Towards Harmonious Adaptation: Balancing Energy Performance and Cultural Values in Vernacular Dwellings

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https://doi.org/10.29227/IM-2025-02-02-075

Submission date: *2025-07-21* | Review date: *2025-08-27*

Abstract

Vernacular architecture is a significant part of cultural heritage but faces increasing pressure from current demands for improved building energy performance. Legislative frameworks and renovation programs often prioritize technical criteria over cultural-historical preservation, leading to irreversible alterations or even demolition. This study aims to identify and categorize the key values that should be considered in the harmonious restoration of vernacular architecture. The research focuses on selected buildings in the Červený Kameň microregion, analyzing their architectural substance, historical value, and relationship to energy performance. The study employs a multi-method approach, combining field research, historical analysis, and homeowner interviews to assess the impact of contemporary interventions. Findings indicate that the building envelope plays a crucial role in both preserving architectural identity and influencing thermal performance. Key features such as proportions (wall thickness, the ratio of solid to open surfaces, roof pitch) and structural tectonics (typical materials and construction systems) are often altered in attempts to improve energy efficiency, affecting both the visual and functional character of the buildings. Historical and field analysis shows that renovation practices frequently disregard traditional construction logic, resulting in loss of authenticity and even reduced long-term sustainability. Interviews with homeowners highlight financial constraints, unclear regulations, and a lack of expertise as key challenges. The study proposes a framework for assessing vernacular architecture, offering practical guidance for owners, architects, and policymakers to support culturally respectful and sustainable restoration.

Keywords: *vernacular dwellings, energy performance of buildings (EPB), cultural identity, continuity of building culture (CBC), harmonious adaptation method (HAVA)*

1. Introduction

The restoration process of existing buildings in Slovakia is currently heavily influenced by strict regulations regarding energy efficiency, driven by global pressures and EU directives such as the Fit for 55 package, often without adequate local, climatic, or cultural adaptation. In the case of buildings with cultural and historical value that are not protected as monuments, there is a lack of specific guidance or regulatory frameworks on how to approach restoration sensitively to preserve these values. Vernacular architecture, which constitutes a significant portion of Slovakia's rural building stock and embodies the identity of the Slovak countryside, often suffers from inadequate maintenance or insensitive renovations.

The tension between the need to preserve cultural and historical values and the application of new interventions to improve energy efficiency raises critical questions about identifying, categorizing, and weighing the values of vernacular architecture. This situation reflects a broader paradigm shift: whereas vernacular architecture was historically shaped by an organic adaptation to climate, landscape, and cultural traditions, the contemporary regulatory environment prioritizes technical performance, especially energy metrics, often at the expense of cultural continuity. Thus, restoration practices increasingly favor optimization of building physics parameters over the preservation of the intangible cultural layers embedded in the built environment. Such a regulatory imbalance exacerbates the disruption of building culture continuity, leading to irreversible loss of cultural landscapes and traditional knowledge.

This paper aims to address these challenges by proposing a framework for the assessment and restoration of vernacular architecture that integrates environmental, socio-cultural, and landscape factors. The proposed approach begins by examining the factors that have formed vernacular architecture (climate, landscape, and socio-cultural context), continues with the identification of key relations between these factors and the built form (such as proportions and materiality), and culminates in defining the limits of interventions that can ensure a balance between improved energy performance and cultural value preservation.

The aim of this paper is to introduce a methodological framework – Harmonious Adaptation of Vernacular Architecture (HAVA) – which seeks to define the values that must be considered before designing interventions. By combining architectural-historical analysis, field documentation, and community interviews in the model area of Red Rock Microregion the study proposes a method for identifying the “point of efficiency”: the threshold where interventions improve energy performance while maintaining authenticity, and where further changes become counterproductive and lead to the erosion of identity.

2. Dimensions of vernacular architecture

2.1 Forming Factors (FF) of vernacular architecture

In contemporary research on vernacular architecture, there is broad consensus that the foundational factors shaping its form, materiality, and spatial logic are primarily rooted in *climate, geography, socio-economic conditions, and cultural-historical context*. Chandel et al. emphasize the interplay between environmental conditions—such as temperature, rainfall, solar exposure, and terrain—and local building traditions, while also recognizing the decisive influence of social structures, economic means, and cultural practices on design choices and construction techniques [1]. Nguyen et al. through a global synthesis of 127 studies on vernacular architecture, confirm that these same categories—climatic zones, geographic location, cultural values, and local lifestyles—are recurrent determinants across diverse vernacular traditions. These forming factors represent a common analytical framework used to interpret and evaluate vernacular built environments, offering a basis for further investigation into their adaptation, transformation, and relevance in contemporary contexts [2].

These forming factors are not isolated and static but always interconnected and dynamic. Climate influences not only the material used and urban composition, but also lifestyle patterns and social customs that feed into spatial organization. Similarly, cultural-historical layers shape the symbolic, functional, and communal roles of dwellings, while socio-economic dynamics determine the feasibility and durability of construction techniques. In this paper, these factors are not treated as static background conditions, but as active forces that continuously shape and reshape vernacular forms. By identifying how they manifest in specific regional contexts—whether in relation to landscape typologies, construction culture, or everyday practices—we can better understand the resilience and adaptability of vernacular architecture. This layered understanding also serves as the starting point for the proposed HAVA methodology, which acknowledges how vernacular architecture was historically shaped by these forming factors and how they remain dynamic today—climate, land use, and cultural practices continue to evolve—and seeks ways to sensitively adapt existing structures in response to these ongoing changes, particularly in the case of pre-1947 rural dwellings in Slovakia.

2.2 Characteristic features (CHF) of vernacular architecture

If the forming factors define the environmental, cultural, and social context of vernacular architecture, the characteristic features represent its tangible and spatial expression. These features are not universal: they are deeply rooted in place and reflect the belonging of buildings in their climatic, geographical, socio-economic, and cultural-historical settings.

As Chandel et al. point out, vernacular dwellings evolve through direct response to local conditions—both physical and cultural—resulting in recurring, yet highly localized, elements such as thick adobe walls in hot-arid zones, wind catchers in Middle Eastern desert environments, or underground summer rooms in Yazd, Iran [1].

Similarly, El-Borombaly et al. confirm that typologies like wind catchers (malqaf) in traditional Egyptian architecture are not stylistic artifacts but intentional passive cooling devices designed for hot-arid climates [3]. In Arctic contexts, Mackin demonstrates that turf-covered domes and catenary structures are purposefully shaped to minimize heat loss, reduce surface exposure, and respond to extreme cold through high thermal inertia and efficient insulation [4].

Characteristic features cannot be neatly divided into qualitative and quantitative categories, because many of them embody both dimensions. For instance, proportions of walls or window frames carry a strong cultural and stylistic meaning, while at the same time they can be measured in terms of thermal performance and energy balance. Similarly, wall thickness or roof pitch express construction tradition and architectural identity, yet also directly determine heat transfer, thermal mass, or solar gain. This dual nature makes CHF a critical interface between cultural values and energy performance, and highlights the need for integrative approaches to their assessment. In Arctic dwellings documented by Mackin, the form (catenary domes), materials (moss, turf, snow), and construction logic (minimal surface-to-volume ratio, passive heat retention) reflect both a cultural tradition and high-performance climate adaptation [4]. Similarly, vernacular structures in tropical regions incorporate large shaded verandahs and high ceilings not only for social interaction, but also for cross-ventilation and heat dissipation [3].

Nguyen et al., through their global synthesis of 127 case studies, go beyond merely linking climatic conditions to regional architectural expressions. They also examine whether there is a correlation between specific climatic zones and the methodologies used to assess vernacular architecture in those regions—suggesting that certain climates may shape not only building forms but also the research approaches applied to understand them. [2] The study also supports the hypothesis that the energy focused research is quite dominant in areas concerning adaptation or restoration of vernacular architecture. According to their global study, 60% of the 127 case studies focus on passive, bioclimatic, environmental, or ecological design principles, while 20% emphasize cultural, social, and intellectual values. Notably, in most of the studies, the conservation of vernacular architecture is not identified as the primary objective (Nguyen et al. 2019).

This observation aligns with Olukoya's critique of standardized heritage value typologies and instead argues for context-sensitive frameworks that integrate community knowledge, participatory processes, and place-specific heritage values [5]. The direct relationship between forming factors and characteristic features means that any methodology for evaluating or adapting vernacular architecture must take into account the *local hierarchy of values*—whether it privileges thermal performance, material authenticity, cultural symbolism, or spatial hierarchy. Nguyen et al. suggest that even in global studies, regional clusters tend to prioritize different features when assessing or adapting vernacular buildings, for example, in hot-humid climates, ventilation and shading dominate as key values, whereas in cold climates, compact massing and insulation are more central. Furthermore, the methodologies themselves vary: Nguyen shows that quantitative experimental methods dominate highly cited studies focused on energy performance, while qualitative interpretive approaches are more common in culturally oriented studies [2].

Therefore, the features of vernacular architecture must be understood not only as physical outcomes of environmental constraints, but as value-laden expressions of community knowledge, resilience, and identity. Their relevance to contemporary challenges such as energy efficiency must be evaluated through this dual lens—of measurable performance and culturally embedded meaning.

2.3 Continuity of Building Culture (CBC)

Building culture is a complex phenomenon shaped not only by the resulting structure, but by the entire process—from demand and design, through craftsmanship and construction, to use, maintenance, renewal, and ultimately demolition or recycling of materials at the end of the life cycle. Its essence lies in the relationships between the forming factors (climate, culture, landscape) and the characteristic features of architecture (materiality, proportion, construction, detail), which at the same time reflect the way of life of

the community. If forming factors define the conditions and characteristic features embody them, continuity of building culture represents the ongoing negotiation between the two.

In the context of vernacular architecture, this continuity depends on the extent to which the process of adaptation respects these characteristic features and integrates them with contemporary requirements of energy performance. Each act of restoration adds a new cultural layer that speaks about its time: whether it takes the form of the cheapest solution—polystyrene insulation covered by thin-layer render in bright colors—or a careful adaptation that preserves the identity of both the dwelling and the community. In the Slovak countryside, this continuity has been significantly disrupted in recent decades. As Bránický observed, "*The lack of contextuality of such architectural undertakings is a frequent problem of the Slovak countryside and also one of the conditioning factors of the decline of building culture* [6]." The disruption of traditional building culture thus directly translates into the erosion of local identity. Similarly, later studies emphasize that "*The disrupted building tradition has caused significant damage, and the identity of some villages is at present difficult to define* [7]"

Instead of widespread replacement of traditional layers with cheap materials or imitations of craftsmanship, restoration should aim for harmonization—so that adaptation simultaneously protects cultural-historical identity and responds to new functional and environmental requirements. In other words, continuity in building culture is not about freezing vernacular forms, but about ensuring that interventions contribute to both cultural meaning and environmental performance.

3. Challenges in the adaptation of vernacular architecture

3.1 Sustainability and energy efficiency regulations

The global effort to mitigate climate change and promote sustainable development is reflected in architecture through three main pillars: environmental, economic, and social. The foundations of this approach were laid at the Earth Summit in 1992, Rio Declaration, Agenda 21 [8] and later strengthened by international and European legislation. A milestone for the building sector was Directive 2002/91/EC on the energy performance of buildings, which introduced mandatory energy assessment, minimum requirements for new and existing buildings, and certification schemes. [9] This directive was later recast and updated, most recently in 2024, when the revised EPBD introduced Minimum Energy Performance Standards (MEPS). These standards require the worst-performing buildings (energy class F) to be renovated to at least class E by 2030, and those in class E to reach class D by 2033. [10] This represents a fundamental shift from voluntary improvements to mandatory renovation targets, placing strong pressure on existing housing stock—including vernacular dwellings.

In Slovakia, this directive was implemented through Act 555/2005 Coll. on the energy performance of buildings, which, however, does not apply to buildings constructed before 1947. [11] These include most vernacular dwellings that form the subject of this study. Nevertheless, such houses are frequently renovated within subsidy schemes such as the Slovak Recovery and Resilience Plan, often without specific guidelines for protecting their cultural-historical values. This promotes standardized solutions that undermine authenticity and disrupt continuity of building culture.

3.2 Paradigm shift: culture as part of sustainability

Until recently, sustainability in architecture was reduced mainly to environmental and energy aspects, while cultural values remained marginal. Culture was viewed as a subset of the social pillar, which hindered its systematic inclusion in decision-making. [12] In the past decade, however, a paradigm shift has occurred: research and practice increasingly emphasize the need to integrate climate, environment, and culture. This trend is reinforced by initiatives such as the UNESCO Culture 2030 Indicators, the New European Bauhaus, and the UN Sustainable Development Goals (SDG 11).

3.3 Energy performance of buildings (EPB) and vernacular architecture

Energy performance of a building is an indicator expressing the amount of energy required for its normal operation. Act No. 555/2005 Coll. on the energy performance of buildings defines that the assessment includes energy needed for heating, cooling, domestic hot water, ventilation, and lighting. The aim of the legislation is to reduce the energy demand of buildings while simultaneously limiting greenhouse gas emissions, based on minimum energy performance requirements and the obligation that new buildings must comply with the standard of nearly zero-energy buildings. [11]

The details are specified in Decree No. 364/2012 Coll., which establishes the methodology for calculating energy performance, standardized input values, and the classification of buildings into energy efficiency classes (A0, A1, B, C, D, E, F, G). Buildings approved after 2021 must reach the highest class A0, which corresponds to very low primary energy consumption, with part of this energy required to come from renewable sources. [13] From 2024, the revised EPBD also introduces Minimum Energy Performance Standards (MEPS), which set binding renovation targets (class F → E by 2030, class E → D by 2033), adding direct pressure on the existing housing stock. [10] Member states, including Slovakia, are required to transpose the directive into national legislation by May 2026, which means the framework for implementation is currently in preparation.

Vernacular dwellings that are the object of our focus originate mainly from the 17th–19th centuries, long before current building standards were introduced. According to Slovak Act 555/2005 Coll., minimum energy performance requirements (EPB) formally apply only to buildings constructed after 1947, which has so far left vernacular houses outside the scope of the law. [11] This situation is about to change: under the revised EU directive and its planned transposition by May 2026, even the oldest parts of the residential building stock will gradually fall under Minimum Energy Performance Standards (MEPS). [10] Nevertheless, these houses are frequently renovated in practice—partly due to the climate crisis and commitments in the field of energy efficiency, and partly because of the availability of national and EU subsidy schemes. For instance, the program NextGenerationEU, launched in 2022 and running until 2026, offered financial support for the renovation of older houses. Every owner of a family house older than ten years could obtain €15,000 if the renovation (typically through insulation) achieved at least 30% savings in energy consumption, or €19,000 if the savings exceeded 60% [14]. In [*Fig.* 3], we can see examples of how such a renovation can look: all characteristic features were covered under polystyrene, while materiality, proportion, and colour were completely eradicated. This paradox shows that although vernacular dwellings were legally exempt until now, in practice they are already pushed into standardized schemes of renovation without guidance on how to protect their cultural-historical values. Energy performance is therefore becoming increasingly decisive in the restoration of historic and vernacular building stock.

3.4 Main evaluated parameters

According to the law and implementing decree, the following indicators are primarily assessed:

- *Overall energy demand of the building* – expresses all energy required for operation.
- *Primary energy consumption* – considers not only final consumption but also the production and distribution chain, thus favouring renewable sources.
- *Specific heat demand for heating (kWh/m²·year)* – a key indicator for residential buildings.
- *Thermal performance of the building envelope* – heat transfer coefficient (U-value) for walls, roofs, floors, windows, and doors.
- *Efficiency of technical building systems (TBS)* – particularly heating systems, domestic hot water preparation, ventilation (with or without heat recovery), and integrated lighting.
- *Share of renewable energy sources* – the obligation to assess the potential use of solar collectors, photovoltaic panels, biomass, or heat pumps.

Although vernacular architecture contains a wide range of characteristic features, this study focuses on the thermal envelope—walls, roofs, windows, doors, and gates. When assessing energy performance, the indicators are directly linked to the thermal envelope: the composition of walls and roofs defines insulation properties, the type and installation of windows influences heat loss and daylight, and the efficiency of heating and ventilation systems determines overall primary energy demand. These elements are decisive both for energy performance and for the cultural identity of buildings. At the same time, they are easily accessible for analysis from the street or via remote documentation tools such as Google Maps, which makes them a practical entry point for assessing the tension between energy requirements and authenticity. In this sense, the thermal envelope becomes not only a technical parameter of building physics, but also a cultural marker—its alteration can simultaneously improve or undermine both energy efficiency and architectural identity.

3.5 Paradigm shift in the adaptation of vernacular architecture

Historically, vernacular architecture represented an organic adaptation to local conditions. Over the past fifty years, however, profound social, technological, and climatic changes have transformed both rural life and building practices. With globalization and the standardization of construction processes, vernacular houses have often been rebuilt according to external technical or aesthetic principles, disregarding their climatic, material, and cultural context. This has eroded their homogeneity—once sustained for centuries through the repetition of archetypal forms optimally responding to local conditions.

The result is a loss of authenticity in individual houses and in settlements as a whole, accompanied by the disruption of continuity in building culture that historically underpinned local identity and sustainable living. Contemporary interventions thus often fragment the traditional rural fabric and diminish its passive resilience to climate. These developments underline the need for new methodological approaches to restoration—approaches that respect original values while addressing current challenges of climate change and energy performance. The HAVA framework, proposed in this study, emerges as a direct response to these challenges.

4. Research methods

The research is based on a multi-level qualitative approach aimed at analyzing the vernacular architecture of the Červený Kameň microregion in relation to its cultural-historical values and the contemporary requirements for building energy performance.

The first step was an architectural-historical analysis of archetypal house forms, drawing on historical maps, archival photographs, and field surveys. The characteristic features of the thermal envelope (walls, roof, windows, doors, and gate) and their proportions and materiality were established as reference points for subsequent comparison.

The second step focused on the analysis of unregulated renovations, in which the original archetypes were compared with available examples of inappropriate interventions. Sources included field documentation and visual records from Google Maps (2012–2025), which made it possible to trace the dynamics of changes over time.

The third step was a sociological survey based on structured interviews with mayors of municipalities and owners of five houses in Štefanová, Vištuk, Dubová, and Doľany. The interviews addressed the relationship to the house, motivations and experiences with renovation, perceptions of characteristic features, and the barriers encountered in preserving authenticity.

On the basis of these data, an evaluative framework—a "methodological bridge"—was developed, comparing the archetypal form of the house with its disruptive renovations in terms of materiality and proportion, while assessing their impact through two dimensions: energy performance and the continuity of building culture.

The synthesis tool is the Harmonious Adaptation of Vernacular Architecture (HAVA) method. Its core lies in identifying the "point of efficiency"—a locally defined threshold where interventions in materiality or proportion still contribute to energy performance without undermining characteristic features and identity. The process consists of identifying the archetype, analyzing negative interventions, defining the point of efficiency, and verifying it through community and municipal participation, ensuring both technical effectiveness and social acceptability.

5. Case study: Microregion Red Rock

5.1 Context – Forming Factors (FF)

The territory of today's Microregion Red Rock (MRR) is historically linked to the Red Rock estate, whose center was the Red Rock Castle, built in the first half of the 13th century. Over the centuries, the estate was owned by several noble families, most significantly the Pálffy family, which had a decisive influence on the economic, social, and architectural development of the region [15].

The estate stretched across the southern slopes of the Little Carpathians and the adjacent Trnava Plain, creating a unified economic framework (winegrowing, forestry, water mills, crafts) and a related architectural homogeneity of settlements. All villages of today's MRR (Dubová, Píla, Doľany, Budmerice, Štefanová, Vištuk, Báhoň, and Jablonec) — with the exception of Báhoň — historically belonged to the estate [Fig. 1]. They therefore share similar forming factors (FF)—climatic, landscape, and socio-cultural conditions—and consequently a related archetype of vernacular dwellings.

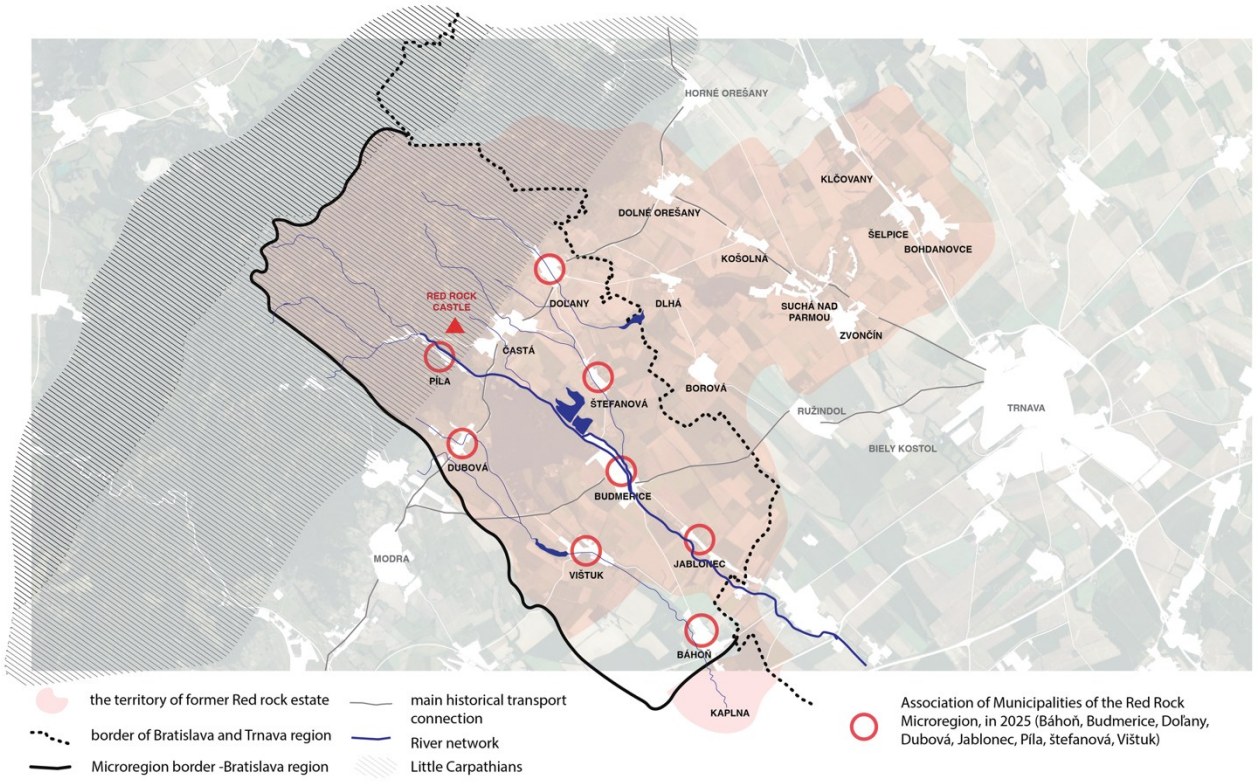

Fig. 1. Microregion Red Rock and current administrative division (source: googlemaps, openstreetmap; graphic: author)

Political and Economic Changes in the 20th Century

The 20th century brought profound political and economic transformations that directly reshaped the rural environment and disrupted the continuity of building culture. The confiscation of large estates and the introduction of agricultural collectivization (from 1949) broke the traditional economic model on which vernacular architecture had long depended. The loss of craftsmanship, the disappearance of local construction expertise, and the unification of materials and building techniques began to manifest themselves in the second half of the century.

Another turning point came after 1989 with the privatization of property and the opening of the market to new materials and technologies. This led to rapid and often insensitive interventions in traditional houses. In recent decades, the process has accelerated further under the influence of globalization and the standardization of the construction industry.

Administrative division and its consequences

Today, the Microregion Red Rock is administratively divided between the Bratislava and Trnava regions. This division creates complications for the coordinated protection and restoration of architectural heritage. Spatial planning documentation is prepared individually at the level of municipalities and rarely contain binding regulations aimed at preserving the characteristic features of vernacular architecture. As a result, heritage values are addressed inconsistently: while some municipalities attempt to integrate conservation principles, others focus almost exclusively on new development.

The absence of a regional framework becomes evident not only in the restoration of historic houses but also in the placement of new construction within historic environments. Without shared guidelines, interventions often follow short-term functional or economic priorities rather than the long-term continuity of building culture.

The lack of a unified methodological framework is most evident in the use of subsidy schemes. In the Microregion Red Rock, as elsewhere in Slovakia, houses restored through the Recovery and Resilience Plan often meet energy standards but undermine architectural identity—through altered window proportions, inappropriate renders on clay walls, or the loss of traditional roofing and colors.

5.2 Archetype of Vernacular Dwelling in the Microregion Red Rock (FF → CHF)

Across the territory of today's Microregion Red Rock, the development of the archetypal rural house follows a principally unified pattern. This archetype is not only characteristic of the entire Red Rock estate, but in a broader sense also of the Little Carpathian region.

The orography of the area strongly determined the form of villages: settlements at the foot of the Little Carpathians (e.g., Dubová, Častá) feature street alignments parallel to the ridge. The exceptions are Doľany and Píla, where the origin and orientation of the villages core were conditioned by a watercourse, which also shaped its urbanism. Whereas villages on the lowlands of the Trnava Plain (Vištuk, Budmerice, Štefanová, Jablonec, Báhoň) are oriented perpendicular to it. The settlement structure is based on elongated plots with linear development. Houses were oriented perpendicularly to the street and opened towards the courtyard, behind them followed a farm garden and vineyard, or an orchard.

Architectural specificities of individual villages (e.g., the form of gates—with arched lintels in Doľany and rectangular ones elsewhere, or different approaches to façade decoration) constitute an important part of cultural identity. However, they do not have a decisive impact on energy performance. For this reason, the subsequent analysis focuses on characteristic features (CHF) that directly affect the thermal envelope of the house.

5.3 Development Phases of the Archetype (FF → CHF)

First phase: The linear three-space vernacular dwelling [Fig. 2]

The house was oriented with its narrow façade towards the street and extended perpendicularly into the plot. The courtyard was originally open to the street, later enclosed by a wall with a gate. The three-space layout consisted of a sequence from the street: room – entrance with a black kitchen – room/storage. Along the longitudinal axis, additional farm structures (pantry, stable, barn) were built as needed. The entrance led from the courtyard side into the central hall. Structurally, it was primarily an earthen construction made of unfired adobe bricks, combined with stone or timber framing. The roof consisted of a wooden truss, originally covered with thatch and later replaced by ceramic tiles. [16]

The choice of materials was deeply rooted in the local environment and its economic use: clay was employed universally—as a building block, as mortar, as plaster, and even for floors and stoves—while stone (mostly slate) formed the foundations. Timber from the communal forests supplied structural elements, and sand and white siliceous sands extracted from local pits and ponds were used in renders. These material resources, directly tied to the agricultural and forestry economy of the Red Rock estate, explain both the materiality and durability of the archetypal dwelling. [17]

Second phase: Transformations from the 18th century onwards [Fig. 2]

During this period, courtyards began to be enclosed, and a second wing parallel to the street was added to the original house. This created an L-shaped dwelling with a carriage passage leading into the courtyard. The entrance was moved directly from the street into a new hall, connected to a room or storage. The passage itself was roofed and became part of the building volume. Depending on the width of the plot and the wealth of the owner, variants of L-shaped houses developed on narrow plots (approx. 10 m) [Fig. 2] or wide plots (approx. 20 m) [Fig. 2] [17]

These transformations reflected both social differentiation (wealthier households extending their dwellings) and technical innovation (e.g., local production of fired bricks in the interwar period). Yet, they still relied on the same palette of local materials—clay, stone, timber, ceramic tiles—that tied the architecture to its environmental and cultural context. [17]

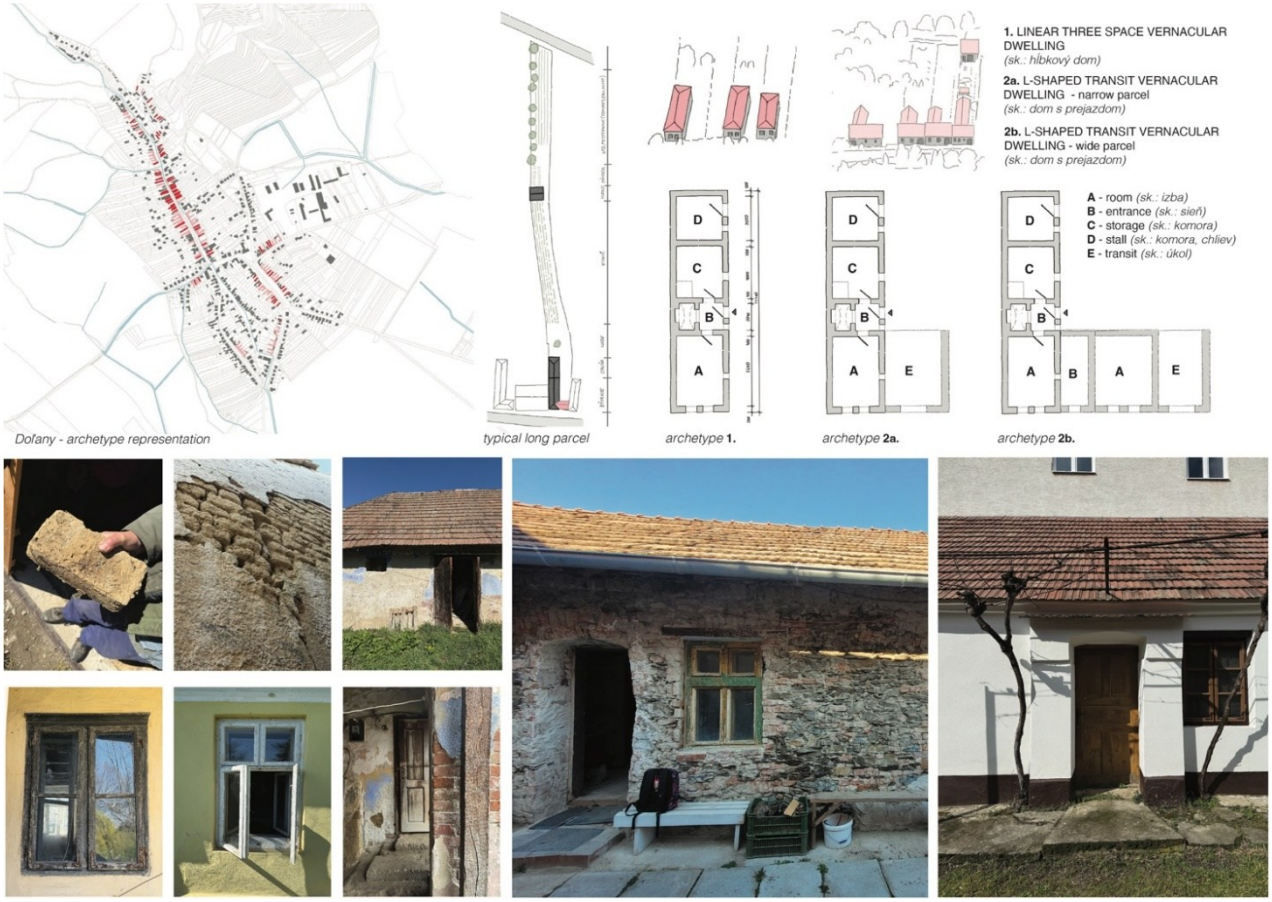

Fig. 2. Archetype of Red Rock Microregion (top, left to right) example from the municipality of Doľany with archetype representation; typical long parcel/plot; two development phases of the archetype (1 and 2a, 2b); photo documentation of adobe brick, blue plaster of a barn, typical wooden double windows, and ceramic roofing tile (sketches: Kristína Djobeková and author; photographs: author)

5.4 Thermal envelope and characteristic features (CHF)

The thermal envelope of vernacular houses in the Microregion Red Rock is defined by external walls of *unfired adobe bricks* combined with stone or timber framing and finished with lime plaster, which ensured breathability and moisture control. Windows were originally double wooden frames, carefully proportioned to balance daylight and heat loss. Roofs consisted of timber trusses, covered first with thatch and later with ceramic tiles, many of which survive today. Façades followed a regional palette: lime renders in beige tones with dark plinths, while outbuildings were often painted blue. [Fig. 2] Floors show similar continuity—clay or ceramic tiles in halls and storage rooms, and timber boards in living spaces—though rising damp remains a recurrent problem.

These features form a consistent architectural language where materiality, proportion, and detail express both climatic adaptation and cultural identity.

5.5 Disruptive Renovation in the Red Rock Microregion

Unregulated renovation—interventions carried out without methodological guidance—has significantly altered the characteristic features (CHF) of the thermal envelope of houses. This is clearly observable through Google Maps records from 2012–2025. In [Fig. 3] the first column shows three archetypes of the region: the linear three-space house (1), the L-shaped transit house on a narrow plot (2a), and the L-shaped transit house on a wide plot (2b). The following two columns illustrate representative examples of these archetypes after unregulated renovation.

The changes are visible in the very materiality of external walls, where lime plasters were replaced by industrial thin-layer systems. Wooden double windows were substituted by plastic ones, often with different frame proportions and subdivisions. The overall façade proportion was distorted by additional insulation, which modified the original volumetric composition of the house. Traditional ceramic tiles were replaced by inappropriate roofing materials, and the typical lime-based color palette largely disappeared.

As a result, the continuity of building culture (CBC) is disrupted: villages lose their homogeneity, craftsmanship details vanish, and the authentic historical layer is replaced by a cheap, universal coating that disregards local traditions. Such unregulated interventions may be referred to as *disruptive renovations*, given their impact on the continuity of building culture (CBC).

It is important to note that these dwellings are not protected monuments. Renovation is therefore not subject to binding conservation rules, which raises the key methodological question: to what extent should interventions be measured against the archetype? While CHF such as materiality or proportion clearly embody cultural meaning, they are also difficult to evaluate without a rigid normative framework. This ambiguity makes it challenging to determine the threshold between acceptable adaptation and irreversible loss of identity. In this study, this challenge is approached by linking CHF to energy performance (EPB) and by seeking the point of efficiency—the moment when interventions still enhance energy balance without negating the cultural identity of the archetype.

Fig. 3. Examples of disruptive renovations in the Red Rock Microregion. First column: archetypal forms; Second and third columns: representative examples after renovation, showing changes in wall materiality, window proportions, façade insulation, roof covering, and color palette (first column from top: 1. photo [18], 2a. photo [19], 2b. photo [20]; second and third column: google maps)

5.6 Sociological factor

As part of the research, structured interviews were conducted with the mayors of the municipalities of the Red Rock Microregion and with the owners of five houses that have not undergone major renovation and still preserve characteristic features of the thermal envelope (CHF). The interviews were carried out in Štefanová (2 houses), Vištuk, Dubová, and Doľany. [Fig. 4]

The interviews revealed that residents have a positive relationship to their houses, seeing them as part of both family and local identity, and perceiving them as a value they wish to preserve. Yet in practice, CHF often evoke uncertainty and helplessness. Homeowners do not know how to proceed technically so that their houses remain functional while retaining their authenticity. Several respondents expressed that they would welcome expert advice or municipal guidance, but such support is lacking in practice.

The individual cases illustrate different approaches and outcomes. In Vištuk, the owners attempted renovation by replacing windows, adjusting plaster, or modifying utilities; however, these were emergency measures that significantly disturbed the original layers on the courtyard side. From the street, the house still appears intact, but it is at risk of collapse. In Štefanová, one of the oldest houses in the village has been continuously restored across generations using traditional techniques. The owners managed to preserve its archetypal form and characteristic features, which makes it a rare example of long-term continuity in building culture. Doľany represents another positive example, where restoration was carried out sensitively, respecting the archetype. The work was done with the help of neighbors and local craftsmen, reflecting the importance of community in sustaining building culture. However, as energy

efficiency and indoor comfort were not addressed, the house remained uninhabitable and today functions more as an exhibit. Conversely, one case (house not pictured) showed the opposite: an owner, discouraged by negative experiences with professionals, rejected any external help and renovates the house on his own—with limited success. Residents in this case focused mainly on damp remediation, but without a clear methodology these interventions remained partial and long-term ineffective.

A strong common denominator across all interviews was the emphasis on community. Residents agreed that regulation without participation is meaningless. In the past, there existed a natural network of family and neighborly relations, complemented by local craftsmen, which ensured the continuity of traditional building practices (CBC). Today, however, due to lifestyle changes, generations no longer live together, and construction solutions are replaced by universal products of commercial companies, regardless of regional context. This weakens cultural identity and leads to isolated, often unsuccessful, attempts at restoration.

The findings therefore confirm that any methodology of adaptation in specific regions such as the Red Rock Microregion must be built on a participatory framework. Regulations or recommendations will be effective only if accompanied by long-term community engagement, the provision of clear examples of both good and bad practices, practical manuals, and lists of recommended materials and manufacturers. In this sense, the weighing of qualitative values—deciding what counts as "authentic enough" and worth preserving—becomes not a technical decision, but a negotiated outcome of dialogue within the community. Participation and systematic education of residents thus emerge as the key precondition for preserving CHF—and with them, the overall identity of the territory.

Fig. 4. Measured houses in the Red Rock Microregion, where structured interviews with the owners were also conducted (Doľany, Vištuk, Dubová, Štefanová) (source: author)

6. Searching for efficiency in the adaptation of vernacular architecture

6.1 Relationships shaping the Continuity of Building Culture (CBC)

Continuity of building culture emerges from the interaction between forming factors (FF) that conditioned the origin of characteristic features (CHF). In the contemporary context, the adaptation of these features is increasingly subjected to the requirements of energy performance of buildings (EPB). This creates a field of tension between two poles: on one side, the archetype as a reference of continuity; on the other, disruptive renovation, which may raise EPB but suppresses cultural identity and specificity.

The methodological bridge developed in this study compares these two poles by abstracting CHF to their materiality and proportion in the thermal envelope, and by assessing how their alteration affects both EPB and CBC. In this sense, the archetype embodies low energy performance but high cultural continuity, whereas disruptive renovation often achieves the opposite—high energy performance at the cost of cultural loss. [tab. 1]

Tab. 1 – Methodological bridge between archetype, efficiency threshold, and disruptive renovation

	Characteristic features (CHF) of thermal envelope			EPB *(Energy Performance of Buildings)*	CBC *(Continuity of Building Culture)*
	building fabric	matriality	proportion		
Archetype	wall	unfired adobe bricks and clay daub combined with stone; lime plaster	thickness 50–60 cm; height of wall-to-roof ratio approx. 1:1	low	high
	roof	timber truss, originally thatch (not preserved), later ceramic tiles	pitch approx. 45°; gable or hipped; in rows gable with fire wall		
	openings: windows, doors, gate	wooden double windows; outer frame flush with façade; simple wooden doors recessed; wooden gates	windows vertical orientation 1:2, subdivided into 4–6 panes		
	Harmonious Adaptation of Vernacular Architecture (HAVA)			**efficiency threshold**	
Disruptive renovation	wall	original clay walls covered with contact insulation system; thin-layer acrylic plasters	altered wall-to-roof ratio after insulation; proportionally distorted	high	low
	roof	ceramic tiles replaced with concrete tiles or sheet metal	changed ridge/eaves height; disrupted roofscape homogeneity		
	openings: windows, doors, gate	wooden replaced with plastic; gates of steel or sheet metal	Windows horizontal or with altered proportions (1:1, wider); loss of subdivision		

6.2 The Harmonious Adaptation of Vernacular Architecture (HAVA)

The HAVA method is proposed as a pathway between these extremes. Its core is the search for the *efficiency threshold* - the boundary where interventions in materiality or proportion still improve EPB while maintaining cultural continuity. Beyond this threshold, interventions cease to bring significant efficiency gains and become merely cheaper alternatives that erode identity.

The process can be described in five stages:

I. Identification of the archetype – documentation of the original building fabric and CHF as a reference point.
II. Analysis of negative interventions – comparison with disruptive renovations, assessing changes in materiality and proportion and their impact on CBC and EPB.
III. Defining the efficiency threshold – locating the boundary where interventions remain both energy-relevant and culturally acceptable.
IV. Participatory framework – engaging residents, municipalities, and professionals to test and verify the threshold through community input.
V. Formulation of recommendations – developing concrete guidelines for restoration (materials, acceptable ranges of proportion, types of insulation) that preserve identity while improving energy performance.

6.3 From Framework to Quantification

At this stage, the results define a conceptual framework rather than a finished solution. The next and most critical step will be to quantify energy performance across both poles (archetype vs. disruptive renovation) and to model intermediate scenarios. This will make it possible to calculate, for instance, whether it is more efficient to leave a house uninsulated, to apply internal insulation or thermal plaster, to use external insulation with alternative natural materials (e.g., wood fibre boards), or to recognize the point at which interventions that radically alter proportions are no longer culturally or energetically defensible.

Through such comparative EPB modelling, the methodological bridge will evolve into a *decision-making tool* that does not only describe the conflict, but actively locates the efficiency threshold for each type of intervention. This will allow future restoration to balance cultural-historical identity and energy performance in measurable, context-sensitive ways.

7. Conclusion

The case study of the Microregion Red Rock has shown that the adaptation of vernacular houses is shaped by multiple, interlinked dimensions. Vernacular archetypes themselves emerged historically from unregulated yet deeply contextualized building practices that responded to geography, climate, and socio-cultural conditions. In contrast, today's unregulated renovations are largely driven by standardized materials, subsidy schemes, and the requirements of Energy Performance of Buildings (EPB). As a result, they often lose touch with local forming factors and continuity in building culture (CBC).

Alterations to the thermal envelope—such as external insulation, plastic windows, or inappropriate roof coverings—may bring measurable improvements in energy performance. Yet they simultaneously disrupt continuity in material use and typical proportions, details, craftsmanship, and local distinctiveness. Interviews with homeowners further revealed that although attachment to the dwellings remains strong, the absence of expert guidance and participatory frameworks results in uncertainty and partial, often ineffective interventions.

In response, the Harmonious Adaptation of Vernacular Architecture (HAVA) method introduces the concept of an efficiency threshold: the point at which interventions into characteristic features (CHF) still contribute to energy performance while maintaining continuity in building culture. This approach situates renovation between two poles—the archetype as a reference of continuity and the disruptive renovation subordinated to energy performance alone. The aim is not to preserve every detail sentimentally, but to allow for new cultural layers and materials as long as they remain responsive to context and identity.

As a further step, it is important to critically reflect on EPB indicators themselves. While they provide a standardized measure of building performance, they may not fully reflect aspects relevant for vernacular dwellings in Slovakia. Before adopting EPB as the sole benchmark for efficiency, it is necessary to consider their gaps and explore complementary metrics—such as thermal comfort indicators (e.g., PMV/PPD by Fanger) or other measures of indoor environmental quality. Linking such indicators to CHF would broaden the methodology from energy savings alone to user comfort and cultural sustainability.

Ultimately, adaptation of vernacular dwellings cannot be reduced to energy performance targets. Energy efficiency must serve as a means rather than an end. The HAVA framework offers a pathway to connect technical, regulatory, and community perspectives, and to integrate continuity of building culture with today's environmental challenges. Only then can adaptation become a tool not only for reducing energy demand but also for reinforcing the cultural identity of villages and regions.

Acknowledgments

„Funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project 09I03-03-V05".

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