting high efficiency mains gas combi boilers removes the need and space requirement for a hot water cylinder and offers a better EPC rating based on current cost per kWh of energy. This offers prospective residents some protection against higher running costs based on the SAP methodology and fuel costs.

5. Indicative Dwelling Performance

- 5.1. Following both strategies described, the dwellings will significantly reduce energy demand and consequent CO₂ emissions compared to the current baseline of the building through the fabric improvements targeted.
- 5.2. Indicative SAP calculations have been undertaken on the proposed dwellings to provide an overview of the typical as-designed energy performance, in comparison with current building performance. The results of these calculations are shown in Table 9 and Table 10 for mains gas and all electric respectively.

Table 9: Indicative dwelling performance - mains gas

Flat	Baseline			Proposed Specification		
	Total emissions kgCO ₂ /yr	Total Energy kWh/yr	EPC rating	Total emissions kgCO ₂ /yr	Total Energy kWh/yr	EPC rating
GF Flat 1	5,375	23,843	E45	1,763	8,536	C72
GF Flat 2	5,375	23,843	E45	1,763	8,536	C72
1F Flat 3	9,001	40,136	E41	2,739	13,024	C77
1F Flat 4	9,001	40,136	E41	2,739	13,024	C77

Table 10: Indicative dwelling performance - all electric

Flat	Baseline			Proposed Specification		
	Total emissions kgCO ₂ /yr	Total Energy kWh/yr	EPC rating	Total emissions kgCO ₂ /yr	Total Energy kWh/yr	EPC rating
GF Flat 1	5,375	23,843	E45	1,344	9,887	D59
GF Flat 2	5,375	23,843	E45	1,344	9,887	D59

1F Flat 3	9,001	40,136	E41	774	12,446	D64
1F Flat 4	9,001	40,136	E41	774	12,446	D64

6. Resource Efficiency and Materials

- 6.1. This section sets out details of additional resource efficiency and sustainable design principles to be applied at the development.

Materials

- 6.2. The impacts of construction materials range from the depletion of natural resources to the greenhouse gas emissions and water use associated with their manufacture and installation.
- 6.3. Within the development choices will be made in order to reduce the consumption of primary resources and use materials with fewer negative impacts on the environment, including but not limited to the following;
- Use fewer resources and less energy through designing buildings more efficiently.
 - Specify and select materials and products that strike a responsible balance between social, economic and environmental factors.
 - Incorporate recycled content, use resource-efficient products and give due consideration to end-of-life uses.
 - Influence, specify and source increasing amounts of materials which can be reused and consider future deconstruction and recovery.
 - All insulating materials will have a Global Warming Potential (GWP) of < 5 in manufacture and installation.
 - All materials used in construction will be responsibly sourced, with certification obtained wherever possible. Materials with a low environmental impact as per the BRE Green Guide will be preferred.

Waste

- 6.4. Sending waste to landfill has various environmental impacts, such as the release of local pollution, ecological degradation and methane emissions, in addition to exacerbating resource depletion. Waste in housing comes from two main streams; construction waste and domestic waste during occupation.

Household Waste

- 6.5. In this respect regard has been given to the policy advice contained in the NPPF together with the Council's current strategy in terms of waste and recycling to ensure that the new dwellings are provided with adequate storage facilities for both waste and recyclable materials.
- 6.6. Wokingham Council currently offer kerbside collection for recycling, separated into two collections streams:
- paper, glass bottles and jars
 - food and drink cans, aerosols, plastic bottles, cardboard, foil
- 6.7. Dedicated bin storage space will be provided on plot to accommodate the relevant collection boxes.
- 6.8. Future occupiers of the dwellings will be provided with an information pack detailing the Council's current collection arrangements for waste and recycling and advising of the nearest recycling centres to the application site.

Construction Waste

- 6.9. The development will additionally be designed to effectively and appropriately monitor and manage construction site waste. Target benchmarks for resource efficiency will be set in accordance with best practice – e.g., <5 m³ of waste per 100m² / tonnes waste per m².
- 6.10. Wherever possible materials will be diverted from landfill through re-use on site, reclamation for re-use, returned to the supplier where a 'take-back' scheme is in place or recovered and recycled using an approved waste management contractor. A target to divert 85% by weight/volume of non-hazardous construction waste will be applied.

7. Conclusions

- 7.1. This Energy Statement has been prepared by AES Sustainability Consultants on behalf of Crest Nicholson Operations Ltd and Defence Infrastructure Organisation to support the “Full Planning Permission and Listed Building Consent for the Change of Use of the Moat House from office (Use Class E) to residential (Use Class C3) to provide 4 residential dwellings and associated internal roads, parking, landscaping, drainage, plant, bin and cycle storage”.
- 7.2. A review of applicable local and national planning policy has been undertaken, concluding that energy standards should be encouraged and enforced through the applicable national regulations. Consideration will be paid to building design and layout to further reduce energy consumption and a range of additional sustainable design considerations will be addressed.
- 7.3. This strategy sets out how the proposed development addresses relevant policies contained within the Wokingham Borough Local Development Framework. The strategy follows a ‘fabric first’ approach to retrofitting energy efficient buildings, with energy efficiency where possible improved beyond the minimum compliance levels within the Building Regulations within the context and constraints of a Grade II Listed Heritage building.
- 7.4. One fabric improvement strategy with gas and electric heating and hot water options have been suggested both with merit.
- 7.5. The all-electric option is aligned with the general direction of travel to decarbonise dwellings, reduce emissions and offers a more sympathetic route to preserving the buildings heritage both inside and out., However it results higher running costs, a lower EPC rating and the requirement for a hot water cylinder in each dwelling.
- 7.6. The gas combi option strikes a balance between on-site practicality and the improved EPC rating which offers lower running costs than direct electric route. It also negates the need to find space for a hot water cylinder in small apartments, however extensive pipework disruption and façade penetrations are required.
- 7.7. A range of additional sustainability measures have been given consideration including reduction of both construction and household waste.
- 7.8. Appropriate provision for internal waste and recycling storage will be provided to ensure that recycling can be split into the appropriate streams for collection.

Appendix A – U values

Table S8B : U-values of party walls

Party wall type	Party wall U-value
Solid masonry / timber frame / system built	0.0
Cavity masonry unfilled	0.5
Cavity masonry filled	0.2
Unable to determine, house or bungalow	0.25
Unable to determine, flat or maisonette	0.0

Appendix S - Party Wall U values assumed in Table S8B

Table S9 : Roof U-values when loft insulation thickness at joists is known (for insulation between joists including insulation at flat ceiling of a roof room)

Insulation thickness at joists (mm)	Assumed roof U-value (W/m ² K)	
	Slates or tiles	Thatched roof
None	2.3	0.35
12	1.5	0.32
25	1.0	0.30
50	0.68	0.25
75	0.50	0.22
100	0.40	0.20
150	0.30	0.17
200	0.21	0.14
250	0.17	0.12
270	0.16	0.12
300	0.14	0.11
350	0.12	0.10
>= 400	0.11	0.09

Appendix S - Roof insulation at joist U values assumed in Table S9

Table S10 : Assumed roof U-values when Table S9 does not apply

Age band	Assumed Roof U-value (W/m ² K) ^(a)						
	Pitched, slates or tiles, insulation between joists or unknown	Pitched, slates or tiles, insulation at rafters	Flat roof ^(b)	Room-in-roof, slates or tiles	Thatched roof ^(c)	Thatched roof, room-in-roof	Park home
A, B, C, D	2.3 (none)	2.3 ⁽¹⁾	2.3 ⁽¹⁾	2.3 ⁽¹⁾	0.35	0.25	-
E	1.5 (12 mm)	1.5 ⁽¹⁾	1.5 ⁽¹⁾	1.5 ⁽¹⁾	0.35	0.25	-
F	0.68 (50 mm)	0.68 ⁽¹⁾	0.68 ⁽¹⁾	0.80 ⁽¹⁾	0.35	0.25	1.7
G	0.40 (100 mm)	0.40 ⁽¹⁾	0.40 ⁽¹⁾	0.50 ⁽¹⁾	0.35	0.25	0.6
H	0.30 (150 mm)	0.35 ⁽¹⁾	0.35 ⁽¹⁾	0.35 ⁽¹⁾	0.35	0.25	-
I	0.26 (150 mm)	0.35 ⁽¹⁾	0.35 ⁽¹⁾	0.35 ⁽¹⁾	0.35	0.25	0.35
J	0.16 (270 mm)	0.20	0.25	0.30	0.30	0.25	-
K	0.16 (270 mm)	0.20	0.25 ⁽²⁾	0.25 ⁽²⁾	0.25 ⁽²⁾	0.25 ⁽²⁾	0.30
L	0.16 ⁽³⁾ (270 mm)	0.18	0.18	0.18	0.18	0.18	-

^(a) If the roof insulation is "none" use U = 2.3 (all roof types).

^(b) Applies also to roof with sloping ceiling

^(c) If there is also retro-fitted insulation between the rafters reduce the U-value to $1/(1/U_{\text{table}} + R_{\text{in}})$ where R_{in} is 0.7 m²K/W for 50 mm, 1.4 m²K/W for 100 mm and 2.1 m²K/W for 150 mm. If retro-fit insulation present of unknown thickness use 50 mm.

⁽¹⁾ The value from the table applies for unknown and as built. If the roof is known to have more insulation than would normally be expected for the age band, either observed or on the basis of documentary evidence, use the lower of the value in the table and:

50 mm insulation 0.68
100 mm insulation: 0.40
150 mm or more insulation: 0.30

⁽²⁾ 0.20 W/m²K in Scotland

⁽³⁾ 0.15 W/m²K in Scotland

Appendix S - Roof insulation U values assumed in Table S10

Table S12 : Exposed/Semi-exposed floor U-values

Age band	U-value (W/m ² K)			
	Insulation unknown or as built	Insulated 50 mm	Insulated 100 mm	Insulated 150 mm
A to G	1.20	0.50 ⁽¹⁾	0.30	0.22
H or I	0.51	0.50 ⁽¹⁾	0.30	0.22
J	0.25	0.25	0.25	0.22
K	0.22	0.22	0.22	0.22
L	0.22 ⁽²⁾	0.22 ⁽²⁾	0.22 ⁽²⁾	0.22 ⁽²⁾
⁽¹⁾ Use these values if known to be insulated but insulation thickness not known				
⁽²⁾ 0.18 W/m ² K in Scotland				

Appendix S - Semi exposed floor U values assumed in Table S12

Table S15A : Doors

Door opens to	Age band	Door U-value
Outside	A to J	3.0
	K	2.0
	L	E&W and N.I: 1.8 Scotland: 1.6
Unheated corridor or stairwell	any	1.4
Heated corridor or stairwell		(omitted from data collection)

Appendix S - Door U values assumed in Table S15A

Table S14 : Window characteristics

Glazing	Installed	Glazing gap	U-value (window)	U-value** (roof window)	g-value
Single	any	-	4.8	5.1	0.85
Double glazed unit*	England & Wales: before 2002, Scotland: before 2003 N. Ireland: before 2006	6 mm in PVC frame, or any in non-PVC frame	3.1	3.3	0.76
		12 mm in PVC frame	2.8	3.0	
		16 mm or more in PVC frame	2.6	2.8	
Double glazed unit	England & Wales: 2002 or later, Scotland: 2003 or later N. Ireland: 2006 or later	any	2.0	2.2	0.72
Secondary glazing	any	any	2.4	2.6	0.76
Triple glazing	any	any	1.8	2.0	0.68
Double or triple, known data	any	any	As provided in RdSAP data set		

* Use this row for conservatories and for other double glazing whose installation date is unknown.

** Roof pitch 45° (unless horizontal). Applies only where all windows are measured individually (otherwise all glazing is assigned to windows).

Frame factor is 0.7 for all window types (not applied if data source is BFRG)

Frame type is wood for single glazing and secondary glazing, PVC for other types

U-values are adjusted for curtains (section 3.2 of the SAP specification).

Appendix S - Glazing U values assumed in Table S14

Appendix B – Solid Brick Wall

U-value calculation

by BRE U-value Calculator version 2.03

Printed on 16 Aug 2024 at 15:13

Filename: C:\Users\Jonathan.Platt.AESSOUTHERN\OneDrive - AES Sustainability Consultants\8108 Moat House, Arborfield\1-- U Values\8108 Solid Brick Wall 1.35.uva (File saved: 08 Aug 2024 09:22)

Element type: Wall - Masonry solid wall

Calculation Method: BS EN ISO 6946

8108 Solid Brick Wall 1.35

<u>Layer</u>	<u>d (mm)</u>	<u>λ layer</u>	<u>λ bridge</u>	<u>Fraction</u>	<u>R layer</u>	<u>R bridge</u>	<u>Description</u>
					0.130		Rsi
1	13	0.570			0.023		Plaster (dense)
2	421	0.770			0.547		Brick
					<u>0.040</u>		Rse
	<u>434 mm</u> (total wall thickness)				0.740		

Total resistance: Upper limit: 0.740 Lower limit: 0.740 Ratio: 1.000 Average: 0.740 m²K/W

U-value 1.352

U-value (rounded) 1.35 W/m²K

Calculated by:

Windows User

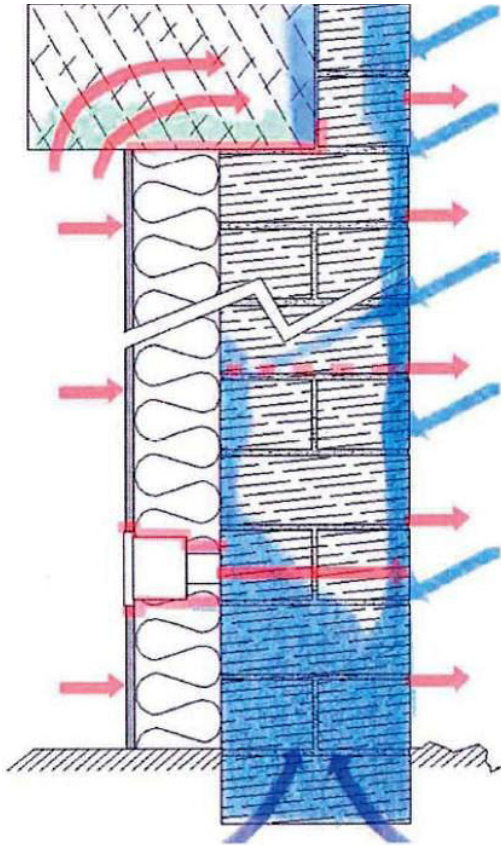
Appendix C – Natural Fibre Internal Wall Insulation Example

NBT PAVADRY

Principles

Behaviour of internal insulation systems

Conventional insulation with vapour barrier

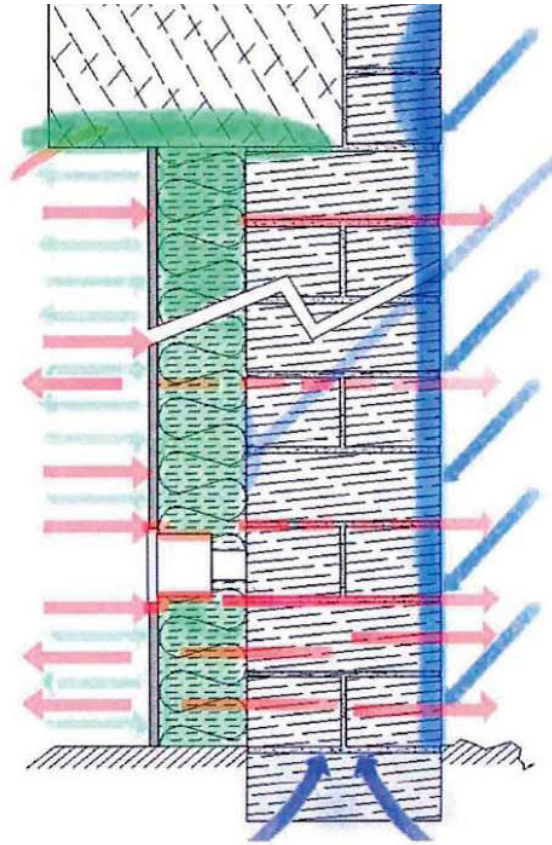


The graphic above shows an external wall with conventional internal insulation on the left side and NBT PAVADRY system on the right side and how each system is affected by moisture. Moisture sourcing from the ground (rising damp), outside (mainly through driven rain) and from the inside (vapour diffusion and convection through leakages) are indicated by different colours. Red arrows show vapour movement, blue arrows show liquid moisture and green indicates moisture storage and buffering.

In a conventional insulated wall, drying out of the wall is reduced to the inside as often a high vapour resistance (vapour barrier) is applied and the materials do not possess capillary or hygroscopic properties. This can lead to higher moisture content within the wall, mould growth and ultimately this could lead to damage to the fabric. The risk is higher around details such as timber joists, services or at ground level.

The risk of excessive moisture can be reduced by the application of a breathable insulation such as NBT

Breathable PAVADRY insulation



PAVADRY. Breathability means that the insulation is vapour open, capillary active and hygroscopic. Thanks to its hygroscopicity and high density NBT PAVADRY can buffer (peak) moisture and release it back to the room which helps to equalize the internal climate. The capillary actions of the material helps to move liquid moisture away from the most critical interface (between insulation and existing wall, where the relative humidity increases due to the lower temperature of the wall). This is why the board must be bonded to the wall and why the density at this point is critical to ensure holding capacity for moisture. The vapour openness allows water vapour to pass through the construction evenly, which reduces the assists drying and avoids moisture becoming trapped within the construction. However, breathable insulation is not the cure for every problem. The wall, gutters, render or french drain need to be in sound condition in order to protect the wall from driven rain.

NBT PAVADRY

Background

Location

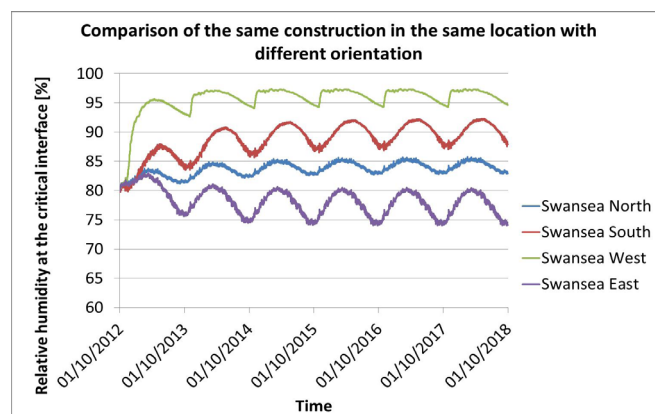
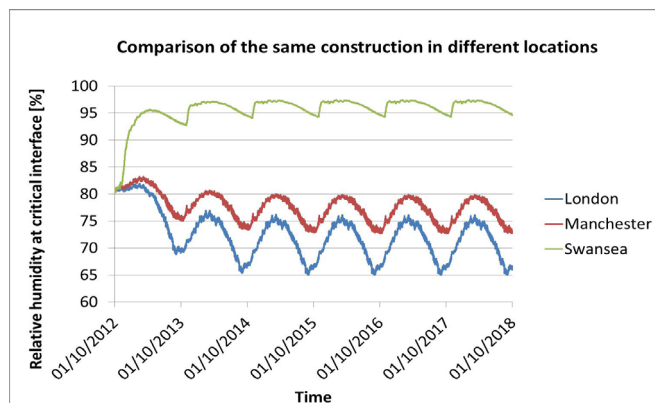
Geographical location and the consequent variations in climate are an important factor affecting how a building will behave. The main variables are:

- precipitation (rain)
- sunshine
- temperature
- relative humidity
- windspeed (closely related to driving rain)
- global radiation

Example

To demonstrate the effect of those factors, the graph below shows the relative humidity at the critical interface of the same construction (9-inch solid brick wall, and 92mm NBT PAVADRY SYSTEM internally) in different locations but from the same orientation, here West.

As can be seen, the relative humidity (RH) is well below the critical value of 85% in London, while the same construction is just at the threshold in Manchester and completely failing in Swansea.



The geographic position is only one aspect in terms of the location. Factors such as orientation (wind driven rain, sunshine) or how exposed or sheltered a house is, can all significantly affect the behaviour of a building (e.g. a nearby building or a large tree will affect the amount of rain and sun getting to the surface of the wall considerably).

This is demonstrated in the second graph, where the same construction is compared in Swansea but with different orientations.

Thickness of insulation

By fitting internal insulation onto a wall, the temperature of the external wall drops, as the “heating” of the wall through heat loss decreases. The more insulation that is applied internally, the higher the risk that interstitial moisture build up will occur (caused by the lower temperature at the critical interface and by the inability of the wall to move moisture from rain, rising damp etc from the wall to the outside of the building). This however, is not the only point that has to be considered in terms of the insulation thickness. Greater thicknesses will also reduce the living space.

Furthermore, the benefit of applying insulation is not linear to the thickness but decreases with added thickness. The decrease in the benefit is even higher when (unavoidable) thermal bridges (windows, partition walls, intermediate floors, etc.) are taken into account. The more insulation is applied internally, the higher the percentage of heat lost through thermal bridging.

The graph below [Schnieders, 2005] shows the reasonable thickness of internal insulation (for a German house; $\lambda_{\text{insulation}} = 0.035 \text{ W/mK}$) being between 40 and 100mm.

