The Influence of «Cross-Subvention» on Economic Efficiency of Thermal Insulation of Buildings

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Abstract – Influence of «cross-subvention» on economic efficiency thermal insulation of buildings is viewed. The optimum thickness of thermal insulation for each tariff group is calculated. Awarded the negative role of the modern tariff policy. It is shown that to improve the attractiveness of the energy efficiency measures required state participation. The proportion of state compensation must be up to the «cross-subvention».

Key words – heating, tariffs, cross-subvention, thermal insulation, economic thickness.

I. Introduction

National energy and utilities regulatory commission in April increased the average tariff for heat for the population to 71.8 % [1]. This would be an impact to the residents of its buildings thermal insulation.

An important issue of the energy efficiency measures is appropriate thermal insulation thickness.

According to regulations of Ukraine heat consumption rate for the second zone is 70-95 kWh/m^2/year, heat transfer resistance – 2.1-2.4 m^2·K/W [2]. In Europe, according to the Directive 2010/31/EU total energy consumption of new buildings must be 15 kWh/m^2/year or zero [3].

From another point of view appropriate thickness of thermal insulation is also economic concept [4].

It should be based on technical and economic modeling to determine the economically attractive thickness thermal insulation of buildings and corresponding heat transfer resistance of enclosure for current prices on thermal insulations and tariffs on heat energy.

II. Criterion Feasibility of Energy Efficiency Measures

The feasibility of implementing energy efficiency measures determined by two components – primary investment K (cost thermal insulation) from on the one hand and annual costs B_a (the cost of heat energy) on other hand. Integral criterion of thermal insulation feasibility is minimum of discounted costs B_{dc} over a horizon T_e

$$B_{dc} = K + \sum_{i=1}^{T_e} B_{ai} E_{di} \qquad (1)$$

where E_{di} – discount rate; i – number of years.

Investments in building thermal insulation

$$K = (k + c)F \qquad (2)$$

where k – cost of 1 m^2 thermal insulation, c – the cost of work, F – square of enclosure.

The cost of heat for different categories of subscribers in Ukraine is not the same – existing so-called «cross subvention». In the Table 1 shows tariffs of Lviv municipal utility company (LMUC) «Lvivteploenergo».

TABLE 1

TARIFFS ON HEAT ENERGY OF LMUC «LVIVTEPLOENERGO»

Category consumer	Components of tariff	
	variable component, UAH/Gcal	constant component, UAH/(Gcal/hour) in month
home	572	21927.14
budget	1335.62	17557.3
spiritual	737.74	17557.3
other	1335.62	17557.3

Cross-subvention is the reason that the return on energy efficiency measures for each category of consumers will be different.

III. Definition Economically Expedient Thickness Thermal Insulation

Consider four-floors house sizes 10m×24m×13m, that belong to different categories according Table 1.

Calculation is made using the application «Energy Efficient Building» a specialized package of energy ma-nager [5]. Thermal load this building P = 0.0722 Gcal/hour, annual heat consumption for the regulatory climate conditions Q = 146.2 Gcal.

Annual costs on heating

$$B_a = c_1 Q + c_2 P \qquad (3)$$

where c_1, c_2 – variable and constant components of tariff on heat energy.

Annual costs on heating this building for different categories of consumers signify-cantly different (Table 2).

TABLE 2

ANNUAL COSTS FOR HEATING

Category consumer	Components of cost, thousand UAH		
	variable component	constant component	sum
home	83.63	19.00	102.62
budget	195.27	15.21	210.48
spiritual	107.86	15.21	123.07
other	195.27	15.21	210.48

The cost of heating a residential building and budget organization differ more than doubled. So through «cross-subsidization» state protects residents from excessive utility costs.

Consider how this affects the need of residents to insulate houses.

Of all the components of the heat loss buildings consider reducing loss through walls and through the attic. The total area of building walls F_w = 10368 m^2, ceiling attic – F_a = 240 m^2. Heat transfer resistance of wall R_w = 0.92 m^2·K/W and of ceiling attic R_a = 1.44 m^2·K/W.

A common thermal insulation material is foam plastic PSB-C-35, thermal conductivity 0.046 W/(m·K), price 1140 UAH/m^3. The cost of work – 120 UAH/m^2.

Heat transfer resistance of enclosure with insulation R

$$R_{\Sigma} = R_t + \frac{\delta}{\lambda} \quad (4)$$

where R_t – heat transfer enclosure, m^2·K/W; δ – thermal insulation thickness, m; λ – thermal conductivity of insulation, W/(m·K).

Foam plastic has a number of shortcomings and it is forbidden to insulate public buildings. As an alternative the mineral wool deals. Thermal conductivity 0.048 W/(m·K), price – 3600 UAH/m^3.

The calculation is made for materials thickness 20, 50, 100, 150, 200, 250 and 300 mm. The calculation results economically expedient foam plastic thickness is displayed graphically on Fig. 1.

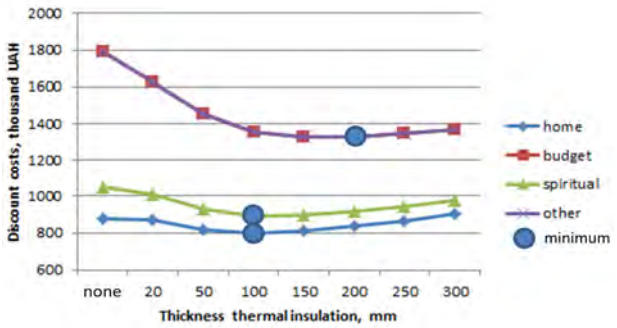

Fig. 1. The dependence of the discounted cost of foam plastic thickness

Economically feasible thick foam plastic insulation for residential building – 10 cm, budget building – 20 cm, spiritual building – 10-15 cm.

Another picture is observed in the case of wall insulation mineral wool, which cost higher (Fig. 2).

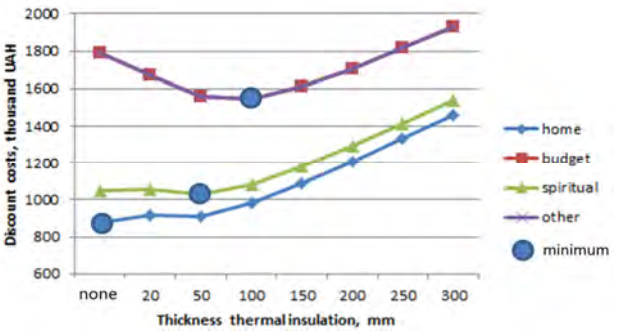

Fig. 2. The dependence of the discounted cost of mineral wool thickness

According to Fig. 2 insulate the residential building altogether inappropriate. This is due to lower prices for heat caused by «cross-subvention». Insulation thickness desired for the budget building 10 cm.

The dependence is similar in the case of attic insulation by glass-wool. Thermal conductivity 0.044 W/(m·K), price – 1860 UAH/m^3, cost of work – 42 UAH/m^2.

Economically feasible thick glass-wool insulation for budget building 10 cm, for spiritual building – 5 cm.

Heat transfer resistances of enclosure, that corresponding to the calculated cost-appropriate insulation thickness shown in Table. 3.

TABLE 3

HEAT TRANSFER RESISTANCES ENCLOSURES WITH DIFFERENT THERMAL INSULATION

Category consumer	Heat transfer resistances, m^2·K/W		
	foam plastic	mineral wool	glass-wool
home	3.094	0.920	1.440
budget	5.268	3.003	3.713
spiritual	3.094	1.962	1.440
other	5.268	3.003	2.576

As seen from Table 3 economically expedient heat transfer resistance for houses is often less than the regulatory requirements 2.1–2.4 m^2·K/W, as required [2].

Conclusion

«Cross-subvention» is intended to protect the population from undue financial burden utilities. However, such subvention make appropriate insulation residents their homes and implementing other energy efficiency measures.

The necessary replacement of «cross-subvention» targeted assistance or state participation in partial compensation costs for energy-saving measures.

Share compensation cost of heat insulation must meet the proportion of «cross-subvention» rate.

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