Introduction

The limitation of energy consuming in country buildings can be perceived both from the aspect of newly designed buildings and also already existing. These latter mainly do not fulfill the current strict requirements on the rational energy consuming and needs an appropriate thermal modernization, i.e. improvement of existing technical features of a building which should lead first of all to reduce heat demands. This operation not only limits heat losses and heating costs but also improves the of using conditions of rooms in a building. It can be an independent modernization venture or within the frames of re-building, modernization or complete refurbishment, i.e. during other serious building changes (Robakiewicz and Gawrylczyk 1999).

There is lot of causes of excessive heating costs in already existing country buildings in Poland (Koc 2002):
- weak insulating power of baffles (walls, flat roofs, ceilings over cellars, windows, doors) which constitutes the most important cause of the excessive heat consumption,
- from the point of view of losses and potential gains of heat, unfavorable shapes and localization of buildings,
- obsolete heating system and its low energetic efficiency,
- lack of automatically controlled installation and the possibility of measurement of consumed heat,
quite commonly occurring lack of understanding of need and usefulness of economical energy consumption.

The proper thermal modernization is extremely important. The most problems to solve occur mainly by a wall insulation. It concerns a choice of appropriate thermoinsulating materials and the insulation methods which considerably depend on the materials and methods which had served to construct the wall.

The decision about the choice of the proper method and technology of works has a big practical importance.

During undertaking thermal modernization ventures in country buildings, one should be guided by the following rules:

- to gain the full safety effect, the thermal modernization of a building structure should be realized simultaneously with the modernization of a heating system,
- the thermal modernization should be carried out simultaneously with a renovation of elevation and roof or within a complete refurbishment to reduce concise costs of insulation in a considerable way,
- there should be created better thermal properties of a building structure than the binding regulations demand,
- there should be introduced air ventilators in a window woodwork or, alternatively, a mechanical ventilation in an insulated and sealed building with changed conditions of a gravitational ventilation,
- the decision about realization and scope of the thermal modernization should be preceded by the analysis of economical efficiency (energetic audit) concerning the main aim of the thermal modernization, i.e. the reduction of consumption costs.

**Method of investigations**

The research work was based on two kinds of investigations – direct and indirect.

The indirect investigations consist in the reconnaissance of the topic by studying a literature concerning – in this case – the application of energy-saving solutions connected with a building structure (including architectonic solutions) during the modernization of the existing (single-family) dwelling houses.

In the direct investigations, carried out in the northern Casubia, the Author used:

- diagnostic survey realized by a free interview with proprietors of dwelling houses on the country, on the chosen by the Author region of Casubia,
- an empiric method realized by the analysis of the applied thermal modernization operations in existing houses and using an observation documented by the photographs made by herself.

**Results of investigations**

The region of the northern Casubia had been chosen mainly due to specific climate conditions and to a big number of preserved buildings from the beginning of the last century which could serve as examples to analyze the realized thermal modernization operations. Other feature of the region is the tourists’ presence, because this region is one of the most attractive areas in terms of tourist attractiveness. The specific conditions of localization at seashore contribute to the fact that the farm tourism, trendy in...
the whole Europe, develops here more and more dynamically what is connected with the expansion of dwelling houses.

The most popular way of the thermal modernization improvement in the investigated single-family houses is an insulation of external walls as well as the exchange of a window and door woodwork. The investigations carried out under the Author’s management shown that the realization of an additive insulation of walls and the exchange of the window and door woodwork can bring significant profits to the investor, because the heat loss reduces by 31% (Tables 1 and 2 – Paździornik 2009).

There should be carried out an energetic audit for the building subjected to the thermal modernization; this audit would determine the scope as well as economical and technical parameters of the thermal modernization venture, such as simply pay back time (SPBT). There is important to point the optimal solution along with taking into consideration the costs of this venture as well as the energy saved which constitute also the assumptions to a works design (Rozporządzenie... 2008).

The architectonic constructive and thermal modernization operations in country houses are presented in the Table 3. The attention was paid to the aim and way of the realization of each solution as well as the quantity of possible energy savings and approximate payout time of the incurred costs.

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**TABLE 1.** List of heat transfer coefficients of external walls and windows before and after thermal modernization (Paździornik 2009)

<table>
<thead>
<tr>
<th>Rodzaj przegrody</th>
<th>Building before thermal modernization</th>
<th>Building after thermal modernization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Współczynnik przenikania ciepła</td>
<td></td>
</tr>
<tr>
<td><strong>External walls</strong></td>
<td>0,518</td>
<td>2,778</td>
</tr>
<tr>
<td><strong>Windows</strong></td>
<td>0,261</td>
<td>1,200</td>
</tr>
</tbody>
</table>

**TABLE 2.** List of the chosen building parameters before and after thermal modernization (Paździornik 2009)

<table>
<thead>
<tr>
<th>Parametr</th>
<th>Building before thermal modernization</th>
<th>Building after thermal modernization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Seasonal demand for heat to warm a building, ( Q_h ) [kWh·rok(^{-1})]</strong></td>
<td>26 563</td>
<td>18 821</td>
</tr>
<tr>
<td><strong>Area index of heat demand, ( E_A ) [kWh·m(^{-2})]</strong></td>
<td>189,2</td>
<td>134,1</td>
</tr>
<tr>
<td><strong>Volume index of heat demand, ( E_V ) [kWh·m(^{-3})]</strong></td>
<td>68,76</td>
<td>48,72</td>
</tr>
<tr>
<td>Element of architecture</td>
<td>Aim of thermal modernization operation</td>
<td>Way of realization of thermal modernization operation</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>External baffles</td>
<td>Improvement of thermal insulation, elimination of thermal bridges</td>
</tr>
<tr>
<td>2</td>
<td>Roofs and flat roofs</td>
<td>Improvement of thermal insulation</td>
</tr>
<tr>
<td>3</td>
<td>Ceilings over non-heated cellars</td>
<td>Improvement of thermal insulation</td>
</tr>
<tr>
<td>4</td>
<td>Floors of the ground floor in buildings without cellar</td>
<td>Improvement of thermal insulation</td>
</tr>
<tr>
<td>5</td>
<td>Windows</td>
<td>Improvement of thermal insulation</td>
</tr>
<tr>
<td>6</td>
<td>Exit doors</td>
<td>Improvement of thermal insulation</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Reduction of uncontrolled infiltration</td>
</tr>
<tr>
<td>Building shape</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------------------------------</td>
<td>-------------------------------------------------------------------</td>
</tr>
<tr>
<td>Loggias, terraces, balconies</td>
<td>Creation of insulating (buffer) areas, elimination of thermal bridges</td>
<td>Extension – additional usable area (hothouse)</td>
</tr>
<tr>
<td>Roof</td>
<td>Creation of insulating (buffer) areas</td>
<td>Superstructure</td>
</tr>
<tr>
<td>External architectonic elements (eaves, porch, canopy, recess e.a.)</td>
<td>Protection of the enter zone to a heated part of building against atmospheric conditions</td>
<td>Extension</td>
</tr>
<tr>
<td>Layout of rooms and functional connections between them</td>
<td>Creation of a warm zone from spacious rooms „opened” from the south side</td>
<td>Disassembly of internal walls – elimination of the traditional division into individual rooms</td>
</tr>
<tr>
<td>Building surroundings</td>
<td>Reduction of unprofitable influence of climate, mainly winds</td>
<td>Anti-wind covers: protection plants, small architecture, appropriate land configuration</td>
</tr>
<tr>
<td></td>
<td>Increase of profitable influence of climate, mainly solar radiation</td>
<td>Removing every possible obstacles overshadowing the southern elevation</td>
</tr>
</tbody>
</table>

*Quantity of possible energy savings and approximate payout time of incurred costs – according directly obtained information in Respect for Energy State Agency (Krajowa Agencja Poszanowania Energii S.A.), Warsaw.*
Unfortunately, in the most cases, the building extension is not coherent with the object being extended and represents totally incidental architectural form, having nothing in common with the limitation of energy consuming. Usually, the extension leads to dismembering the mass of building or to the creation of a form characteristic for energy consuming architecture from the second half of 20\textsuperscript{th} century. Also, the modernization means replacing the traditional building materials with new ones, contributing to changes in colors and character of a country house (Figure 1). A similar problem can be noticed for instance in unnecessary and not finished balconies which in considerable degree affect the creation of thermal bridges. Those elements usually occur in the buildings being modernized in a urban way without taking into consideration local traditions of a rural environment.

During the investigations, there had been repeatedly observed that the protection of external walls against the unprofitable influence of the climate limits itself only to one of the building’s walls and even only to its facing (Figure 2). This occurrence comes from the lack of financial resources of rural investors and is quite characteristic especially for the northern regions of Poland which do not belong to the wealthiest ones.

As a rare – unfortunately – example of the thermal modernization having essential meaning for a country building from the point of view of its architecture, there can be observed the cover with a traditional steep roof (with an attic playing a role of a thermal buffer) and protection of the enter zone against external atmospheric conditions (Figure 3). There must be emphasized that due to constructive and architectural accounts, the extension of so-called “cube-houses” from the 1960’s and 1970’s is difficult. If the problem is being solved within the existing storeys, it is connected to the

![Figure 1](image1.png)

**FIGURE 1.** Modernization with thermal modernization of building made of red brick from the turn of 19\textsuperscript{th} and 20\textsuperscript{th} centuries. Some reservations can be expressed about the mansards of various covering forms, faced from inside with a white siding, as well as replacing the traditional ceramic roof tile with a metal one: a – state before modernization, b – state after modernization – Karwia, June 2005 – August 2008 (photo by Author)

**RYSUNEK 1.** Modernizacja z termomodernizacją budynku z czerwonej cegły z przełomu XIX i XX wieku. Zastrzeżenie budzą mansardy o różnych formach przekrycia oblicowane od wewnątrz białym sidingiem oraz zastąpienie tradycyjnej dachówki ceramicznej blachodachówką: a – stan przed modernizacją, b – stan po modernizacji – Karwia, lipiec 2005 – sierpień 2008 (fot. autor)
problem of high ground floor; if the investor decides to a superstructure on the existing object, usually changes this object into a tenement what causes departure from the traditional and historically developed form of country buildings.

The rational energetic economy in country houses, i.e. the reduction of their energy consumption, i.a. through properly made thermal modernization, including possible using of renewable energy sources, has nowadays a considerable position in rural farmsteads. Hence, there must be concluded that one of the basic current tasks is the increase of the effectiveness of social influence of the law on the thermal modernization at rural areas.

Résumé

The most of country dwelling houses does not comply with the current, strict requirements on the rational energy consumption. One of the reasons of excessive heat consumption is mainly its loss through external baffles. These houses hence require a thermal modernization, i.e. improvement of the existing technical features of the building, what, first of all, will result in reduction of the needs of warming heat.

There is recommended to propagate the solutions which base on the passive utilization of solar energy as a renewable energy source.

The investigations carried out in the northern Casubia allow to state that the most popular theroinsulating material is a StyroFoam. Simultaneously, a lot of
improprieties in realization of the thermal modernization was observed – both in brick and stone buildings as well as in wooden ones. The reason of such situation is in large measure the fact that rural investors do not take into consideration the importance of influence of the local climate conditions on precise solutions limiting the heat losses from the building and the costs of its heating. The thermal modernization operations in existing buildings are mostly carried out without design and consultation with entitled person.

**Summary**

**Application of architectural solutions in thermal modernization of existing buildings on rural areas.** The paper discusses at the beginning the term of thermal modernization, ways of its realization and causes of implementation in dwelling houses on rural areas. Those houses mostly do not fulfill current strict requirements on rational energy consumption. The most important cause of excessive heat consumption is mainly its loss through external components. The second part of the paper characterizes the current state of buildings from the point of view of improvement of thermal properties of building baffles on an example of the Author’s researches realized in a chosen region of the northern Casubia.

**Literature**


Rozporządzenie Ministra Infrastruktury z dnia 14 lutego 2008 r. w sprawie szczegółowego za- kresu i formy audytu energetycznego, Dz.U. z 2008 r., nr 33, poz. 195.

**Streszczenie**

**Zastosowanie rozwiązań architekto- nicznych przy termomodernizacji istnie- jącej zabudowy na terenach wiejskich.** W artykule omówiono na wstępie pojęcie termomodernizacji, sposoby jej realizacji oraz powody wdrażania w domach mieszkalnych na wsi, które w większości nie spełniają obecnych zaostrzonych wymogów w zakresie racjonalnego zużycia energii. Naj- ważniejszą przyczyną nadmiernego zużycia ciepła są przede wszystkim jego straty przez komponenty zewnętrzne. Następnie scharakteryzowano stan obecny budynków pod kątem poprawiania właściwości termicznych przegród budowlanych na przykładzie wła- snych badań na wybranym terenie północ- nych Kaszub.

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