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Evaluating moisture risks in vapour-open biobased wall assemblies: design and methodology of a long-term field study

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ABSTRACT

The transition toward rapid, low-carbon housing in the Netherlands has accelerated the adoption of biobased light timber frame construction (LTF) systems. However, the suitability of vapour-open biobased wall assemblies in the country's humid, temperate maritime climate (Cfb) remains insufficiently validated. This paper presents the design and methodology of a comprehensive five-year field study aimed at experimentally assessing the long-term hygrothermal performance, moisture risks, and thermal stability of vapour-open versus vapour-closed LTF walls insulated with five biobased materials.

Two identical full-scale dwellings were constructed in Groningen, The Netherlands, differing only in the presence (vapour-closed) or absence (vapour-open) of a PE vapour barrier. Each dwelling incorporates five biobased insulation types: grass, cellulose, hemp-jute, wood fibre, and flax, installed across multiple façade orientations. A dense array of embedded sensors measures moisture content (M%), relative humidity (RH), and temperature (T) at hourly intervals within wall layers and indoor spaces, complemented by local and KNMI weather data.

Laboratory characterisation of sorption isotherms, vapour diffusion resistance, and baseline moisture content supports the interpretation of field measurements. The monitoring strategy is designed to test three hypotheses: (1) vapour-open assemblies maintain sufficient drying capacity to avoid exceeding critical timber moisture thresholds associated with decay; (2) moisture-induced thermal resistance (R-value) reduction differs between vapour-open and vapour-closed walls; and (3) hygroscopic biobased materials contribute to measurable differences in indoor moisture buffering.

The study provides one of the first long-term, high-resolution datasets for biobased LTF assemblies in a temperate, maritime climate. Its outcomes will inform moisture-safe design principles for sustainable, vapour-open construction systems in the Netherlands and similar regions, contributing to evidence-based policy and building practice.

KEYWORDS: Moisture buffering; Vapour-open dwellings; Hygroscopic behaviour; Light Timber Frame Wall; Biobased materials.

1. INTRODUCTION

The Netherlands faces a growing housing shortage, increasing the need for rapid and affordable construction methods that meet environmental sustainability and indoor comfort requirements. This urgent demand is underscored by national targets aiming for an annual housing production of 90,000 to 100,000 units from 2025 through 2030.[1]

In this study, 5 different biobased wall assemblies, some for multiple orientations are investigated for two buildings. For the purpose of this research, biobased wall assemblies are defined as Light Timber Frame (LTF) constructed pre-fabricated walls insulated with biobased insulation materials, which contain at least 70% renewable mass (as per EN 16575:2014) in line with Dutch national goals for biobased construction.[2] For instance, biobased insulation materials such as wood fibre, hemp, cellulose and flax insulation sheets. Two characteristics of biobased insulation materials are the primary motivations for this field study method. The first is their composition of renewable mass rather than fossil-based resources, which supports national targets for lowering the embodied carbon impact of construction. The second is their hygroscopic properties, which is the ability to absorb and release moisture. This hygroscopic characteristic has driven significant interest in biobased, vapour-open building systems, based on the hypothesis that these materials can moderate the absolute indoor air humidity through moisture buffering. Maintaining indoor relative humidity (RH) levels within the target range of 30% and 70% is linked to improved thermal perception, as noted in existing literature.[3,4]

While the benefits of sustainable and biobased materials are clear, their application in the construction of biobased wall assemblies in a climate like the Netherlands presents a significant technical challenge. The Netherlands is classified by the Köppen climate system as a Cfb climate, or temperate maritime climate (without a dry season, warm summer), a similar classification as Great Britain and Ireland. This temperate maritime climate results in a consistently high yearly average external relative humidity (typically around 80%). The primary concern is the potential for interstitial condensation, a risk traditionally mitigated by the inclusion of a non-permeable vapour barrier on the warm side of the wall assembly (a vapour-closed approach). Conversely, vapour-open assemblies, which deliberately omit this barrier, rely on the assembly's drying potential to rapidly release any moisture that enters or condenses. Compared to warmer, drier reference climates, there is concern that the limited drying potential in the Dutch climate may be insufficient. This is because the consistently colder exterior side of the insulation layer increases the risk of interstitial condensation, potentially preventing the materials from drying adequately. Excessive moisture accumulation compromises the structural integrity and long-term performance of the assembly. Specifically, moisture can reduce the material its thermal resistance (R-value).[5] In worst-case scenarios, this can lead to biological decay, wood rot, or mould growth.[6]

1.1. Research Gap and Study Contribution

Literature confirms the theoretical risks associated with moisture accumulation (reduced R-value, decay, mould growth) and the potential benefits of hygroscopic materials (moisture buffering). However, a significant gap remains in literature:

- Limited experimental validation: There is a lack of long-term, high-resolution experimental data for recently developed biobased insulation materials applied within full-scale, vapour-open light timber frame assemblies.
- Climate specificity: existing field studies often focus on climates with lower average external humidity or different thermal profiles than those found in the Netherlands.

This field study methodology directly addresses these limitations by providing a comparative, multi-year, and highly detailed monitoring experimental framework specifically tailored to investigate the performance of five distinct biobased materials in a high-humidity, temperate Dutch climate. This setup is designed to provide the necessary data for future analytical work on the dynamic performance of these sustainable construction systems.

1.2. Research Objective and Hypotheses

This paper presents the detailed methodology for a long-term field study designed to compare the dynamic performance of vapour-open and vapour-closed light timber frame construction systems utilizing five different biobased insulation materials.

The primary research question guiding the methodology is: How should the long-term performance and dynamic moisture behaviour of vapour-open and vapour-closed biobased wall assemblies be monitored and compared in the temperate, high-humidity climate of the Netherlands?

The field study is designed to gather data to test the following hypotheses:

1. The vapour-open biobased assemblies will maintain a sufficient drying potential to prevent long-term moisture accumulation, such that the equilibrium moisture content (M%) of the structural timber does not exceed the critical threshold for material decay (structural integrity).
2. The thermal performance (R-value) reduction due to moisture uptake will be statistically different between the vapour-open and vapour-closed assemblies.
3. The vapour-open assembly will exhibit a statistically different moisture buffering capacity compared to the vapour-closed assembly, leading to a measurable difference in the stability of indoor relative humidity (RH).

To investigate this research question and its hypotheses, two unoccupied, light timber frame residential buildings were constructed identically, with the single exception being the design of the wall assemblies. One dwelling incorporates a vapour-closed approach with a vapour barrier between the insulation layer and the interior plaster. The second dwelling has a vapour-open structure, which omits the interior vapour barrier. Both buildings feature five different wall sections, each insulated with a distinct biobased material. These dwellings are being monitored over a five-year period to collect comprehensive data on moisture dynamics, the resulting change in thermal performance (R-value) due to moisture uptake, and structural integrity. To investigate this research question and its hypotheses, the following section describes the methodology and research design. Section 3 describes preliminary outcomes and lastly, the discussion and conclusions are presented.

2. METHODOLOGY

Moisture management is important in building physics, especially for biobased materials because they are more susceptible to mould and decay. Controlling the movement of water dictates the long-term durability, thermal performance, and health outcomes of a building assembly. All moisture-related strategies, whether vapour-open or vapour-closed, are rooted in controlling the fundamental mechanisms of water transport: liquid flow, capillary suction, air movement, and vapour diffusion. The hypotheses guiding this study require the monitoring of specific hygrothermal parameters that directly correlate with the structural integrity, thermal performance, and indoor climate quality (via RH) of the wall assemblies. Prior research highlights the critical importance of these parameters, justifying their inclusion in the field study methodology. The long-term structural integrity of a light timber frame assembly is directly compromised by excessive moisture accumulation, which can lead to material decay, mould growth and resulting structural risks.

The following indicators are monitored to evaluate the hygrothermal performance, energy demand and moisture buffering: M%, RH and T. High M% in wood and biobased materials is directly related to the risk of decay. Critical thresholds, often around 20%-25% M% by mass, are frequently cited in literature as the necessary conditions for the initiation of wood rot and decay.[7] Monitoring of M% is therefore required in all components, the biobased insulation materials and the wooden studs. Mould growth requires nutrient, mould spores, favourable temperature (T) and relative humidity (RH) to exist simultaneously for an extended period. These conditions are typically analysed using isopleth diagrams.[3] Research indicates that while some studies use an RH of 70% as a cautious threshold for mould risk[8], fungi often require RH over 75% to grow, with certain renewable materials only being at risk above 85% RH.[9,10] The combination of elevated RH (e.g., 80%) and optimal temperatures (e.g., 15 °C to 30 °C) within the wall cavity presents the highest risk. Since condensation occurs when the temperature of a layer falls below the dew point, continuous monitoring of interstitial T and RH is crucial for detecting or predicting this structural failure mechanism.[11] The collected data can also be used to validate hygrothermal modelling software like WUFI, which has been applied in similar Danish and international studies to assess mould growth risk.[6,11] Research demonstrates that when materials become saturated, their insulating ability is lowered.[5] Increased moisture content raises the material's thermal conductivity. For instance, studies on biobased materials like hempcrete have observed increases in thermal conductivity ranging from 10% to over 50% when moving from a dry state to a moist state.[6] The critical moisture threshold for significant change is often above 45% RH. Thus, this field study must determine if the vapour-open assembly, by allowing greater moisture ingress or retention, leads to a statistically significant, detrimental decrease in the assembly's R-value compared to the vapour-closed control.

Hygroscopic materials (such as wood fibre, hemp, or straw) exchange moisture with the surrounding air, effectively dampening the daily fluctuations of indoor RH.[5,12] This phenomenon, known as the moisture buffering capacity (MBC), can be quantitatively demonstrated by monitoring the change in RH over time. To assess the significance of the MBC on indoor RH, the resulting RH must be evaluated against established criteria. Keeping the indoor relative humidity level between 40% and 60% is widely considered the optimal zone for minimizing adverse health effects related to mites, fungi, and the survival rate of infectious bacteria and viruses.[4] Furthermore, dry air tends to be more common in colder climates, which can lead to low humidity (below 30%).[4] The acceptable range is between 30% and 70% RH. The field study will compare the RH stability and compliance with this optimal zone between the two assembly types.

2.1. Experimental Design and Conditions

The field experiment is conducted on a dedicated testing site at the Zernike Campus in Groningen in the north of the Netherlands, featuring two newly constructed, unoccupied residential dwellings. These dwellings are identical in terms of their physical layout, geometric orientation, and the technical installations used for heating, ventilation, and energy supply. To investigate the hygrothermal performance, each dwelling incorporates five distinct biobased wall assemblies (biobased wall assemblies A–E). These sections are distributed across the façades to capture the impact of different environmental orientations. Four of the five wall assemblies (A, B, C, D) are equipped with multiple sensors. To account for varying solar radiation and wind-driven rain, these sections are monitored across two different orientations (North-west and South-west). The fifth wall assembly (E), is equipped with only two sensors to provide indicative data for comparison with the primary sections.

The experiment utilizes a two-dwelling comparative design (Figure 1):

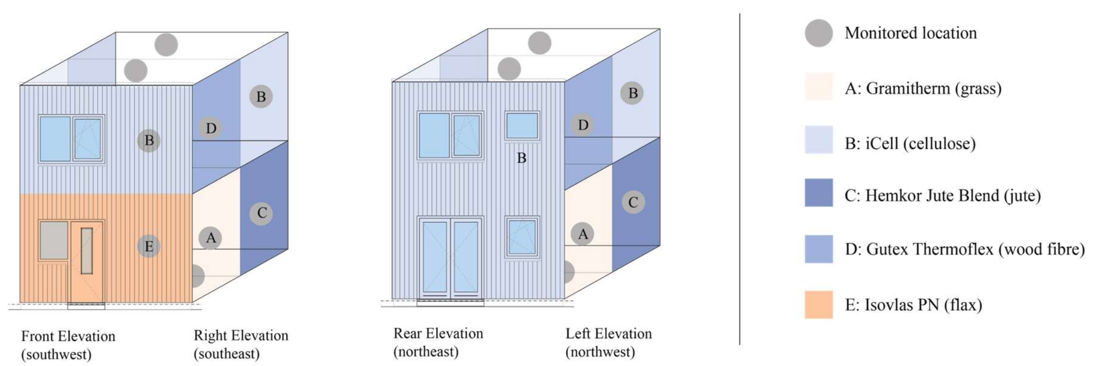

Figure 1. Test dwelling elevations and placement of biobased wall assemblies. Illustration showing the front, rear, and side elevations of the two identical test dwellings and the specific placement of the five biobased wall assemblies (A–E) across the various facades. Left is dwelling 1 without vapour barrier, right is dwelling 2 with vapour barrier.

1. **Dwelling 1** (without vapour barrier): Constructed with a vapour-open light timber frame wall assembly, where the interior vapour barrier is deliberately omitted.
2. **Dwelling 2** (with vapour barrier): Constructed with a standard vapour-closed wall assembly, incorporating the specified Profol PE Plano 150 µm foil as a conventional vapour barrier on the warm side of the insulation layer.

The biobased wall assemblies were designed to represent typical Dutch light timber frame (LTF) construction while allowing for a direct comparison between five biobased insulation materials (see Table 1). To ensure ease of manufacturing and uniform insulation thickness of 240 mm was maintained, despite the variations in thermal conductivity of the biobased insulation materials. Each dwelling incorporates five distinct wall assemblies, featuring the following specific biobased insulation products (as illustrated in Figure 1) that are the focus of the comparative study: (A) Gramitherm (Grass insulation); (B) iCell (Cellulose insulation); (C) Hemkor Jute Blend (Hemp and Jute fiber insulation); (D) Gutex Thermoflex (Wood fiber insulation); and (E) Isovlas PN (Flax insulation). These constructions are built according to Dutch national standards, ensuring the findings are directly applicable to the local building sector.[13]

Table 1. General layer composition of the wall assemblies (from outside to inside).

Layer	Function	Material	Material origin	λ-value (W/mK)	Thickness (mm)
1	Façade cladding	DumoWood	Wood	-	18
2	Air cavity including framework/wooden studs	Cavity	Wood and air	-	56
3	Membrane	MorgoVent 110	Polymeric	-	0.12
4	Exterior sheathing board	Siniat weather defence	Gypsum based	-	12,5
5A	Thermal insulation	Gramitherm	Grass	0.039	240
5B	Thermal insulation	iCell	Cellulose	0.036	240
5C	Thermal insulation	Hemkor Jute blend	Hemp and jute	0.040	240
5D	Thermal insulation	Gutex	Woodfibre	0.036	240
5E	Thermal insulation	Isovlas PN	Flax	0.035	240
6	Membrane	Profol PE Plano 150 µm	Polymer	-	0.15
7	Internal sheathing board	Elka ESB	Wood based	-	15

*Note: Layer 6 (vapour barrier) is only installed in Dwelling 2; it is omitted in Dwelling 1 to create a vapour-open assembly.

The field monitoring campaign is planned for a minimum duration of five years to capture comprehensive long-term seasonal effects, including multiple winter periods with possible condensation risks and summer periods with drying cycles in the Dutch climate. The external climate is continuously monitored. On-site local weather stations provide precise measurements of T and RH. These local measurements are supplemented by broader regional data from the nearby KNMI (Royal Netherlands Meteorological Institute) weather station in Eelde, which provides among others precipitation, wind speed, and solar irradiance.[14]

Since the dwellings are unoccupied, the interior conditions are actively managed to simulate typical human occupancy and to establish controlled boundary conditions. The temperature (T) setpoint is maintained at a constant minimum setpoint 20 °C during heating season to control the thermal gradient across the wall assembly. The RH is monitored passively. Following the validation of the initial monitoring equipment, controlled moisture sources (using humidifiers to introduce a daily moisture load based on established data) will be introduced.[15] The setup monitors the resulting indoor RH and to investigate the hygrothermal performance differences between the vapour-open and vapour-closed dwellings. This allows for an assessment of how the presence of a vapour barrier influence the indoor RH with a simulated living environment.

2.2. Instrumentation and Monitoring Parameters

The monitoring system is organized into two primary categories: whole-building environmental monitoring and interstitial wall assembly monitoring. All sensor data is logged automatically every hour.

Interstitial wall assembly monitoring

Monitoring equipment is placed within the wall assemblies of the Northwest, Southwest and Southeast facades (excluding the Northeast orientation). The interstitial monitoring focuses on capturing key hygrothermal parameters within the wall assemblies (Figure 2 and 3). In table 2 the sensor specifications are presented.

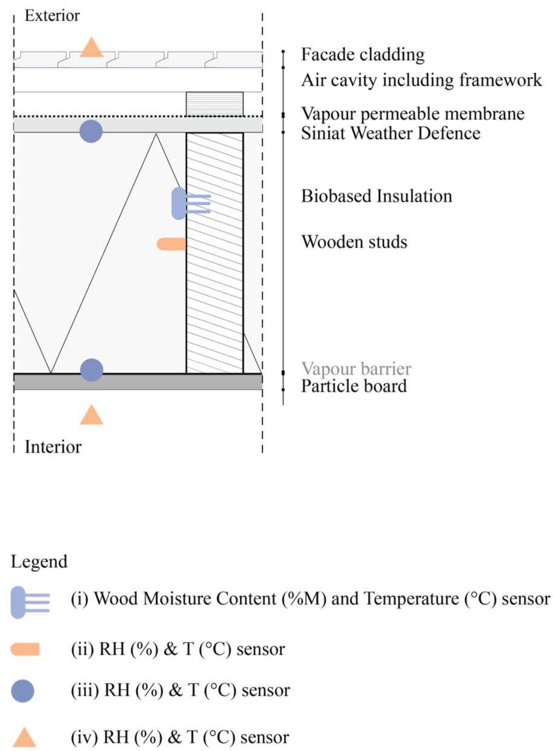

Figure 2. Schematic overview of sensor positions in the light timber frame wall assembly with biobased insulation.

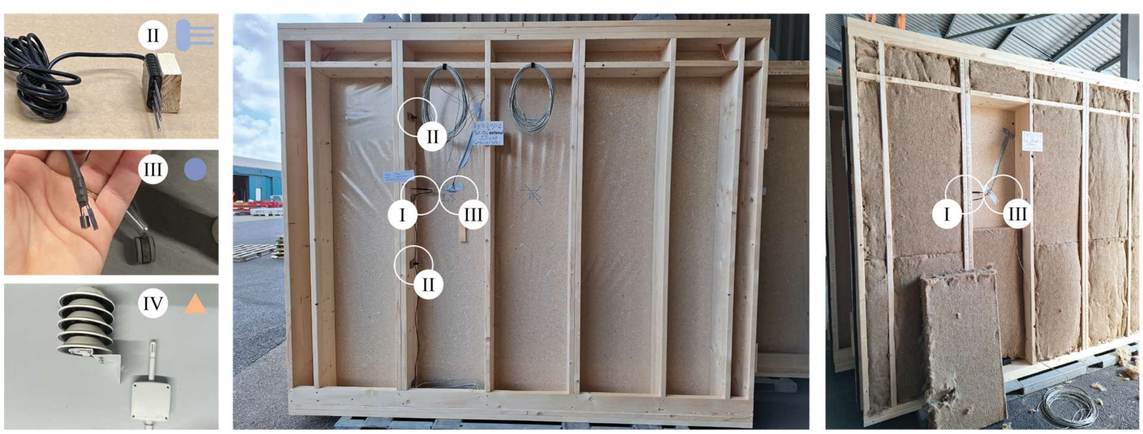

Figure 3. Overview used sensors (left). Sensor positions in the light timber frame wall assembly with biobased insulation (centre and right).

The following sensors are depicted in figure 3:

(i) Moisture Content (M% Wood): Wood Moisture Sensors provide a direct assessment of structural integrity by measuring M% in the load-bearing timber studs and timber frame elements (HSB elements) to ensure the critical decay threshold is not breached. The sensor is placed at a height of 1500 mm.

(ii) Relative Humidity (RH) and Temperature (T): measure RH and T at the centre (extra depth) of the element to observe bulk changes in the insulation material (one at a height of 1000, plus one at a height of 2000 mm and mid-depth of 120 mm within the 240 mm insulation).

(iii) Relative Humidity (RH) and Temperature (T): Wired sensors measure RH and T near the inner (most risk) and outer (least risk) surfaces of the insulation element. This data establishes a comprehensive hygrothermal profile for determining thermal gradients, locating the dew point (for condensation risk), and assessing mould growth risk (via isopleth analysis). The measured RH profile is used (in conjunction with laboratory-derived sorption isotherms) to determine the material's Moisture Content (M%) and calculate moisture-induced changes in thermal conductivity (λ-value) and R-value reduction. These sensors are placed at a height of 1500 mm.

(iv) Relative Humidity (RH) and Temperature (T): Wired sensors measure RH and T for exterior climate conditions. At a height of 1500 mm.

Table 2. Sensors details

Number	Manufacturer	Measuring Range	Accuracy
I	Dragino (LSE01 LoRaWAN Soil Moisture & EC Sensor.)	M%: 0 – 100% T: -40 °C – 85 °C	Moisture: ±3% (at 0-53%) / ±5% (at >53%) Temperature: < ±0.3 °C (between -10 °C and 50 °C)
II	Renesas (HS3001)	RH: 0% to 100% T: -55 °C – 150 °C	RH: ±1.5%RH, typical (HS3001, 10 to 90%RH, 25 °C) T: ±0.2 °C, typical (HS3001, HS3002, -10 to +80 °C)
III	RH: Honeywell (HIH 4000 series T: Texas Instruments (LM35/LP 0003A TO-92 - 5.34 mm max height)	RH: 0% to 100% T: −55 °C to 150 °C	RH: ±3.5%RH T: 0.5 °C Ensured Accuracy (at 25 °C)
IV	**Interior** RH: Honeywell (HIH 4000 series T: Texas Instruments (LM35/LP 0003A TO-92 - 5.34 mm max height) **Exterior** CaTec: EE210 with a Radiation shield HA010501 for type T13	**Interior** RH: 0% to 100% T: −55 °C to 150 °C **Exterior** RH: 0 – 100% T: -40 to +60 °C	**Interior** RH: ±3.5%RH T: 0.5 °C Ensured Accuracy (at 25 °C) **Exterior** RH: ±(1.6 + 0.005*measured value) %RH ±3 %RH T: 0.2 °C to 0.7 °C

Whole-Building and Environmental Monitoring

Table 3 summarizes the monitoring instruments and parameters used to establish the boundary conditions and assess the overall hygrothermal performance of the test dwellings. The indoor air is monitored to assess the moisture buffering capacity (MBC) and its potential influence on indoor RH. The T and RH of the crawl space was monitored to account for boundary effects on the thermal and moisture performance of the overall envelope. An exterior T and RH sensor was places to provide boundary conditions for analytical modelling. The KNMI weather data (T, RH, rainfall, cloud cover and solar irradiation) has been used to create the exterior boundary conditions for analytical modelling.

Table 3. Overview of Whole-Building and Environmental Monitoring Instrumentation

Location	Parameter	Location	Sensor type	Accuracy
Indoor air	T, RH	There is one sensor in the centre of the ground floor and one in the centre of the first floor.	III - RH: Honeywell (HIH 4000 series T: Texas Instruments (LM35/LP 0003A TO-92 - 5.34 mm max height)	RH: ±3.5%RH T: 0.5 °C Ensured Accuracy (at 25 °C)
Ground/Crawl space	T, RH	These sensors are placed in the middle of the crawl space.	II- Renesas (HS3001)	RH: ±1.5%RH, typical (HS3001, 10 to 90%RH, 25 °C) T: ±0.2 °C, typical (HS3001, HS3002, -10 to +80 °C)
Exterior (local)	T, RH	Near the dwellings.	IV Exterior: **Exterior**	RH: ±(1.6 + 0.005*measured value) %RH

			CaTec: EE210 with a Radiation shield HA010501 for type T13	±3 %RH T: 0.2 °C to 0.7 °C

2.3. Laboratory validation of material properties and supplementary testing

To ensure the accurate conversion of field RH and T measurements into meaningful M% data, laboratory testing should be performed on the five biobased insulation materials used in the field study. Hygroscopic sorption properties should be tested according to EN-ISO 12571:2021 to determine the sorption isotherms (the relationship between RH and M%).[16] This allows the field measurements (RH and T) to be accurately aligned with the M% of the material, for assessing R-value reduction and structural risk. Moisture content determination is measured by initial material moisture content via EN 12570 upon delivery to establish a baseline for long-term M% changes.[17] The water vapour diffusion coefficient is determined via NEN-EN-ISO 12572:2016 to characterize the moisture transport property of vapour permeability of the specific biobased materials used.[18] To ensure that observed moisture dynamics are primarily driven by vapour diffusion rather than uncontrolled air movement, the airtightness of both dwellings is compared via a blower door test. Pressure tests are performed regularly on both dwellings to verify that moisture transport due to air leakage is minimised and remains consistent between the two structures. This ensures that the comparative analysis focuses specifically on the performance of the vapour-open versus vapour-closed strategies.

2.4. Planned Analyses

The data collected hourly over five years will be subjected to the following analyses:

1. Moisture dynamics comparison: statistical tests (e.g. paired t-tests and mixed-effects models) will be used to compare the mean and variance of M% and interstitial RH between the vapour-open and vapour-closed assemblies. This directly tests hypothesis 1 (drying potential and structural integrity).
2. Thermal performance analysis: M% measurements will be used to calculate the time-dependent R-value reduction due to moisture uptake in both assembly types. The differences will be statistically compared to test hypothesis 2 (R-value reduction).
3. Mould risk assessment: interstitial T and RH data will be plotted on mould-growth isopleth diagrams to quantify the number of hours the wall assemblies operate above critical mould growth thresholds for each insulation type and assembly strategy.[19]
4. Moisture buffering capacity evaluation: Indoor RH fluctuations will be analysed and compared between the two dwellings to quantify the effectiveness of the hygroscopic materials in the vapour-open context, testing hypothesis 3 (moisture buffering capacity).
5. Simulation calibration: The measured field RH and M% data will be used to calibrate and refine complex hygrothermal simulation tools (e.g., WUFI) for increased reliability in predicting the performance of vapour-variable biobased assemblies for the Dutch climate.

3. DISCUSSION

Since data collection starts in 2026, at the end of January, results are not yet available. This discussion highlights methodological limitations and details the backup plans adopted to ensure robust data collection.

Although the experimental design is robust, several challenges and limitations inherent to real-world field studies may influence the results and their interpretation. The reliability of RH sensors over multi-year deployment is a challenge. Sensor drift is anticipated, and even minor miscalibration can lead to errors in calculating the dew point and the determined M% via sorption. To account for drift, the sensors need to be calibrated after the study to determine a possible correction factor.

While blower door tests will verify overall airtightness, undetected micro air leaks or construction errors around sensor penetrations could locally introduce advective moisture transport. This air movement, rather than the intended vapour diffusion, could severely affect the interstitial measurements and threaten the internal validity of the vapour diffusion comparison. An experimental study will be executed to gain more insight into the influence of such air leaks on moisture behaviour.

The buildings are currently unoccupied and lack furniture, textiles, and other interior fixtures. As noted by Kurnitski, these elements typically act as secondary moisture buffers.[20] Their absence means the wall assemblies are exposed to a disproportionately high vapour load, which may exaggerate the measured moisture dynamics compared to a truly occupied dwelling.
The planned controlled moisture source (humidifier) introduces a predictable, uniform moisture load. However, this differs fundamentally from the dynamic, localized moisture generated by human activities such as a high activity level, cooking, or showering, which could impact the vapour drive direction and magnitude differently.
The necessary cabling for the wired sensors creates penetrations through the assembly layers. Despite sealing efforts, these cables and the minor moisture reservoir they represent may locally affect the hygrothermal conditions within the component, or even act as unintended, localized air leaks.

To mitigate the identified risks and ensure the integrity of the data, the following additional backup plans are in place. The use of multiple, strategically doubled sensors (where financially feasible) allows for cross-validation and the statistical filtering of erratic readings due to drift or failure. If a sensor fails, physical replacement is impractical due to the embedded nature of the sensors; the resulting discontinuity in the time series will be noted, and data gaps will be addressed through statistical methods, such as fitting mixed-effects models that can accommodate incomplete data, or through gap-filling using localized weather station data as covariates.

Given that RH and T may differ significantly across the dwelling's volume (e.g., between the centre of the room and near an exterior wall), a simple, single conclusion about "indoor RH" will be avoided. Furthermore, the current hourly measurement interval for these boundary conditions might not capture rapid fluctuations in indoor climate sufficiently. If initial data analysis suggests that this frequency leads to missing critical peaks in moisture load, the sampling rate will be increased where possible, or additional localized sensors will be deployed to better map the spatial and temporal distribution of the indoor climate.

The two test buildings are now fully built. All sixteen wall assemblies (eight types in the vapour-closed building and eight in the vapour-open building) are finished and have been equipped with sensors. Data collection officially started on January 2026, with continuous recording from all environmental and wall sensors.

4. CONCLUSION

This paper presents a detailed methodology for a long-term field study designed to provide experimental validation for the use of biobased, vapour-open light timber frame systems, which are increasingly adopted to meet the Netherlands' demand for rapid, sustainable housing construction.

The research directly addresses the critical question of how the presence or absence of a conventional vapour barrier affects the moisture dynamics and structural integrity of these assemblies in a temperate, maritime climate (Cfb climate class). Specifically, the study aims to evaluate the performance of five distinct biobased insulation materials on two fronts:

1. Durability: assessing the assembly's drying potential to maintain the structural timber below the critical moisture content threshold (M% < 20%).[7] This threshold is essential to avoid the conditions for decay (i.e., sustained interstitial RH above 70% or 80%) in the temperature range of 15 °C to 30 °C).
2. Functionality: quantifying the moisture buffering capacity (MBC) of the hygroscopic materials to stabilize indoor RH.

The comparative experimental design, which simultaneously monitors interstitial RH, T and M%, forms a contribution to the field, offering a test case for LTF-systems under real-world Dutch boundary conditions. The results of this five-year monitoring campaign, including the detailed analysis of moisture accumulation, thermal performance reduction, and structural risk, will be presented in subsequent publications.

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6. ADITIONAL INFORMATION

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