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Modern State of Autonomous Heating and Electricity Supply Systems of Village Houses in Uzbekistan

Khamraev S.I.

PhD, docent, Department “Thermal Power Engineering”.Karshi Engineering Economics Institute, 180100, Karshi, Uzbekistan

ABSTRACT : The article analyzes the energy consumption for heating, hot water supply and power supply of one-story standard cottages operated in the Karshi district of the Kashkadarya region. Based on the analysis, energy diagrams were compiled, which are used to develop energy-saving measures for heat supply of buildings.

KEYWORDS : hot water supply, heating, ventilation, indoor air temperature, outside température, electricity consumption, natural gas, energy saving.

I.INTRODUCTION

In recent years, large-scale work on providing housing to the rural population is being carried out in our country on the basis of the updated model projects. In particular, the President of the Republic of Uzbekistan dated November 22, 2016 "On measures to implement the Program for the construction and reconstruction of affordable multi-apartment houses in cities in 2017-2020" No. PQ-2660, dated November 24, 2018 "In rural areas and for certain categories of citizens No. PQ-4028 of January 18, 2018, No. PQ-3480, dated January 18, 2018, No. PQ-3480 of Uzbekistan More than 53,000 low-cost houses and apartments have been built on the basis of updated model projects in 2017-2021, approved by the President of the Republic's decision PQ-2639 dated October 21, 2016, and need to improve living conditions. About 65,000 families were provided with housing [1,2,3,4,10,11,12].

Today, one-story 3-room houses are being built in our Republic based on the model project 184-46s-16, 2-story 4-room houses based on the model project 144-41s-16, and one-story 4-room houses based on the model project 184-33s-10/13I. Creating a stable heat supply of rural houses in new model houses, especially in areas far from centralized energy supply, is one of the most pressing issues today.

II.MATERIALS AND METHODS

In order to evaluate the energy efficiency of model houses, the article analyzed the heat and electricity supply based on the design parameters. The plan of one-story 3-room houses built according to the sample project 184-46s-16 is 8.62x9.0 m in plan, 2.7 m high, it includes common rooms, bathroom, kitchen and utility room, walls are raised from baked brick and laminate and ceramic tile flooring. have An overview of the house built according to the model project 184-46s-16 is presented in Fig. 1 [5].

According to the results of the analysis of the project documents, the total required heating volume of the house is 344.7 m^3, the surface area is 66.58 m^2. In the climatic conditions of the Karshi district, the minimum calculated temperature of the outside air is -13 °C, and the indoor air temperature of the house is required to be 16-25 °C. If the maximum amount of heat required for heating the house is 13.45 kW, of which 3.4 kW of heat is wasted through the main and auxiliary wall structures of the building, the relative heat consumption for heating the surface of 1 m^2 of the building is 124.8 W/m^2 was found to be equal.

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Figure 1. General view of a one-story 3-room house (based on the model project 184-46s-16).

The amount of heat required for the total volume of the building was determined and presented in Table 1.

Table 1
Thermal technical indicators of the building

Building name	Volume m^3	Minimum temperature, t, °C	Heat consumption, W (kcal/hour)		
			For hot water supply	For heat supply	Wall construction. wasted through
1 floor 3 bedroom house	344,7	-13	1500 (1289)	8363 (7349)	3345 (3806)

The analysis of heat-technical indicators of a one-story 3-room sample house shows that in the total heat balance of the house, 75% of heat is used for heating, 5% is used for hot water supply, and 20% of heat energy is lost to the environment (Fig. 3, 2 table).

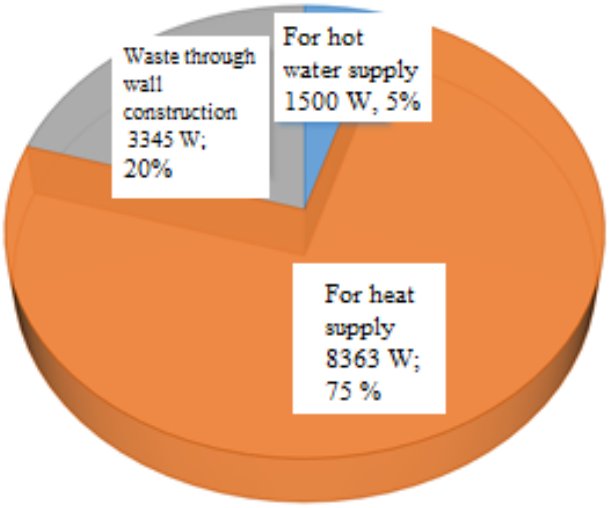

Figure 3. Heat consumption for the heat supply systems of a 3-room house with a usable area of 67 m^2.

ISSN: 2350-0328
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Vol. 10, Issue 10, October 2023

Table 2
Calculated indicators of thermal energy parameters of a 1-story, 3-room house

№	Calculation parameter, indicator name	Symbol	Unit of measure	Calculation indicator
1	Indoor air temperature	$t_{a.t}$	°C	16-25
2	Outside air temperature	t_{out}	°C	-13
3	Total area of the building	F	m^2	67
4	Heat loss through the main and auxiliary walls of the building	Q_{loss}	W	3345
5	Heat flow to the heating system	Q_0	W	8363
6	Calculation temperature of the heating system	t_1, t_2	°C	95-70
7	Relative consumption of heat for heating the building (in relation to 1 m^2 surface)	q_{heat}	W /m^2	124,8

For the cold season of the year, it is taken into account that the air temperature will be minus 13 °C, and as a source of heat supply, a KMU-15A boiler with a capacity of Q=15 kW, designed to work on natural gas fuel, will be installed. In the heating system, water with a temperature of t_1=95°C, t_2=70°C is used as a heat carrier. The heating system is one-pipe, natural circulation and branched from the bottom, "Rotto-575" aluminum radiators manufactured by "Liderline" LLC were used as heating devices. Polypropylene pipes with thermal insulation are used in the heating system.

Specific weight in the gas supply of the house in the project ρ=0,79 kg/nm^3 and heat of combustion$Q_c^h = 35590 \frac{kJ}{nm^3}$ (8500 kcal/nm^3) intended for use of natural gas. Based on the results of the calculations, 54,000 kJ of heat is required per hour to obtain 15 kW of power in the water heating boiler, that is, according to the parameters of the given gas fuel, 1.51 m^3 of natural gas is burned. So, 36.24 m^3 of natural gas is consumed per day for heating the house in the winter months.

The value of 1.84 kg.sh.yo/h is obtained by converting the required amount of heat into the equivalent value of conventional fuel. According to the calculation results, considering that the duration of the heating season is 132 days in the conditions of the city of Karshi, it was determined that the consumption of natural gas fuel during this period is 4806.7 nm^3. The main costs and the heating efficiency indicator are calculated in conditional fuel equivalent. Table 3 below shows the correspondence of the amount of natural gas used for heat supply to the conventional fuel equivalent.

Table 3
The required heat for the heat supply of a 3-room model house and the fuel consumption of the KMU-15A water heating boiler used

№	Fuel consumption	Heat, kJ	Natural gas, nm^3	Conventional fuel, kg
1	Compared to 1 nm^3 of used natural gas	35 590	1	1,215
2	Hourly consumption for water heating boiler	54 000	1,51	1,84
3	Fuel burned per day	1 296 000	36,24	44,2
4	For a month	38 880 000	1092,4	1326,0
5	Fuel burned during the heating season (132 days).	171 072 000	4806,7	5834,4

In addition to the heating system, natural gas fuel is also used for daily household needs (cooking, making tea, etc.). The house is equipped with a PG-4 gas stove, and together with the gas stove of the water heating boiler, the maximum hourly gas consumption is 2.1 nm3/h.

The electrical supply system of the building is designed according to the requirements of the current "Rules for the installation of electrical devices", ShNK-2.08.01-05 "Residential buildings", KMK 2.04.17-98 "Electrical equipment of residential and public buildings" [8]. The maximum hourly load for the building's electricity supply is 5.6 kW:

$$P_{y.x} = P_{c.h} \cdot n + P_{эси} = 4{,}1 \cdot 1 + 1{,}5 = 5{,}6 \text{ kW}.$$

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Vol. 10, Issue 10, October 2023

here $P_{c.h}$ – the comparative electrical load of the house; n – house number; $P_{e.w.h}$ – calculated power of an electric water heater.

The estimated electrical load of a 3-room model house is presented in Table 4.

Table 4.
Estimated electrical load of a 3-room house with a living area of 67 m², kW.

Parameters	To illuminate	For household needs (laundry, ironing, TV and radio)	Air conditioner, to regulate the air	To use an electric water heater	Total
Energy onsumption (electricity)	0,12	1,88	2,1	1,5	5,6

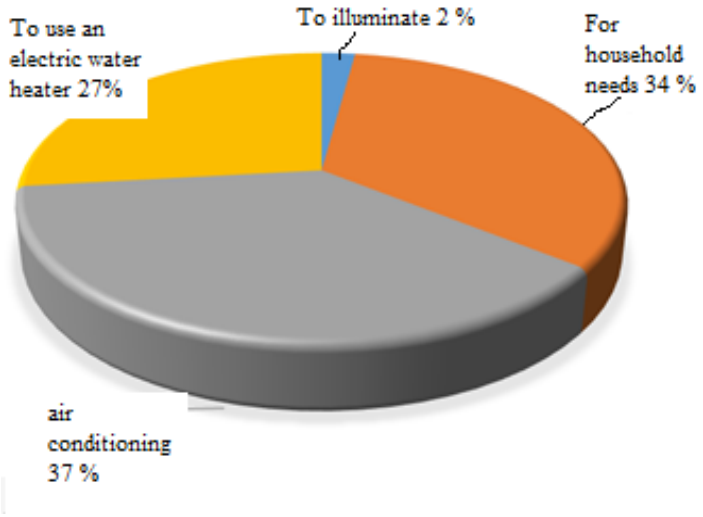

Figure 5. Electricity consumption diagram for a typical 3-room house.

The project of the heat supply system of a one-story, 4-room house based on the model project 184-33s-10/13I, architectural assignment and KMK-2.04.05-97 - "Heating, ventilation and air conditioning" and ShNK-2.08.01-05 - "Residential houses " was developed in accordance with the requirements. The total heating required volume of the house is 940 m3, the area is 189.2 m². The general view of the house is presented in Figure 6.

Figure 6. General view of a one-story 4-room house based on the model project 184-33s-10/13I

The minimum calculated temperature of the outside air is -15 °C, and the indoor air temperature of the house is required to be 16-25 °C. The heat loss through the wall structures of the house is 6.4 kW, and the amount of heat required for heating is 23.6 kW (20277 kcal/h), that is, when the temperature in the heating system is 70-95 °C, to heat the surface of 1 m² of the building taking into account that the relative consumption of heat is 124.8 W/m², a KOGn/T-30 water

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Vol. 10, Issue 10, October 2023

heating boiler with a heat efficiency of Q=30 kW is installed as a heat source for the heat supply system of the house (Table 5).

Table 5
Table of heat indicators for the heat supply system

Building name	Volume m^3	Minimum temperature, t, °C	Heat consumption, W (kcal/hour)		
			For hot water supply	Wall construction for heat supply.	wasted through
1 floor 4 bedroom house	940	-13	1500 (1288)	23600 (20277)	6400 (5499)

For the heat supply system of a 4-room house with an area of 189.2 m^2, the diagram presented in Figure 1.16 was obtained based on the table of distribution of heat indicators in relation to total heat.

The minimum calculated temperature of the outside air is assumed to be -13°C [6,13]. Water with a temperature of 95-70 °C was used as a heat carrier in the heat supply system. The heating system has a two-pipe structure, with natural circulation.

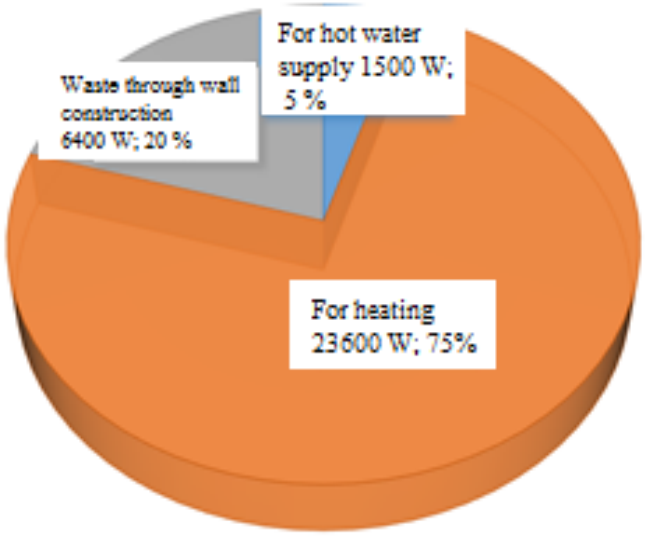

Figure 7. Distribution diagram of heat indicators for the heat supply system of a 4-room house with an area of 189.2 m^2.

The house project envisages the installation of a tap water line with a pressure of 1 atm. It was estimated that the total consumption indicator in the water line is 0.69 m^3 per hour and 1.25 m^3 per day, that is, cold water supply is carried out for 2 hours per day based on local conditions (Table 6).

Table 6.
Water flow indicators on the pipeline line

System name	Water pressure, м.	Estimated consumption indicator		
		m/day	m^3/hour	liter/sec
Cold tap water	10,0	1,25	0,69	0,43

The heating system is equipped with an electric water heater separate from the hot water supply system, that is, an ARISTON SG 80 electric water heater with a capacity of 80 liters and a power consumption of 1.5 kW is installed in the model house. The water heating index of the electric water heater is 20-60 °C.

The fuel supply of the model house is designed to use natural gas with specific gravity r=0.79 kg/nm^3 and heat of combustion Qhc = 35590 kJ/nm3 (8500 kcal/nm^3). The total gas consumption indicator is 4.5 nm^3/hour in the maximum state. 100-110 m^3 of natural gas is used per day in a PG-4 type gas stove and KOGn/T-30 combined water heating boiler.

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The electrical supply system of the building is designed according to the requirements of the current "Rules for the installation of electrical devices", ShNK-2.08.01-05 "Residential buildings", KMK 2.04.17-98 "Electrical equipment of residential and public buildings" [8,9]. The maximum hourly load for the building's electricity supply is 7.65 kW, and the lighting of the area where the house is located is planned to be carried out in accordance with construction standards and regulations. Special attention is paid to insulation during installation of electric line.

One-story 3-room houses built on the basis of project 184-46s-16 and 4-room houses built on the model project 184-33s-10/13I are expected to use the same hot water supply system. In addition to the heating season, it is also required to provide hot water for domestic needs throughout the year, if a 1.5 kW electric water heating device is used in the house, the daily energy consumption is 36 kW, and the annual figure is 13140 kW, so the hot water supply of the house annual conditional fuel consumption is 1614.5 kg.

Table 7.
Indicators of consumption of energy resources of sample houses

№	1 floor 3 bedroom house	Q, MJ	Q, kWh	Natural gas, m^3	Conditional fuel, kg
1	Heating system	171072	47520	4806,7	5834,4
2	Hot water supply	47304	13140	-	-
3	Power supply	87091,2	24192	2453,3	2968,5
	Total	305467,2	84852	7260,0	8802,9

III. RESULTS

The energy analysis of the heat and electricity supply system of model rural houses built in Karshi district of Kashkadarya region shows that it is necessary to save traditional energy resources in heating, hot water supply and electricity supply of model houses, to provide energy (heat and electricity) in a stable manner, especially in heat supply with traditional (natural gas, coal, firewood, etc.), there are problems such as reducing the share of fuels and reducing their environmental impact.

The analysis of the heating system of a sample 3-room house shows that 709 kWh/m^2 of heat energy is consumed during the heating season. Therefore, the consumption of fuel and energy resources for 1 m^2 of heating area is high, and it is appropriate to use the solar energy potential of the area.

REFERENCES

[1] Uzakov G N, Davlonov H A, K.N.Xoliqov K N 2018 Study of the Influence of the Source Biomass Moisture Content on Pyrolysis Parameters. *Applied Solar Energy* 54 481-484
[2] Decision No. PQ-2660 of the President of the Republic of Uzbekistan dated November 22, 2016 "On measures to implement the Program for the construction and reconstruction of affordable multi-apartment houses in cities in 2017-2020".
[3] Decision No. PQ-4028 of the President of the Republic of Uzbekistan dated November 24, 2018 "On additional measures to expand the construction of affordable housing in rural areas and for certain categories of citizens".
[4] Decision No. PQ-3480 of the President of the Republic of Uzbekistan dated January 18, 2018 "On measures for the effective implementation of targeted programs for the development of housing construction in 2018"
[5] Program for the construction of affordable housing according to updated model projects in rural areas in 2017-2021, approved by the decision of the President of the Republic of Uzbekistan No. PQ-2639 of October 21, 2016.
[6] Standard project 184-46s-16. One-story 3-room residential building. Tashkent. 2016
[7] Standard project 184-33s-10-13I. One-story 4-room residential building. Tashkent. 2016
[8] KMK.2.04.05-97 “Heating, ventilation and air conditioning.” Tashkent. 1996 (amended 2011)
[9] ShNK.2.08.01-05 “Residential buildings”. Tashkent. 2005
[10] KMK 2.04.17-98 “Electrical equipment of residential and public buildings.” Tashkent. 1998.
[11] Uzakov G.N., Khamraev S.I., Khuzhakulov S.M. Rural house heat supply system based on solar energy // IOP Conf. Series: Materials Science and Engineering 1030 (2021) 012167 IOP Publishing doi:10.1088/1757-899X/1030/1/012167
[12] Khamraev S. I, Ibragimov U. Kh Kamolov B.I. Removal of hydrodynamic lesions of a heated floor with a solar collector // APEC-V-2022 IOP Conf. Series: Earth and Environmental Science 1070(2022) 012018 IOP Publishing doi:10.1088/1755-1315/1070/1/012018.
[13] Sh Mirzaev, J Kodirov, S I Khamraev. Method for determining the sizes of structural elements and semi-empirical formula of thermal characteristics of solar dryers// APEC-V-2022 IOP Conf. Series: Earth and Environmental Science IOP Conf. Series: Earth and Environmental Science 1070(2022) 012021 IOP Publishing doi:10.1088/1755-1315/1070/1/012021.
[14] Uzakov G. N., Charvinski V. L., Ibragimov U. Kh., Khamraev S. I., Kamolov B. I. (2022) Mathematical Modeling of the Combined Heat Supply System of a Solar House. Energetika. Proc. CIS Higher Educ. Inst. and Power Eng. Assoc. 65 (5), 412–421. https://doi.org/10.21122/1029-7448-2022-65-5-412-421