THE COMPARATIVE ANALYSIS OF HOUSEHOLDS' HEATING SYSTEMS IN RUSSIA

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Dynamic increase in country house building in Russia is one of the modern trends. More and more citizens especially citizens of megalopolises like Moscow and Saint-Petersburg prefer country house cottage villages, town houses and private residences to block of flats in cities. Despite the fact that such choice has wide range of advantages it also faces some complex issues one of which is service lines' implementation.

Heating is one of the core elements of service lines. Decision regarding heating system type is complicated by severe climate conditions of the most country territory in Russia. For instance the following climate conditions of cold year period are typical for Leningrad region – Table 1 [1].

Table 1

Climate conditions of cold year period in Leningrad region

Air temperature minimum, °C	The coldest days' air temperature, °C	The amount of days with its average air temperature ≤ 10°C	The average air temperature in °C with days' average air temperature ≤ 10°C	Monthly average relative humidity of the coldest month, %	Precipitation amount from November to March
-48	-37	249	-1,9	86	231

Taking into account mentioned above climate conditions for this region it is necessary to use heating source with power more than 16 kW to heat the house with living space nearly 160 m^2. It should be noted that Leningrad region is referred to regions with the least severe environmental conditions and hence the more powerful heating source should be used in regions where winters are frostier.

Now in Russia both traditional and untraditional ways of heating are available. Traditional heating systems are represented by big line of natural and liquefied gas, diesel and coal fire boilers with various degree of power while there are also such alternative heating systems as heat pumps based on geothermal energy usage and pellet fire boilers which are considered as heating sources based on biofuel consumption. Yet many individual for any construction operation factors influence the choice of definite heating system it is reasonable to determine some comparative characteristics permitting to mark pros and cons of every heating source. Table 2 [2] demonstrates such comparative characteristics of all types of different heating sources represented in russian market.

Fuel availability degree. This relative indicator is created to character availability of every fuel usage by any consumer and has range from 1 to 3. Fuels for general use have the first degree, the second degree includes those fuels which in some exceptional cases may be used with restrictions while the third degree is appropriate only for fuels usage of which is always limited by certain factors. Fuel with the third degree of availability, for example, is natural gas the usage of which is always defined by the remoteness of trunk gas pipeline from the object of heating. Heat pumps have the second degree of availability due to their exceptional character determined by that factor that usage of geothermal energy may be restricted by special features of house location.

Maximum fuel consumption per month. It is one of the most important rates which describes the high point of heating costs per month. As a rule this point is reached in represented absolute value only in coldest month of the year. Nevertheless according to that fact that the amount of days with its average air temperature ≤ 10°C in Leningrad region is 249 days it will be fair to conclude that heating source will be active nearly 8.5 month of the year. As heat pumps and electric convectors don't use fuels as heating resource this comparative characteristic isn't estimated for them.

Table 2

The comparative characteristics of heating systems available in Leningrad region

Comparative characteristics	Gas fire boiler	Liquefied gas fire boiler	Diesel fire boiler	Pellet fire boiler	Coal fire boiler	Heat pump	Electric convector
Fuel unit	m^3	l	l	kg	kg	kW	kW
Fuel availability degree	3	1	1	1	1	2	1
Maximum fuel consumption per month[1]	697	1051	699	1939	2280		
Fuel price, rub/unit[2]	3,60526	14	24	5,325	3,98		
Fuel costs, rub/month[1]	2513	14717	16768	10323	9076		
Electric capacity consumption, kW/month[1]	65	61	36	172		3406	11520
Electric consumption costs, rub/month[1]	167	159	93	444		8822	29837
Total costs for heating, rub/month[1]	2680	14876	16860	10768	9076	8822	29837
Average price of heating source, rub.	33266	33266	50740	161313	39336	389336	55232
1 kW of heat energy cost, rub/hour[1]	0,23	1,29	1,46	0,93	0,79	0,77	2,59
Emission CO_2, %	6	6	12	13	10	0	0

[1] when heating source is functioning 24 hours of 30 days per month at rated power.
[2] for all fuels (except natural gas) it is stated average retail price during January-March'2011 in Leningrad region; for natural gas it is stated tariff which was established by government for the population of Leningrad region for 2011.

Electric capacity consumption. This rate is the core one for heat pumps, electric convectors and other heating system generating heat energy from electric as it is that which influence on monthly costs for heating. Exception are that cases when electricity is generated by own wind stations and solar systems but such heating systems despite of their high ecological and innovative characteristics are not investigated in this analysis as due to climate conditions of observed region they can be used only as supplementary way of heating aiming to energy saving. If to return back to investigated heating sources which transform electric energy from central electricity systems to heat it is fair to note that heat pumps are nearly in four times more cost-effective than traditional electric convectors. Electric capacity consumption is also essential for fuel heating sources as it is one of the core components of monthly costs for heating. All boilers excluding coal and pellet ones have similar electric capacity while pellet boiler is the most cost-based and coal one doesn't use it at all. It makes coal boiler autonomous that means that its functioning doesn't depend on electricity.

Fuel price. Monthly costs for heating appreciably depend on this variable parameter. It should be considered that there is some unpredictability in planning monthly fuel costs because many external factors affect on fuel retail prices dynamics. For instance from the Fig. 1 which shows diesel retail prices dynamics in Leningrad region during 2007 – 2011 you can see that the character of diesel pricing is spasmodic. Natural Gas prices are established by the government and as it is seen from the Fig. 2 have certain increase trend hence they are more prognosticated.

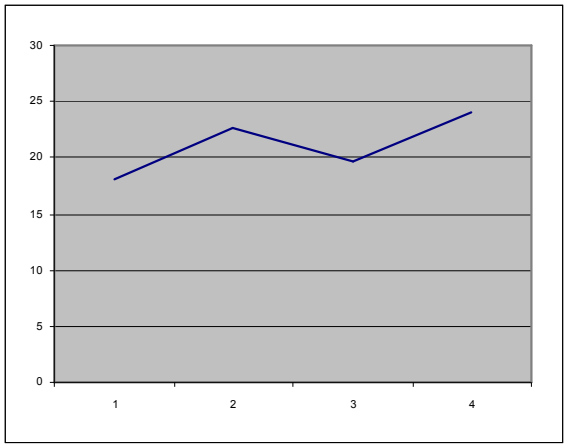

Fig. 1. Dynamics of diesel retail prices in Leningrad region in 2007 – 2011.

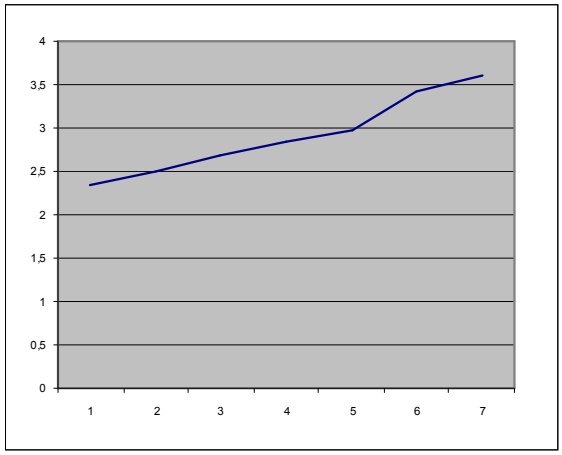

Fig. 2. Dynamics of natural gas tariffs in Leningrad region in 2009-2011.

Electric consumption costs. It is evident that this parameter is directly influenced both by electric capacity consumption of heating source and by 1 kW of electricity cost. Here should be stated that electricity prices are fixed by government. During the last five years electricity tariff in Leningrad region raised in more than 1,5 times – Fig. 3. This growth makes consideration of this comparative characteristic more crucial.

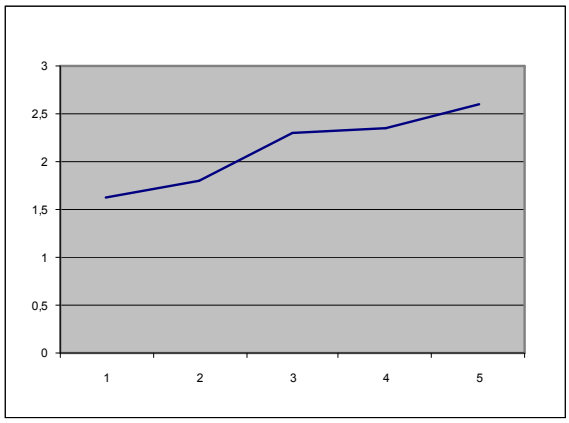

Fig. 3. Dynamics of electricity tariffs in Leningrad region in 2007 – 2011.

Total monthly costs for heating. Along with 1 kW of heat energy produced cost these two indexes are absolutely useful for heating sources' comparison. Due to their amount we can determine the cheapest from the point of current costs way of heating which is heating by the use of natural gas in Leningrad region and the most expensive one which is heating by electric convectors in investigated region. It should be noticed that there is no analogues to heating by the use of natural gas by its amount of monthly costs. Next cost category (0.77 – 0.93 rub/kWh) to which heat pumps, coal and pellet fire boilers are belonged exceeds its cheapest analogue by monthly costs amount more than three times. Heating by the usage of liquefied gas and diesel characterized by the following cost category (1.29 – 1.46 rub/kWh) is rather expensive though it is cheaper than heating by electric convectors almost in two times. Despite that fact that this index allows to range heating systems and identify the most attractive of them it will be wrong to consider it as a result of analysis as there are some other important characteristics like fuel availability degree, initial investments which significantly influence on the choice of heating system.

Average price of heating source. In this analysis this characteristic is only informational as it takes into account the cost only of the heating source itself and hence doesn't represent the total amount of initial investments. For example despite the low price of gas fire boiler total initial investments when choosing this type of heating system are rather significant as all necessary services required for house connection to trunk gas pipeline (if gas pipeline is located near house's lot) cost nearly 200 000 rubles in Saint-Petersburg [3]. Nevertheless even such appraisal can be useful as it allows to see that heat pump choice entails substantial initial investments as only heat pump itself costs in ten times more that liquefied fire boiler for instance. Also it should be noted that as electric convectors don't require anything else except themselves to heat the house for them the stated amount is almost final. So it can be supposed that from the point of initial investments the usage of electric convectors is the most cost-effective way of heating.

CO_2 emission. Nowadays when the ecological issue transforms into global problem as environment suffers from polluting consequences caused by human activities index of CO_2 (however like of other harmful toxic scrap) emission becomes priority. A man constructs his house, equip it, implements necessary service lines – all of this is made for long future hence it is evident that everyone should think not only about material aspects but also take into account such parameters as ecological. If house heating will be considered as long-term project it will be obvious that analysis of its efficiency and risks linked with its realization is vital. Installed equipment has to be not only cost-effective but also must suit to all demands of modern times that allocate ecological characteristics as obligatory to be taken into account.

Thereby comparative analysis of heating systems is complicated and versatile. Only a part of possible parameters were investigated in this analysis. It is necessary to understand that there is no common decision suitable for every situation, any heating system may be effective and impossible depend on peculiarities of each case. Such detailed analysis is obligatory every time when the choice of heating system should be made because energy balance of the country someway is influenced by people's decisions regarding their own heating systems. The existence of such analysis or sometime its absence determines efficiency of households' energy system as a component of country's energy balance.

REFERENCES

[1] СНиП 23-01-99

[2] Table is created with the usage of user guides of heating sources of Viessmann, Rinnai, Electrolux, Buderus, De Dietrich, Olympia, Faci, Grandig, Herz, Kostrzewa, Stiebel Eltron, Rehau, Protherm, Bosch, AEG, Siemens-Dimplex, Timberk, Noirot.

[3] http://www.peterburggaz.spb.ru/services/fis/howto