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Orginal Article

Management of energy renovation for traditional rural residential houses

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Abstract: Energy renovation aims to reduce a building's energy consumption by improving the thermal properties of building partitions and enhancing the efficiency of installation systems. This is an essential component in achieving the climate goals set by the international community. Renovating buildings of cultural value requires preserving architectural features that define their recognisability, which significantly complicates and limits the choice of methods and materials. In Poland, this process typically involves partial thermal modernisation, addressing selected elements of the building alongside the replacement of the heating source. This approach results in only a minor reduction in energy loss and a considerable loss of architectural value. This study assesses the feasibility of implementing comprehensive energy renovation management at the local level to improve the protection and preservation of traditional brick buildings, which are an architectural hallmark of the Pomeranian countryside. A model for an integrated energy renovation management system was proposed, drawing on European solutions and analysing their adaptability to national specificities. The complexity of the issue is highlighted, and the article recommends considering the entire life cycle of the building in the renovation management process: from findings on planning, design, and implementation solutions to monitoring energy performance during operation.

Keywords: energy renovation, residential buildings, rural heritage

1. Introduction

1.1. Research problem

The primary reason for undertaking this study is the growing issue of the loss of brick architectural heritage in the Pomeranian countryside due to thermal modernisation efforts from 2010 to 2023. Research conducted by the Author in the Pomeranian Voivodeship indicates significant distortions in the appearance of traditional rural houses with original brick façades. In the Puck municipality, 67% of masonry buildings with semi-flat roofs from the turn of the 19th to the 20th century have already been partially or significantly altered [1]. The cited data pertains to only one of several historical forms of masonry rural houses in Gdańsk Pomerania. However, the entire stock of culturally valuable rural architecture is at risk. The most common changes resulting from thermal modernisation include:

- covering the brick façade with polystyrene for thermal insulation, followed by plastering and altering its colour scheme,
- removal of distinctive architectural details, such as brick cornices, arches above windows and doors, window sills, and wooden decorative roof finials,
- replacement of windows and doors, along with changes in their dimensions, style, and placement,
- replacement of the roof covering with alterations to the roof slope angle.

Additionally, entire building forms are often altered due to extensions in the form of annexes, which frequently have arbitrary sizes, shapes, and placements in relation to the main structure. The scope of these changes is individual, depending on the current needs and resources of the owner. The described actions negatively impact spatial order, understood as "*the shaping of space that creates a harmonious whole, considering all functional, environmental, cultural, and compositional-aesthetic conditions and requirements in an orderly relationship*" [2]. The new, colourful façades give an impression of disorder. Changes in colour schemes and other modifications related to thermal modernisation significantly diminish the recognisability of the buildings' cultural value. The principles for energy renovation of traditional houses were established by Directive 2018/844/EU. In light of contemporary environmental challenges, thermal modernisation of traditional buildings is essential to ensure their continued use and to reduce the carbon footprint generated during operation. It is also necessary to safeguard European cultural heritage, of which historical rural architecture is a part.

1.2. Research contexts

According to data from 2022 in the Global Status Report for Buildings and Construction [3], buildings and the construction sector globally are responsible for approximately 38% of global CO2 emissions, of which 28% are related to building operations (operational carbon footprint) and the remaining 10% stem from energy used in the production of building materials (embodied carbon footprint). Mitigating climate change by reducing CO2 emissions into the atmosphere—resulting from the use of conventional heating sources in buildings, such as solid fuel boilers without efficiency standards—and reducing the carbon footprint generated during construction processes is a key objective of Europe’s pro-environmental policy. Consequently, the use of renewable energy is widely promoted. The first directives of the European Parliament and the Council of the European Union on the energy performance of buildings (31/2010) and on energy efficiency (27/2012) were introduced in 2010. EU Member States were then required to develop individual investment strategies aimed at reducing the demand for non-renewable energy in existing buildings. In 2023, additional support tools for the energy modernisation process were introduced, in the form of building renovation passports and energy classes [4,5]. Attention was also given to the social aspects of this process. EU countries should educate their citizens, disseminate knowledge on the importance of renovation solutions, and provide transparent advisory systems for investments that improve home energy efficiency. To this end, the creation of local or regional networks of one-stop shops for energy renovation processes has been proposed, where experts will provide information, manage the organisation of investments, offer technical support, facilitate financial assistance, and monitor energy savings. These are intended to create a stable environment for optimising investors' decisions.

Energy-saving strategies in construction vary according to social and financial conditions in different countries [6]. In Poland, a principle of direct financial support for investors has been adopted in the form of grants and tax relief for selected thermal modernisation activities, such as replacing heating sources with low-emission options like heat pumps, insulating external walls with window replacement, and utilising renewable energy sources (solar collectors, small photovoltaic installations). This approach results in the aforementioned loss of historical building characteristics. In many other member countries, such as Germany, the Czech Republic, Bulgaria, the United Kingdom, Ireland, France, and Denmark, the choice of thermal modernisation activities depends, among other factors, on an assessment of the building's architectural value [7,8], and the multi-stage modernisation process is coordinated [9,10,11,12]. European experiences indicate that the standard approach to modernising existing buildings in Poland [1] – limited to insulation and sealing of external partitions without prior studies, replacing heating sources with low-emission ones, and installing intelligent renewable energy systems – results not only in the loss of the valuable character of traditional buildings but also in unintended operational problems. It can lead to a decline in thermal comfort [13], the health conditions of residents, and the degradation of the building's structure itself. As part of thermal modernisation, it is therefore necessary to regulate and improve ventilation (hybrid ventilation – gravity ventilation mechanically assisted, installation of fans on chimney caps, window and wall vents) to maintain indoor microclimates and prevent the development of microorganisms in dampened building partitions.

In Poland, regulations regarding thermal insulation requirements changed four times between 2008 and 2021 (Table 1). As a result, older modernisation projects do not meet current standards. This illustrates the considerable pace of change in energy efficiency requirements in construction and supports the argument for developing a long-term energy renovation strategy. Such a strategy would consider various aspects – economic, technical, energy-related, health, and cultural – and enable their coordination.

Table 1. Summary of the dynamics of changes in thermal insulation requirements for external partitions based on Technical Conditions from 2008 to 2021 [14]. *Source:* own work

TC	U_{max} [W/m²K] external wall	U_{max} [W/m²K] floor on ground	U_{max} [W/m²K] roof	U_{max} [W/m²K] doors	U_{max} [W/m²K] windows
TC 2008	0.30	0.80	0.25	2.6	1.8
TC 2014	0.25	0.30	0.20	1.7	1.3
TC 2017	0.23	0.30	0.18	1.5	1.1
TC 2021	0.20	0.30	0.15	1.3	0.9

2. Aim and methods of the study

The primary aim of the study is to formulate recommendations for managing the energy renovation of rural buildings with cultural value. An assessment was conducted of the conditions for implementing a new tool in Poland to support the energy renovation process within EU countries [8] – one-stop shops [15]. The main research question is: *What* *changes in the energy efficiency support model in Poland are necessary to effectively protect the architectural values of traditional houses and improve their energy efficiency?*

The study is of a review nature. Based on published research results, reports, conference materials, and legal acts, strategies and principles supporting energy renovation of private, single-family residential buildings in Poland and other EU countries were qualitatively compared. The research findings were presented in the form of comparative summaries and visualised in graphics.

3. Comparison of national and European solutions for supporting energy efficiency in construction

Currently, two approaches to managing modernisation aimed at mitigating the effects of global warming and protecting the climate are emerging:

1. "Simplified" approach, which involves implementing thermal modernisation measures outlined in government programmes, characterised by:
   a) a focus on reducing demand for usable energy,
   b) a defined scope of basic works recommended by support programmes, such as insulation, replacement of windows and doors, heating sources, and the use of renewable energy sources,
   c) a one-off intervention.
2. "Comprehensive" approach, which involves carrying out a full energy renovation, encompassing:
   a) reducing demand for usable energy,
   b) reducing energy consumption over the building's lifecycle and adopting a long-term perspective,
   c) improving user comfort,
   d) considering environmental influences (e.g., wind protection),
   e) reducing the carbon footprint through selected building materials and utility installations,
   f) employing smart technologies,
   e) preserving the architectural value of existing structures.

3.1. "Simplified" approach

The "simplified" approach in Poland depends on the offerings of support programmes and is based on specific actions outlined within them to improve the thermal properties of basic external elements such as floors, external walls, roofs, doors, and windows, including the replacement of heating systems with low-emission alternatives (Table 2). This approach follows the definition: "*Thermal modernisation of buildings: Performing a basic range of work to improve the energy efficiency of buildings, such as insulating external partitions, replacing windows and/or doors, installing thermostats, replacing the heat source, and insulating building transmission systems and adjusting them to new parameters. This typically reduces energy demand by 30% to 50%, directly lowering building maintenance costs and thereby contributing to the elimination of energy poverty.*" [16] The result of the "simplified" approach is low-energy buildings with an annual specific usable energy demand for heating and ventilation of ≤ 40 kWh/(m² year) [17].

Table 2. Financial support for thermal modernisation processes in Poland from 2008 to 2024. *Source:* own work

No.	Program name	Source of support / funding	Programme
1.	Clean Air	NFOŚiGW, grant, repayable loan	1. Replacement of old-generation heat sources. 2. Installation of devices and systems meeting technical requirements: solid fuel boilers, heat nodes, electric heating systems, oil boilers, condensing gas boilers, air heat pumps, ground or water heat pumps, along with connections. 3. Use of renewable energy sources (solar collectors, micro photovoltaic installations). 4. Thermal insulation of single-family buildings (designated residential units).
2.	STOP SMOG	NFOŚiGW, National Development Bank Thermal Modernisation and Renovation Fund	1. Replacement or removal of high-emission heat sources with low-emission alternatives. 2. Thermal modernisation of single-family residential buildings. 3. Connection to district heating or gas networks.
3.	“My Electricity” Programme	NFOŚiGW	1. Construction of a micro photovoltaic installation with a capacity from 2 to 10 kW.
4.	Thermal Modernisation and Renovation Fund (thermal modernisation bonus)	National Development Bank	Scope of thermal modernisation project*: 1. Improvement resulting in reduced energy demand for heating, domestic hot water, and heating of residential buildings. 2. Improvement resulting in reduced primary energy losses in local heating networks and the local heat sources supplying them. 3. Installation of a technical connection to a centralised heat source. 4. Full or partial replacement of energy sources with renewable sources or the use of high-efficiency cogeneration.
5.	Thermal Modernisation Tax Relief	Annual PIT settlement with the Tax Office. Deduction from tax/income for expenses related to the implementation of a thermal modernisation project.	Scope of thermal modernisation project*: 1. Improvement resulting in reduced energy demand for heating, domestic hot water, and heating of residential buildings. 2. Improvement resulting in reduced primary energy losses in local heating networks and the local heat sources supplying them. 3. Installation of a technical connection to a centralised heat source. 4. Full or partial replacement of energy sources with renewable sources or the use of high-efficiency cogeneration.

*Definition of a thermal modernisation project in accordance with the Act of 21 November 2008 on Supporting Thermal Modernisation and Renovations and the Central Register of Building Emissions, Journal of Laws 2008, No. 233, item 1459, Article 2, point 2.

According to information on the Ministry of Climate and Environment and the National Fund for Environmental Protection and Water Management websites, comprehensive thermal modernisation is defined as a thermal modernisation project that includes all actions specified in the "Clean Air" programme, along with the implementation of the energy audit recommendations [17]. Additionally, at least one comprehensive thermal modernisation indicator must be met, stating a reduction in usable energy demand by a minimum of 40% or to 80 kWh/(m² year). However, it sometimes happens that not all programme requirements are met, which negatively impacts the final outcome. This applies to investments where low-emission heat sources were introduced without insulating and sealing external partitions, or where the building was insulated without replacing heat sources. The "Clean Air" programme allowed for the realisation of these solution variants.

3.2. "Comprehensive" approach

The process involved in comprehensive energy renovation encompasses a series of actions, with the "simplified" thermal modernisation discussed above serving as just one component. Comprehensive energy renovation is a long-term approach based on analysing feasible technical solutions to minimise environmental impact, protect the building structure, improve user comfort, and preserve architectural value. These actions result in reduced costs associated with usable energy demand, enhanced quality of life for residents, reduced consumption of non-renewable energy sources, and decreased CO2 emissions through the use of natural environmental resources. According to the definition provided in the Annex to Resolution No. 23/2022 of the Council of Ministers of 9 February 2022, this includes "*All modernisation activities that improve the functional value of a building. This particularly concerns improving the building's energy efficiency, reducing emissions, and actions to enhance quality of life, protect health, adapt to climate change, implement smart technologies, or other aspects affecting the building's functional value.*" [17]. The measurable outcome of energy renovation should be nearly zero-energy buildings in line with the principle that "*nearly zero or very low required energy should come, to a very high degree, from renewable energy sources, including renewable energy generated on-site or nearby*" [18].

The differences resulting from the described approaches to energy renovation management are presented in the table below (Table 3).

Table 3. Comparison of differences in implementing assumptions related to energy renovation management using the "simplified" and "comprehensive" approaches. *Source:* own work

Scope	"Simplified" approach	"Comprehensive" approach
Reduction of usable energy demand.	+	+
Coordination of proposed thermal modernisation actions within the support programme.	+/-*	+
Life cycle analysis of the building.	-	+
Long-term approach considering adaptation to climate change.	-	+
Incorporation of natural environmental resources (location, environmental resources, functional zoning).	-	+
Monitoring of thermal modernisation actions during further building operation.	-	+
Improvement of user comfort.	+/-*	+
Preservation of architectural value of existing buildings.	-	+

* Partial effect due to lack of coordination.

4. Conditions and assumptions for managing comprehensive energy renovation of culturally valuable houses

A crucial factor in the energy renovation of traditional buildings is preserving architectural features that define their recognisability. Given the age of the buildings, a key action is assessing the technical condition of external partitions and conducting an expert analysis of the feasibility of using modern insulation methods. Between 2015 and 2019, as part of the international research programme RiBuild (*Robust Internal Thermal Insulation of Historic Buildings*) [9,19], guidelines and tools for selecting thermal insulation in historic buildings were developed (such as a multi-criteria decision-making model and an online assessment tool). This included a detailed analysis of issues related to the construction and physical properties of external walls in traditional buildings and an evaluation of the use of thermal insulation on the internal side of partitions. The multi-stage nature of the energy renovation process was highlighted, along with the dependence of renovation types on their declared social objective, which could include reducing energy consumption, minimising investment costs, improving indoor climate, or mitigating environmental impact. It was emphasised that renovations should comply with building regulations and local planning guidelines. Additionally, the chosen solutions must not negatively affect the hydrothermal properties of external partitions or the heritage value of the building. The selection of renovation actions and type of thermal insulation should begin with documenting the condition of external partitions, given the potential for long-term damage due to building use and weather conditions, such as prolonged exposure to rain or wind. The building's internal climate, which affects the humidity of materials and rooms, should be examined, and a review of previous renovations conducted. To assess the potential for long-term energy savings, environmental impact, and operating costs, a life cycle analysis of the building undergoing modernisation is recommended.

The results of the RiBuild study demonstrate that the energy renovation process is complex and multi-stage. This means that expert support for the investment process is essential for its effectiveness [20].

4.1. Management of the energy renovation process

The implementation of comprehensive investor services (One-Stop Shop) in the process of carrying out thermal modernisation projects for traditional residential buildings can significantly support the realisation of a long-term energy renovation strategy. European experience [6] indicates the possibility of coordinating the management of the renovation process at successive stages of the investment (analysis, financing selection, design, implementation, operational control) (Fig. 1). The developed solutions are tailored to the specific investment intention. The choice of financing programme is preceded by an assessment of the potential energy performance improvements. Following the analytical phase, the investment is costed, and financial resources are secured. An important aspect, particularly for culturally valuable residential buildings, is the possibility of supporting the selection of specialised services for the execution phase and ensuring quality control of the implemented solutions.

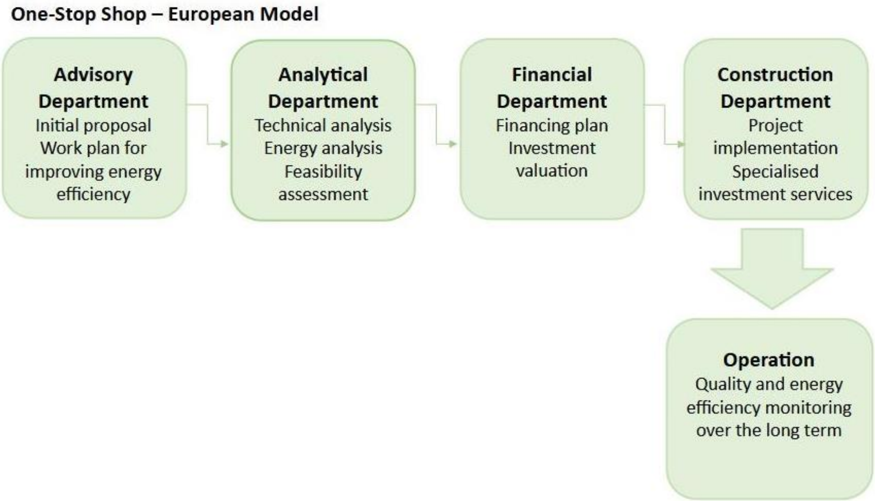

Fig. 1. Scheme of guidelines for managing one-stop shops in European Union countries. *Source:* own work based on [6]

In Poland, comprehensive energy renovation services are currently in the planning phase [21]. Existing support programmes are not flexible; they offer universal solutions for financing energy renovation tools (such as renewable energy devices, technical installations, building materials) that are not tailored to individual needs and conditions. There is a lack of coordination and monitoring of their application. To develop recommendations for a regional One-Stop Shop model, the current types of support for thermal modernisation activities in Poland and selected EU countries were compared (Table 4 and Table 5).

Table 4. Scope and financial support for thermal modernisation processes in Poland and selected EU member states from 2008 to 2021. *Source:* own work

Country	Form of financing	Insulation of partitions Modernisation of windows Replacement of heat sources Use of renewable energy sources	* Mechanical ventilation	One-Stop Shop
Poland	Funding from NFOŚiGW Grants in the form of repayable and non-repayable loans; thermal modernisation bonus, thermal modernisation tax relief.	+	-	-
Germany	Thermal modernisation tax relief, loans.	+	-	+
Czech Republic	Funding - State Environmental Protection Fund.	+	+	+
Slovakia	Grants from the state budget.	+	-	-
Bulgaria	Funding - REECL credit line.	+	-	+

Croatia	Funding from the Environmental Protection and Energy Efficiency Fund, EU structural funds, local and regional government, and funding sources for citizens.	+	–	-
Slovenia	Grants, preferential loans, and informational campaigns. Eco Fund, the largest financial institution in the Republic of Slovenia.	+	-	-
Italy	Funding, tax relief to cover renovation costs.	+	+	-
United Kingdom	Thermal modernisation credit, thermal modernisation vouchers from the government.	+	-	+
Ireland	Government grants.	+	+	+
France	Funding, renovation bonus and loan.	+	+	+
Denmark	Business model.	+	+	+

* In Poland, ventilation regulation (mechanical) in single-family residential buildings is rarely included in thermal modernisation projects; however, it is frequently funded as part of renovation projects for multi-family buildings [22,23].

Table 5. Comparison of the model strategy for improving energy efficiency in Poland with One-Stop Shop models for investor support in European Union countries. *Source:* own work

Model Structure	One-Stop Shop European Model	"Simplified" Approach Poland
Advisory Department	Development of a plan for improving the energy efficiency of the entire investment. Initial proposal of solutions.	Not included in support programmes.
Analytical Department	Technical analysis of the building. Energy analysis. Assessment of the feasibility of specific solutions	Not included in support programmes.
Financial Department	Financing plan. Investment valuation based on the preliminary concept supported by previous analyses.	Selection of support programme. Investment valuation based on the support programme offer.
Construction Department	Implementation of the investment according to the project. Use of qualified specialists in execution.	Self-implementation of the investment. Use of generally available construction companies. Lack of qualified specialists.
Operations Department	Long-term quality and energy efficiency monitoring during operation.	Not included in support programmes.

The comparison shows that Poland's thermal modernisation strategy relies on a basic set of construction and financial tools, which does not guarantee long-term effectiveness.

All EU countries included in the study implement a similar scope of thermal modernisation projects. Approaches to mechanical ventilation, which supports user comfort regulation, vary; it is an additional element not always included in the modernisation of single-family buildings. The pace of implementing one-stop shops in the EU is satisfactory. In 2019, there were 63 One-Stop Shops operating in 22 countries [6]. EU funds provide support for establishing new one-stop shops for legal entities such as public authorities and private companies [24]. Reviewing models in 11 countries that coordinate renovation processes, established through the Horizon 2020 European programme between 2017 and 2020 [25], reveals a considerable diversity of organisational structures. Entities responsible for their implementation included local regional governments, limited liability companies, private and municipal firms, and government programmes focused on business innovation issues.

4.2. Limitations of implementing the One-Stop Shop model in Poland

The limitations of implementing a comprehensive one-stop shop model in Poland are social, institutional, and legal in nature, stemming from knowledge gaps regarding culturally valuable rural buildings at the municipal level. The one-stop shop concept is based on considering the specific conditions of each building. In Poland, the assessment of an existing building's environmental impact, technical condition, and environmental and functional factors is currently overlooked in the planning of thermal modernisation projects.

In the current spatial planning system, there is a lack of comprehensive data on the condition of traditional rural buildings, including brick structures. A 2018 study in the Puck municipality showed that out of 42 examined brick buildings, only 6 were included in the Municipal Heritage Register [1]. Moreover, the Municipal Heritage Register serves only as a catalogue and does not influence the future status of buildings. Thermal modernisation is not considered in the official procedures for issuing building permits. According to the current Building Law (Art. 29, Sec. 2, Point 4), as of 2020, insulating buildings up to a height of 12m does not require a building permit or notification of construction works. Traditional single-family buildings generally do not exceed this height. Therefore, without additional regulation within the spatial planning system, preserving the cultural value of traditional rural buildings cannot be ensured. Due to ineffective regulations for protecting rural architectural heritage and insufficient education in this area, common errors occur in the choice of façade colours, building materials, and inappropriate modifications to house forms (Fig. 2). Another significant limitation is the shortage of certified experts qualified to conduct the necessary architectural, technical, energy, and financial assessments.

4.3. Recommended scope of architectural, construction, and energy analyses in the energy renovation of a traditional rural house

Improving the energy efficiency of a traditional rural house requires the following analyses:

1. Definition of architectural guidelines to protect the building’s cultural value:
   a) identification of architectural elements that should be preserved;
   b) analysis of the building’s functional interior layout;
   c) analysis of locational factors (compact or dispersed building layout, terrain configuration, sunlight exposure, surrounding greenery, etc.);
2. Assessment of the building’s environmental impact and its potential for energy renovation:
   a) life cycle analysis of the building;

b) analysis of CO2 emissions generated by all existing building elements and the heating system in operation;
c) determination of the energy class;
d) assessment of energy-saving potential;

4. Evaluation of the building's condition and risks associated with the use of modern technologies and building materials:
   a) technical assessment of external partitions;
   b) identification of damage causes and moisture levels in partitions;
   b) analysis of thermal comfort and methods for regulating it;
   c) analysis of energy-saving requirements;
   d) analysis of the construction market resources and feasibility of implementation for the analysed building;
   e) assessment of solutions in terms of physical properties, carbon footprint, recyclability, and the durability of selected solutions for long-term planning adapted to climate change.

The outcome of these analyses should be the selection of solutions that meet the theoretical assumptions of comprehensive energy renovation (Fig. 2):

1. Reduction of building emissions.
2. Improvement of residents' quality of life, local wellbeing, and health protection.
3. Adaptation of the building to climate change, with long-term planning.
4. Enhanced usability of the building while preserving its cultural value.

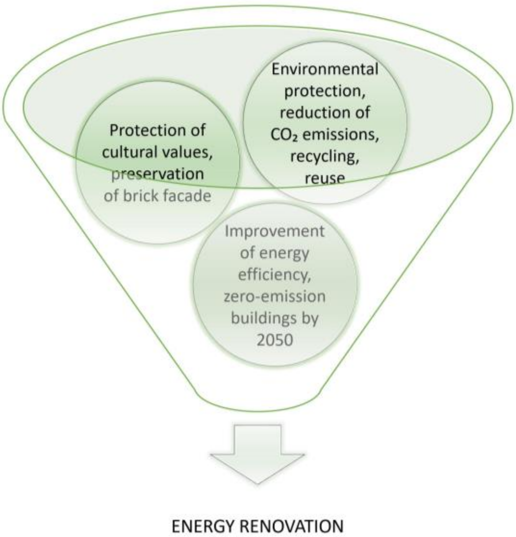

Fig. 2. Main assumptions of the energy renovation strategy for a traditional rural house within modernisation activities. *Source:* own work

5. Management model for energy renovation of traditional residential buildings in rural areas

An effective renovation process consists of three main stages:

1. Stage I – formulation of energy renovation policy for architectural heritage at the municipal level (Fig. 3).

2. Stage II – assessment of the conditions for comprehensive energy renovation of the building, including financing analysis (Fig. 4).
3. Stage III – development of the renovation project and selection of specialised contractors, along with monitoring during operation (Fig. 5).

The tasks necessary to complete in Stage I include the inventory and classification of residential/farmstead heritage assets in the municipality/locality, assessment of social value in the context of development vision, definition of renovation principles, and adaptation of financing programmes to the local renovation strategy. To achieve these, municipal databases of historic buildings and their energy classes should be developed and used as a basis for formulating the heritage renovation policy. As of April 2023, there is a requirement to prepare energy performance certificates for buildings being put into use, sold, or rented [23]. These documents are collected by public administration authorities, primarily building supervision offices. Eventually, they could provide valuable information for the energy classification of the municipality's building stock.

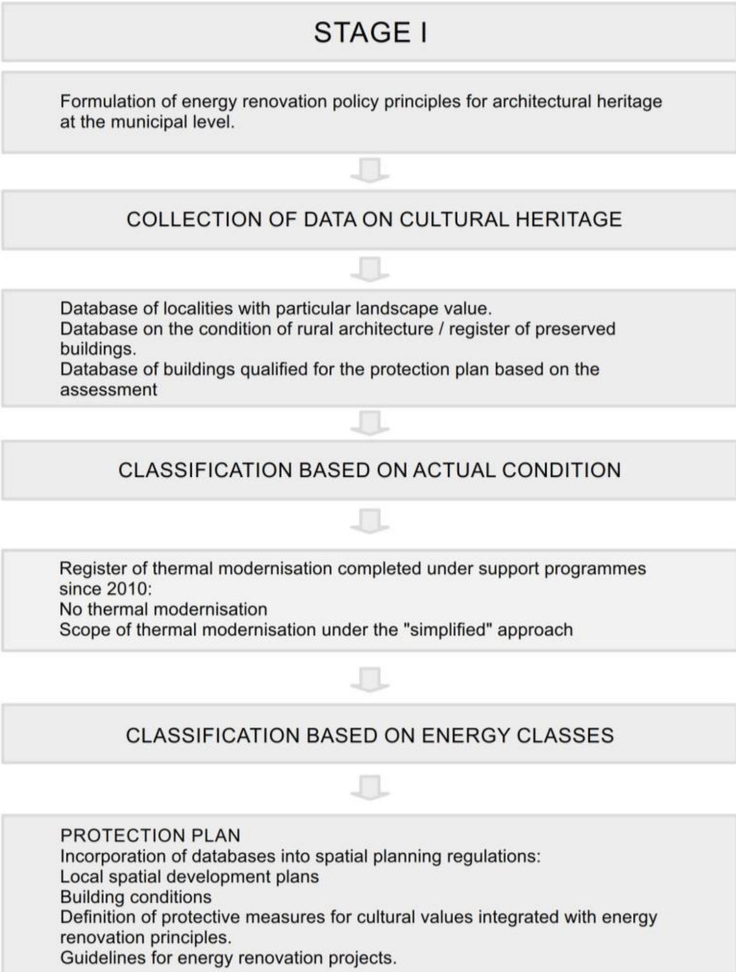

Fig. 3. Stage I – proposal of preliminary actions necessary to create a database influencing the success of energy renovation in terms of preserving cultural value. *Source:* own work

Stage II involves developing individual guidelines for the building renovation project (Fig. 4). Technical, energy, and environmental analysis, considering the use of passive tools and a review of financing options, will enable the selection of the most coherent solutions, devices, and insulation materials available on the construction market. Each building requires separate consideration in terms of energy potential due to its uniqueness. "*It should be emphasised, however, that a building is a structure of building partitions and their joints with unique physical characteristics, subject to external and internal environmental influences*" [26].

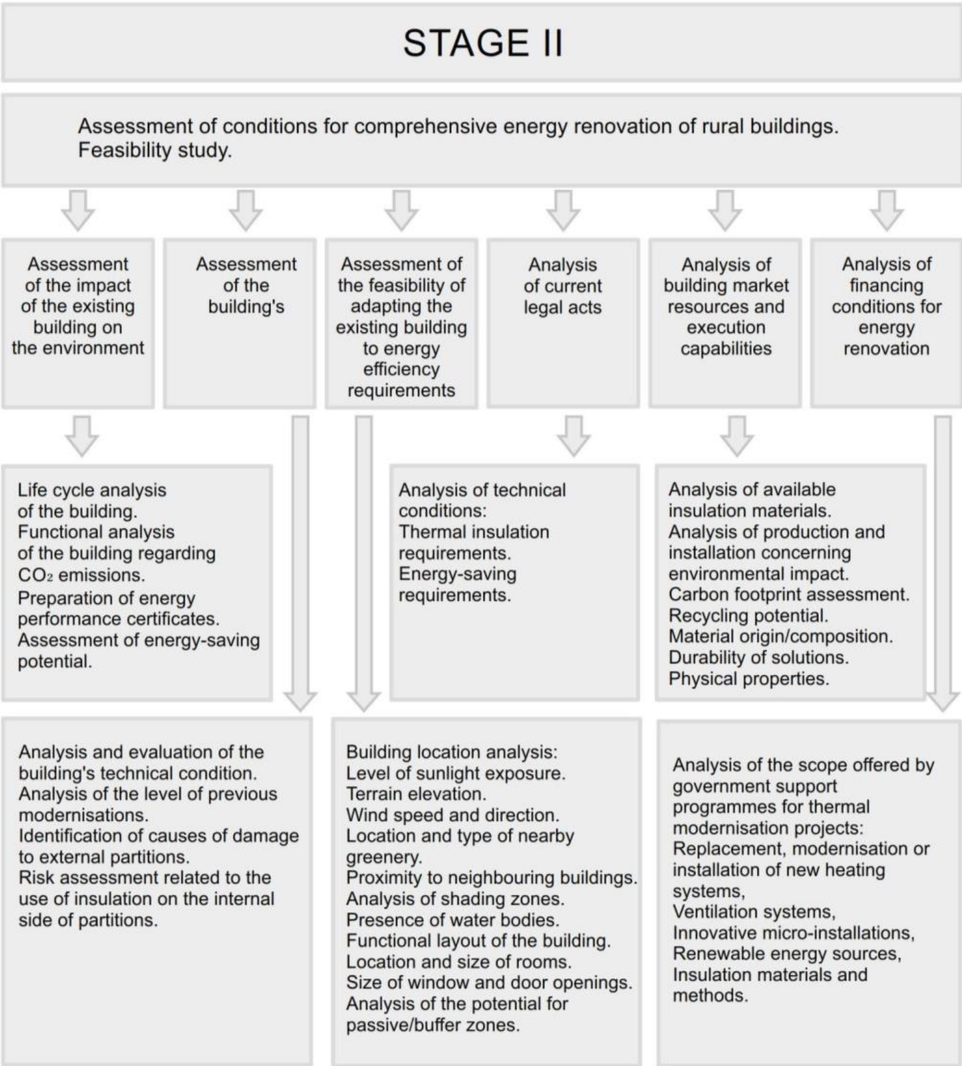

Fig. 4. Stage II – proposal of preliminary analyses necessary to develop a coordinated design concept influencing the success of energy renovation in terms of energy savings and environmental impact. *Source:* own work

The final stage is the development of the investment project, supported by prior analyses, and the selection of qualified contractors. The prepared documentation should serve as the basis for investment valuation and obtaining funding from government/municipal support programmes. Monitoring of the adopted solutions during the building's further operation should be ensured.

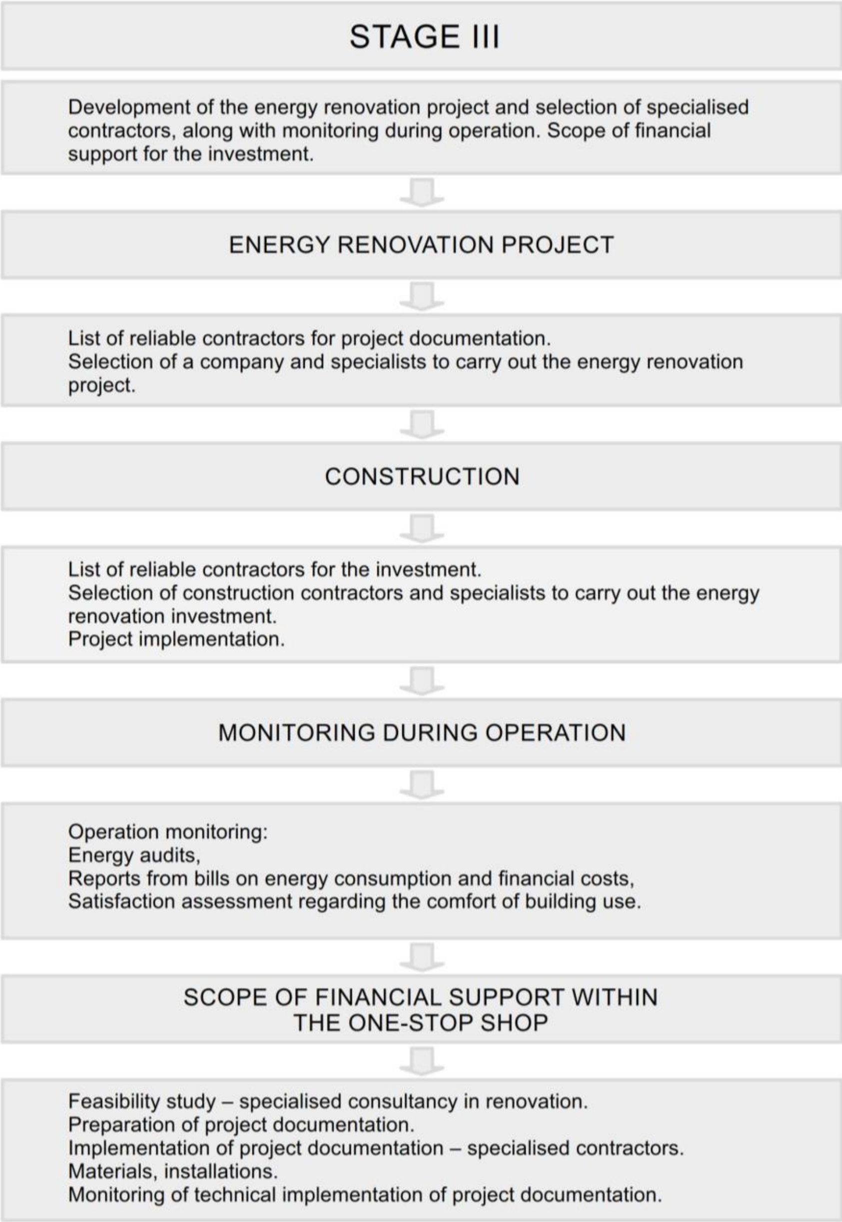

Fig. 5. Stage III – proposal for the process and scope of financial support for the entire investment process leading to effective energy renovation of traditional rural brick buildings. *Source:* own work

All three stages form a model for comprehensive management of the energy renovation of a traditional rural house (Fig. 6), taking into account national conditions. The one-stop shop serves as a coordinating tool for all stages of the investment process. Its integration into the planning system organisation requires further discussion, though it would be ideal for it to operate at the municipal level, as close to investors as possible. Funding may be supported by EU funds and based on public-private partnerships. Consideration should be given to modifying financing rules within existing and future thermal modernisation support programmes to encourage the use of consultancy, the protection of buildings' cultural value, and the energy efficiency of their renovation. Energy renovation management, therefore, has a systemic character, similar to the systemic approach in shaping contemporary eco-friendly architectural solutions, resulting from the close interconnections within the built environment across the entire building life cycle. "*However, the certain layout remains unchanged, namely one in which the building or, in a broader perspective, the built environment constitutes the system, refers to environmental borrowings, whereas the output is connected to the effects of the life cycle of the building*" [27].

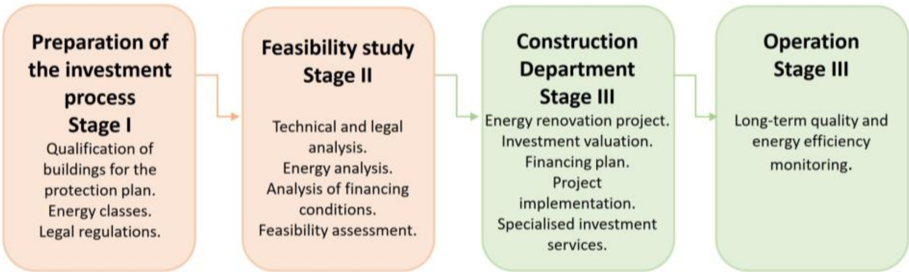

Fig. 6. Diagram of the proposed management model for energy renovation within a one-stop shop for a traditional rural house. *Source:* own work based on [6]

6. Conclusions

The article discusses thermal modernisation programmes in Poland from 2010 to 2023 in the context of protecting rural architectural heritage. It was observed that the thermal modernisation measures undertaken so far degrade the cultural value of rural architectural heritage, and their energy effects may be insufficient and require reconsideration. An assessment was conducted on the potential to improve the effectiveness of energy renovation for traditional rural buildings, considering the preservation of their cultural value. To this end, financing tools in Poland were compared with those in other EU countries. Legal and social constraints that significantly impact the shortcomings of comprehensive energy renovation in Poland were examined. Attention was drawn to gaps in the spatial planning system and the variability of regulations defining thermal requirements for buildings. Additionally, a lack of coordination in thermal modernisation efforts and gaps in necessary analyses, such as life cycle assessment of buildings or evaluation of the potential for integrating local natural resources to enhance renovation outcomes, were noted. Ultimately, a model for comprehensive management of energy renovation for rural heritage buildings was proposed, along with expert support for investors through One-Stop Shops.

Initiating a discussion on the management model for energy renovation of traditional rural houses in Poland is currently particularly relevant due to the observed increase in social risks, delays in achieving climate adaptation goals, and the opportunity to draw on the experiences of other EU countries.

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