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RESEARCHES ON ENERGY CONSUMPTION IN HOTEL IN BRASOV AREA

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Abstract :*In this article an analysis is made of the main energy consumers in the hotel units in Brasov. Consider energy consumption for heating, hot water consumption, lighting. For example, it is considered a hotel unit with the capacity of 19 rooms and spaces. It is considered that in the Brasov area, being a mountain area, the number of days required for heating is higher than in other regions of the country. The annual average temperature in the area varies is different from the other areas*
Keywords): *hotel unit, energy consumption for heating, domestic hot water and lighting*

1. INTRODUCTION

Research on thermal energy consumption for a hotel unit in Brasov, with the capacity of 19 rooms, is based on the data and observations obtained from in situ analysis of the building and the heating, hot water and lighting installations. The evaluation was based on the technical documentation drawn up for the design and execution of the construction. The results obtained on the basis of the energy assessment of the building and of the heating installations, the preparation of the hot water and the lighting associated with it, serve to the energy classification of the building in the consumption grid, but also to the deepening of the necessary knowledge for designing some hotel units with an energy independence bigger.

2. MATERIAL AND METHOD

2.1 Determination of annual energy consumption for heating

For Brasov, which is in the climatic zone IV, the conventional and outdoor temperature calculation during winter is considered, according to STAS 1907/1: $\theta i = -21\ °C$ *(1)*
For the calculation of the annual energy consumption the following data are required: θek - temp ext. monthly average (MC001 / 6, page 10, table 2.1); the outdoor temperature which marks the start / stop of the heating (SR 4839 Page 4 Chapter 2.3) (θ = 12 ºC - the conventional equilibrium temperature); DZ - number of days in which heating / month is needed (table 1); DZp - duration of preheating / year

Table 1: Determination of the actual heating period, Dz

	07	08	09	10	11	12	01	02	03	04	05	06	
θ_{ek}	19,1	18,20	13,20	8,40	2,70	-2,80	-3,30	-1,90	2,70	8,50	14,20	17,40	
θ_{eo}	12,00	12,00	12,00	12,00	12,00	12,00	12,00	12,00	12,00	12,00	12,00	12,00	
days/ month	31,00	31,00	30,00	31,00	30,00	31,00	31,00	28,00	31,00	30,00	31,00	30,00	
	θek> θeo	θek> θeo	θek> θeo	θek< θeo	θek< θeo	θek< θeo	θek< θeo	θek< θeo	θek< θeo	θek< θeo	θek> θeo	θek> θeo	

DZ	0,00	0,00	2,00	*31,00*	*30,00*	*31,00*	*31,00*	*28,00*	*31,00*	*30,00*	28,00	0,00	**242**
θem	0,00	0,00	0,12	1,17	0,36	-0,39	-0,46	-0,24	0,38	1,14	1,78	0,00	3,86

θek - monthly average outside temperature (MC001 / 6 pag 10 tab 2.1);θeo- the temperature which marks the start / stop heating (SR 4839, Chapter 2.3); DZ - number of days when heating / month is needed;
DZp - duration of preheating / year; θemp - average outside temperature during preheat. From Table 1. It follows that: DZp = 242 days, the average outdoor temperature over the preliminary warm-up period is: θemp = 3.86; If the existing plant has a consumption of 150 W / h, the auxiliary annual energy requirement for the 19 rooms of the hotel unit is shown in Table 2.

Table 2: Auxiliary energy consumption (heating energy) of the heating installation

150W/1000=0,150 KW		
We=0,150 * 24 *242 *19		
24h		
242 days real heating		
19 rooms		
We=	16552,8	KWh/year

In Table 3, there are elements to be taken into account when calculating annual energy consumption in the 19-room hotel unit.

Table 3: Calculation of annual energy consumption for heating, Qinc

Qinc = Qh+Qth+We-Qrec.acc-Qrg		
Qh=	118557,488	[kWh]
Qth=	29722,269	[KWh/ year]
We=	16552,800	[KWh/year]
Qrec.acc=	0,000	there is no heat recovery or renewable sources
Qrg=	0,000	
Qinc=	**164832,557**	[KWh/year]

where: Qh- heat demand for heating (in the heated space); Qth - heat losses of the heating systems subsystems; We -auxiliary energy consumption (heating energy) of the heating installation; Qrec.acc - recovery heat from the hot water supply system; Qrg - the energy provided by renewable sources.
The specific annual energy consumption is calculated as shown in Table 4.

Table 4: Annual specific energy consumption for heating, qinc

qinc=	Qinc	KWh/ square meter* year
	Au	
qinc=	164832,6	
	1074,90	
`qinc=	153,3	KWh/ square meter* year

where: Qinc- annual energy consumption for heating; Au - useful area

The result of the calculation of specific annual consumption of energgie's compliance with the building energy **Class C**, according figure.1 in accordance with national regulations; qinc=153,3 KWh/ square meter* year

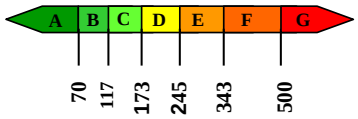


Figure 1. Energy grid according to annual energy consumption for heating

2.2 Determination of the demand for hot water for the analyzed hotel unit

Calculation of hot water demand for the hotel unit with capacity 19 rooms will be made according to the relationship (2)

$$Q_a = Q_{ac} + (Q_{acpc} + Q_{acpd} + Q_{acpb} + Q_{acpg}) + W_{ace} - Q_{rgac}\ [kWh/year] \quad (2)$$

Qa - annual energy consumption for hot water; *Qac* - annual heat consumption for hot water consumption to the user; *Qacpc* - heat loss for lost hot water (mass loss); *Qacpd* - heat losses on hot water distribution pipes; *Qacpb* - heat loss to the storage tank (boiler); *Qacpg* - heat losses to heat generation source for hot water consumption; Wace - auxiliary power consumption; *Qrgac* - the energy provided by renewable sources.

2.3 Setting water temperatures carecteristice

θar cold water temperature; θac - the hot water preparation temperature at the point of consumption; θacc - the hot water supply / use temperature at the point of consumption; θar = 10.5 C mountain rivers; θac = 50 C we will choose a value of 50 C for the water is prepared locally, and until the distribution in the hotel unit there are no big losses; θacc = 40 ° C

2.4 Setting the number of users for hot water consumption at the hotel unit with the capacity of 19 rooms

Consider the number of users for hot water consumption at the hotel unit as 60 people. The determination of the specific hot water consumption requirement will be determined according to the STAS 1478 standard, where for a person the consumption of hot water is *a= 60 liters / day; a-* required hot water consumption.

- Calculation of heat consumption for hot water consumption at user

$$Q_{ac} = 1.143*10^{-3}*a*z*N_p*(\theta_{ac} - \theta_{ar})\ [kWh/year] \quad (3)$$

where: *a* - specific hot water demand; *z* - annual number of days of hot water use; *Np* - number of people; θ_{ac} - hot water consumption temperature; θ_{ar} - cold water temperature used to prepare hot water for consumption.
For the year that has 365 days, 15 days of which are not consuming hot water, the results are shown in Table 5:

Table 5: Calculation of annual hot water demand

z=	350,00	day
θ_{ar}=	10,50	C
θ_{ac}=	50,00	C
a=	60,00	litre/day
Np=	60,00	person
Q_{ac} =	57101,92	kWh/year

The calculation of the heat consumption for the hot water lost (mass loss), for the hotel unit with the capacity of 19 rooms, will be done with the specific water loss method, according to the condition of the installation, according to the relation (4):

$$Q_{acpc} = 1.154*10^{-3}*b*z*(n_{ac}/24)*N_p*(\theta_{acc} - \theta_{ar})\ [kWh/year] \quad (4)$$

where: b - specific losses of hot water; z - daily number of hours of hot water delivery; Np - number of people; θ_{acc} - hot water supply temperature; θ_{ar} - the cold water temperature used for the preparation of hot water

Table 5. Calculation results of the hot water mass losses

b	5,00	litre/day person
z	350,00	day
Np	60,00	person
θacc	40,00	C
θar	10,50	C
na	24,00	hour
Qacpc	3588,01	kWh year

2.5 Calculation of heat losses on the distribution pipes for the analyzed hotel room will be done according to the calculation relation (5).

$$Q_{acpd} = Q_{acpd1} + Q_{acpd2} + Q_{acpd3}\ [kWh/year] \quad (5)$$

Q_{acpd1} - heat loss of distribution pipes located in basements and technical ducts; $Q_{acpd1} = 0,00;$ because we do not have distribution pipelines located in basements and technical channels.
Q_{acpd3} - heat loss on hot water recirculation pipes; $Q_{acpd3} = 0,00$ we do not have hot water recirculation pipes
Q_{acpd2} - heat loss of hot water pipes and connections to sanitary items; These losses are calculated according to the calculation relation (6);

$$Q_{acpd2} = 10^{-3}*U_2*L_{c2}*(\theta_{mac} - \theta_{amb2})*n_{ac}*z \quad (6)$$

where: $U2$ - represents the specific heat loss of pipes and connections to sanitary objects, $Lc2$ - column length; θ_{mac} - mean hot water temperature through pipes; θ_{amb2} - the ambient temperature of the location of the columns; n_{ac} - number of hours per day, hot water supply; z - number of days in one year of hot water supply

Table 6 Calculation results for heat losses through hot water distribution pipes

Lc2=	275,500 ml	the length of all the hot water pipes in the building (14.5 meters linear * 19 rooms)
U2=	1,000	W/m*K,
	0,001	kW/m*K
θmac=	50,000	C
θamb2=θio	19,815	C
nac=	24,000	day
z=	350,000	day
Qacpd2=	69,855	kWh/year

According to the data from the calculations table (6) results that the heat losses on the distribution pipes for the hotel unit in the area of Brasov are shown in relation (7).

$$Q_{acpd} = Q_{acpd1} + Q_{acpd2} + Q_{acpd3}\ [kWh/year];\quad Q_{acpd} = 69,855[kWh/year] \quad (7)$$

wher:Q_{acpd1} - heat loss of distribution pipes located in basements and technical ducts; Q_{acpd2} - heat loss of hot water pipes and connections to sanitary items; Q_{acpd3} - heat loss on hot water recirculation pipes;

2.6 Calculation of heat losses to the source of generation for preparation hot water consumption

$$Q_{acpg} = (1-\eta_g)*(Q_{ac} + Q_{acpc} + Q_{acpd1,2,3} + Q_{acpb})\ [kWh/year] \quad (8)$$

η_g - the energy efficiency of the hot water supply source; Q_{ac} - annual heat consumption for hot water consumption to the user; Q_{acpc} - Heat loss for lost hot water (mass loss); Q_{acpd1} - heat losses on hot water distribution pipes; Q_{acpb} - heat loss to the storage tank;
Calculation of heat loss at the source of generation for the preparation of hot water for the hotel unit with the capacity of 19 rooms is made taking into account the efficiency of the existing installation
The results of heat loss calculations at the source .

η_g - 0,9; Q_{ac} = 57102 [*kWh/year*]; Q_{acpc} = 3589[*kWh/year*]; Q_{acpd} =69,85[*kWh/year*];

2.7 Calculation of annual energy consumption for hot water consumption

Annual consumption of hot water energy at the hotel unit with the capacity of 19 rooms is made according to the relationship (9).

$$Q_a = Q_{ac} + (Q_{acpc} + Q_{acpd} + Q_{acpb} + Q_{acpg}) + W_{ace} - Q_{rgac} \quad [kWh/year] \qquad (9)$$

When:Q_a - annual energy consumption for hot water; Q_{ac} - annual heat consumption for hot water consumption to the user; Q_{acpc} - heat loss for lost hot water (mass loss); Q_{acpd} - heat losses on hot water distribution pipes; Q_{acpb} - heat loss to the storage tank (boiler); Q_{acpg} - heat losses to heat generation source for hot water consumption; W_{ace-} auxiliary power consumption; Q_{rgac} - the energy provided by renewable sources.

Table .8 The results of annual energy consumption

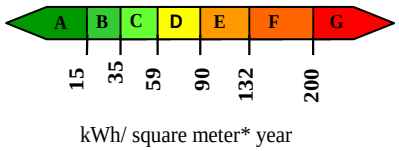
Qac	57102	kWh/year
Qacpc	3588	kWh/year
Qacpd	69,855	kWh/year
Qacpb	0	kWh/year
Qacpg	6076	kWh/year
Wace	0	kWh/year
Qrgac	0	kWh/year
Qa	66836	kWh/year

2.8 Specific annual energy consumption for hot water

Table .9 The result of annual energy consumption for warming hot water

qac=	Qa/ Au	kWh/ square meter* year
Qa=	66835,761	
Au=	1074,900	
qac=	62,179	kWh/ square meter* year

Figure 2. Energy grid according to annual energy consumption for domestic hot water



kWh/ square meter* year

According to the results, the analyzed hotel unit can be included in the **D-class** consumption grid in terms of annual energy consumption for hot water preparation, qac=62,179 kWh/ square meter* year

2.9 Calculation of annual energy consumption for lighting, qil

$q_{il} = (W_{il} - W_{rgil})/A_u$ [kWh/year] (10)

where: *Wil*- average annual energy consumption for lighting; W_{rgil} - renewable sources of energy; A_u the useful area of the building; *qil* - specific annual consumption; q_{il} *=10,821 [kWh/year square meter]*

$$w_{il} = \frac{W_{il}}{A_{inc}} \left[\frac{kWh}{m^2 year} \right] \quad W_{il} = 8.303{,}10 \ [kWh/year]; \ A_{inc} = 1074{,}90 \ [square \ meter] \tag{11}$$

w_{il}*= 7,72 [kWh/ square meter year]* (12)

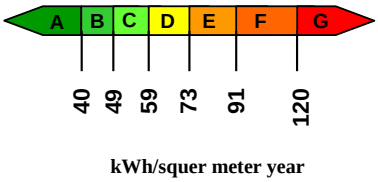


Figure 3. Energy grid depending on annual electricity consumption for lighting

The hotel unit under consideration is in the A-class grid due to the annual energy consumption required for lighting

3. CONCLUSION

1. For a hotel unit the knowledge of the energy consumption related to the annual amount of energy needed for heating, domestic hot water preparation and the annual energy consumption required for lighting are essential for designing and building a hotel unit to meet the quality requirements and to reduce these uses using plants that use renewable energy;
2. For specific energy consumption calculations, we need to use relationships according to standards;
3. The classification of the hotel units in the energy classes specific to the specific consumption is done according to the legislation in force.

REFERENCES

Mc001/2 - Methodology for calculating the energy performance of buildings ;
NP048-2000- Normative on thermal and energy expertise of existing buildings and heating and hot water heating systems;
NP048-2000- Normative for the elaboration and granting of energy certificate for existing buildings
STAS 1478-90 Standard for the design, construction and operation of sanitary facilities related to buildings;