REPORT

Strategy study on inter-fuel substitution implemented in the Kolpashevo municipality

Recommendations for future inter-fuel substitution implementations in municipalities of the Russian Federation

Moscow
2010

This analytical paper assessing energy, economic and environmental effects of the recent inter-fuel substitution in the town of Kolpashevo was prepared by Gazprom promgaz compliant with Contract No. PS 13683 concluded with UNECE on 03 July 2008 and with the tripartite agreement signed on 24 September 2008 in Munich (Germany) between UNECE, EBC and Gazprom promgaz.

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Introduction

The United Nations Fund together with the European Business Congress (EBC) have co-financed project “Financing Energy Efficiency Investments for Climate Change Mitigation” implemented as part of the Energy Efficiency 21 programme. Other co-financers of the project include French Ministry of Foreign and European Affaires, French Fund for Global Environment and Global Environmental Fund.

EBC in particular finances implementation of the study on reducing emissions of greenhouse gases by implementing inter-fuel substitution in the Russian Federation.

The paper aims to analyze the outlook of implementing inter-fuel substitution in municipal entity «Kolpashevo urban settlement», the Tomsk Region, and to develop recommendations on implementing inter-fuel substitution in urban and rural settlement of the Russian Federation. Connecting the Kolpashevo urban settlement to gas supply and requirement for effective gas use via replacing of deteriorated and obsolete equipment of boiler house and heat supply facilities, decreasing production costs, converting to modern technologies of heat and electric power generation and distribution underpin the study.

The paper includes:

1. An evaluation of the energy efficiency, environmental, social and financial outcomes related to the inter fuel substitution from coal and oil fuel to natural gas use in district heating and regional/local key industries, basing on:

   - quantitative analysis of performance indicators of the boilers operated in district heating and at industrial facilities,

   - comparative and future projected performance and costs indicators of fuels previously and currently used,

   - comparative estimate of GHG emissions generated by natural gas use and previous coal and oil fuel use in heating and key industries.

2. A study considering the relevance of upgrading currently used gas boilers to combined cycle boilers in the district heating and industry sector and recommendations on the equipment options as are the best suited the district needs in terms of cost and efficiency.

3. An analysis of barriers discouraging investors from installing the best cost/efficiency equipment in the public, private and industry sectors, and suggestions on instruments that should be put in place to avoid these barriers in the future.

4. An assessment of the training needs for the municipal administration’s decision makers and municipal managers of electricity and heat systems.

5. Recommendations made on the basis of the Kolpashevo case study on future inter-fuel substitution within the Russian Federation’s municipalities.

This paper presents a finalized version of the analytical study submitted to the UNECE and EBC in November 2008 and includes the following amendments required by the above two organizations:

- Completion of the analytical study with an executive summary describing major features, conclusions and recommendations of the case;

- Inclusion of a chapter comparing dynamics of the analyzed alternatives' parameters;

- Adding details of gas supply organization economic effect on different consumer categories under all the alternatives analyzed, including investment climate, business entities' economic efficiency, schemes of the inter-fuel substitution financing;

- Description of the effect that implementation of the inter-fuel substitution alternatives may have on the socially significant consumer groups;

- Identification of barriers hampering investments in energy efficiency and energy saving and of means to eliminate such barriers and facilitate investments in the energy industry;

- Adding list of energy sector personnel development programmes and recommendations on the personnel annual retraining, inclusive of positions and quantity of employees to be retrained.

The work was performed on the basis of:

- Analysis of data of the Tomsk Region Administration Department for Economics and Modernization of the Housing and Communal Services, Administrations of the Kolpashevo District and Kolpashevo urban settlement, directorates of utility companies LLC "Kolpashevo Heating Company" and LLC "Heating Systems and Technologies";

- Statistic records of the Territorial Body of the Federal State Statistics Service for the Tomsk Region.

It seems appropriate to conduct a post-audit of the Kolpashevo inter-fuel substitution project in 2 or 3 years in order to compare of theoretical and practical outcomes of the case.

1 Executive Summary

1.1 Assessment of Inter-Fuel Substitution of Coal and Liquid Fuel by Natural Gas

Municipal entity “Kolpashevo district”, located in the South-East of the West Siberian Plain, is part of the Tomsk Region northern territory.

The city of Kolpashevo is the capital of the municipal entity “Kolpashevo district”. The Togur village is the biggest rural settlement in the district. The distance between the city of Kolpashevo and Tomsk exceeds 300 km.

At the beginning of 2007 the population of the Kolpashevo district was 44 072 people, incl. 25 815 urban residents of the Kolpashevo city, and 17 257 rural residents.

Industry in the district is presented by timber, wood-processing, food-processing, machine-building, metalworking, geologic survey, agriculture, construction, wholesale and retail trading, catering enterprises, some of them in the stagnation state though.

Practically all these enterprises and infrastructure facilities are concentrated in the city of Kolpashevo and in the near-by Togur village.

In 2007 the fuel and energy complex (FEC) accounted for the greatest part (42%) of the overall industrial production, while coal and crude oil dominated in the district fuel and energy balance.

Existing state of the district FEC had negative impact on the environment, while the high prices of fuel and energy resources (FER) hampered the economic development. To improve such environmental and economic situation the district was included in the Programme of Establishing Gas Supply and Distribution in the Russian Federation Regions. Under the said Programme in the later half of 2007 the district was connected to the Unified Gas-Supply System (UGSS).

During the elaboration of the gas supply and distribution scheme of the district (in 2006), the Regional Administration together with the Gazprom group decided to develop an integrated energy supply system based on modern equipment and technologies. JSC “Gazprom Promgaz” therefore developed the programme Creation of the High Energy Efficiency Zone in the City of Kolpashevo. The following achievements have been reached in the framework of the programme:

- General scheme of gas supply and distribution in the Tomsk Region, including the Kolpashevo district;
- Technical and economic proposals on reconstruction and modernization of the Kolpashevo city heat supply systems;
- Scheme of the Kolpashevo city integrated energy supply;
- Justification of investments in the construction of mini combined heat and power (CHP) plants and self-contained block boiler houses.

However, after the district was connected to the unified gas supply system, modern heat and power generation facilities were not put in place, but a decision was taken to switch operating boilers from coal and oil to gas, which was de facto withdrawing from the high energy efficiency zone project.

By December 2008 the following activities had been implemented:

- Construction of a gas pipeline to Kolpashevo;
- Implementation of the first and second stages of gas supply;
- 14 municipal boiler houses have started operating, which covers 70 % of the heat needs of the district;
- Installation of modern gas boilers with chemical water treating, processing automation, gas flow meters;
- Reconstruction of 7.5 km heat network. For the purpose of implementing comparative study of the inter-fuel substitution and accepted decisions effectiveness four alternatives were defined:

1 **Alternative 1 "Before gas supply and distribution organization"** reflects situation in the district FEC prior to the UGSS connection;

2 **Alternative 2 "First stage"** describes the district FEC after implementation of the 1st and 2nd stages of gas supply and distribution establishing and re-equipment of 14 boiler houses.

This case must be commented on. When the district had been connected to the UGSS, the Kolpashevo district Administration invited potential investors to bid for design, construction and operation of housing and utilities infrastructure (gas-fired boiler-houses) at the territory of the Kolpashevo city. The tender was won by open limited liability society production company "Octane"[1] (hereinafter LLC "Octane"). Investor funds were seen as means to improve the communal infrastructure and have the utility users ready for gas connection without financing from the regional budget. As follow-up of the tender on July 13th 2007 municipal entity "Kolpashevo Urban Settlement" (Lessor) and Open Limited Liability Society "Kolpashevo Heating Company"[2] (Lessee) concluded Agreement[3] for Lease of Estate Making Part of the Municipal Property, which entitled the Lessee to operate the greater part of the municipal heat-supply facilities. According to this Agreement Open Limited Liability Society "Kolpashevo Heating Company" (hereinafter LLC "Kolpashevo Heating Company") operates the leased heat-supply and production assets, provides energy-supply services for consumers (collects payment for rendered services), and is allowed to introduce improvements. Implementing this Lease Agreement LLC "Kolpashevo Heating Company" has replaced 25 old boiler-houses constructing 14 gas-fired ones in their stead. In aid of the project financing, they engaged a Leasing Company, which bought equipment from LLC "Octane", while LLC "Kolpashevo Heating Company" acted as the Lessee. The income of LLC "Kolpashevo Heating Company" is derived from selling energy supply services.

As LLC "Kolpashevo Heating Company" invests in construction of the gas-fired boiler-houses, the Lease Agreement validity term should evidently be long enough to ensure the investments payback and desired rate of return.

The 2nd alternative uses 2009 forecast data for consistency sake. As the gas boiler houses were commissioned in spring 2008 and before that in January-March (considerable part of the heating season) the operating boiler houses had still been fuelled by coal, 2009 forecast data are more feasible for comparison purposes.

3 **Alternative 3 "Gas-fired boiler-houses"** analyses the situation when all boiler-houses fed by coal and oil have been shut-down and replaced by gas-fired boiler-houses.

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[1] The biggest boiler equipment manufacturer in West Siberia

[2] Affiliate of open limited liability society production company "Octane"

[3] valid until December, 31, 2008

Conversion of all Kolpashevo city heating sector to gas has been agreed without identifying any concrete investor though. The investor still to be identified, the present study leaves a number of organizational, legislative and economical issues without.

4 **Alternative 4 "Mini combined heat and power (CHP) plants"** deals with a virtual (modeled) FEC state in case of implementing the high energy-efficiency zone project.

This alternative makes use of the JSC "Gazprom promgaz" project envisaging construction of 3 mini CHP plants in the district.

Alternatives 3 and 4 treat the hypothetic situation when all project stages have been fully implemented, thus necessarily leaving dates of stages completion and facilities commissioning unspecified. The FEC performance characteristics are only inferred.

Detailed operation parameters of the FEC and more specifically of the Kolpashevo city are provided in Chapters 2-5. The present chapter comprises brief comparison of the alternatives specified above.

1.1.1 The Kolpashevo City Energy Balance under the Analyzed Alternative Situations

Individual features of the Kolpashevo city energy balance under the considered alternatives are compared below (in Table 1.1).

Table 1.1 Comparison of individual parameters of the Kolpashevo city energy balance under different alternatives

Parameter	Unit	Alternative 1 «Before gas supply and distribution» (2007)	Alternative 2 «First Stage» (2009)	Alternative 3 «Gas-fired boiler-houses»[4]	Alternative 4 «Mini CHP plants»[5]
Primary energy, incl.:	**10^3 tce**	**128,8**	**106**	**67,3**	**83,4**
- fuel wood	10^3 solid m^3	199,5	167	13,9	13,9
- coal	10^3 t	75	37	0	0
- power energy	10^6 kWh	58,7	55,7	52,6	14,3
- LPG	10^3 t	1,0	1,0	0	0
- natural gas	10^6 m^3	0	20,7	47,5	64,6
- oil	10^3 t	10,4	1,9	0	0
- fuel oil	10^3 t	0,03	0,03	0,03	0,03
Final consumption, incl.	**10^3 tce**	**95,3**	**88,9**	**58,7**	**58,7**
- fuel wood	10^3 solid m^3	199,5	167,1	13,9	13,9
- coal	10^3 t	11,3	11,3	0	0
- power energy	10^6 kWh	51,3	51	48,5	48,5
- LPG	10^3 t	1,0	1,0	0	0
- natural gas	10^6 m^3	0	3,5	21,4	21,4
- oil	10^3 t	0	0	0	0
- fuel oil	10^3 t	0,03	0,03	0,03	0,03

[4] provided full-scale implementation of the project

[5] provided full-scale implementation of the project

Annual primary energy consumption in the Kolpashevo city is 128,87 ths. tce. After implementation of the first stage of gas supply and distribution and construction of 14 gas-fired boiler-houses primary energy consumption will decrease by 22 ths. tce and later on to 63,7 ths. tce (or by 1,9 times versus 2007), and to 83,4 ths. tce in case of mini CHP plants construction.

The presented data prove that in case of the project full-scale implementation (gas supply and distribution organization or creation of high-energy efficiency zone) coal and oil will be completely ousted by gas, while the fuel wood consumption will drop considerably. It should be also noted that under Alternative 4 “Mini CHP plants” electric power is generated locally and consequently electricity import witness a sharp decrease (by 44,3 million kWh or by 75,5% of the initial consumption), while gas consumption increases in comparison to Alternative 3 “Gas-fired boiler-houses”.

Presented below (Figure 1-1) is final consumption per fuel and energy type.

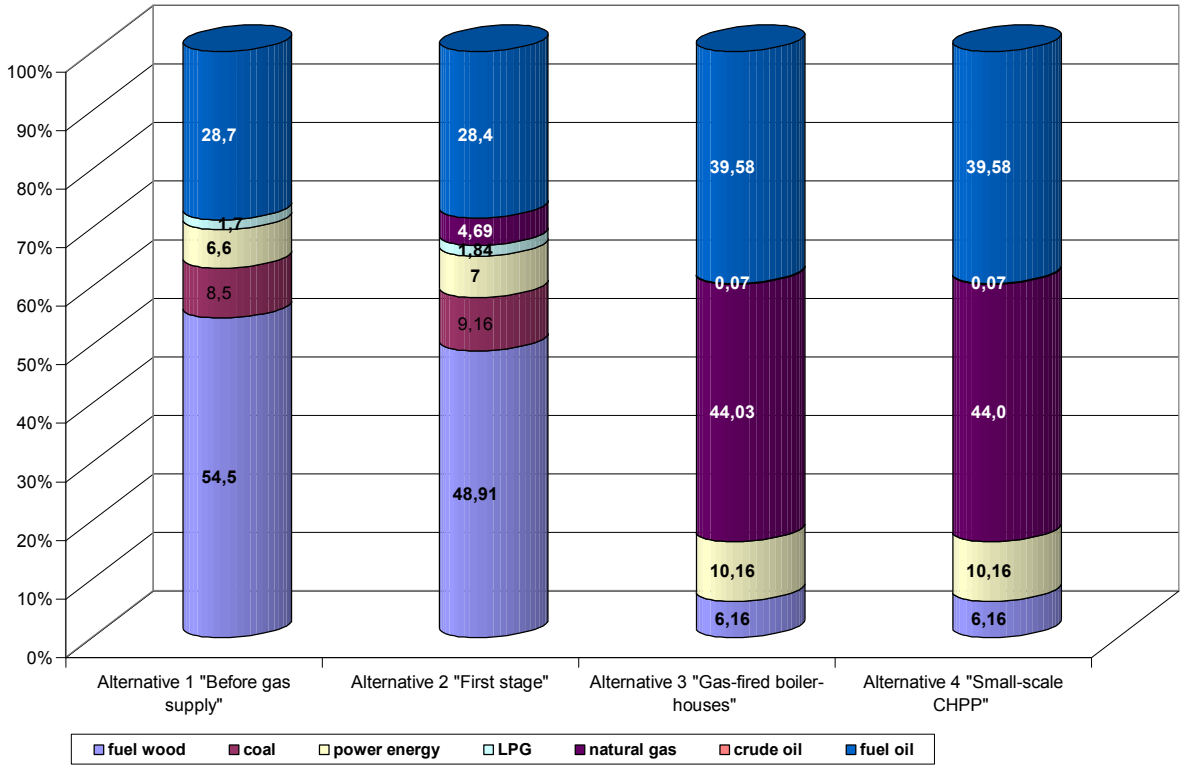


Figure 1-1. Fuel and energy consumption per energy type

As the above diagramme shows, final consumption of fuel and energy resources (FER) in the district changes considerably, with fuel wood dominance weakened and the fuel wood use dropping by 6% (under Alternative 2) or even practically nine-fold (in case of Alternatives 3 and 4). Natural gas begins to play a more and more prominent role and its share is estimated to exceed 40% of the final consumption once either the gas supply and distribution or high energy efficiency zone projects are implemented.

As the gas supply and distribution organization has no material effect on the district commerce and industry structure, whatever the Alternative, residential sector will continue predominant with more than 70% share of the final consumption.

The maximal share of the total energy production belongs to the heat and energy facilities supplying the Kolpashevo city with heat.

1.1.2 Description of Heat-Supply System

As of January 1st 2007, heat was supplied to the Kolpashevo city by **50** boiler-houses with 147,94 Gcal/h of total installed capacity, of which boiler-houses **39** were municipal property and **11** in ownership of different industrial entities. At the stage of the energy-supply scheme designing it was decided to have the heat producing facilities scaled-up and switched to the natural gas.

Table 1.2 Heat supply characteristics under the considered alternatives

Item	Unit	Alternative 1 «Before gas supply and distribution» (2007)	Alternative 2 «First stage» (2009)	Alternative 3 «Gas-fired boiler-houses»	Alternative 4 «Mini CHP plants»
Main heat-supply facilities (boiler-houses), incl.:	**pcs.**	50 (39 municipal)	39 (28 municipal)	31 (20 municipal)	23 (12 municipal)
- gas-fired boiler-houses		0	14	31	23
- mini CHP plants		-	-	-	3
Fuel type		coal/oil	natural gas /coal/oil	natural gas	natural gas
Installed heating capacity, incl.	Gcal/h	147,94 (127,5 municipal)	120,41	102,09	102,09
- gas-fired boiler-houses	Gcal/h	0	79,53	102,09	102,09
- Mini CHP plants		-	-	-	6,4
Installed electric power capacity	MW	-	-	-	5,45
Utilization factor of maximum capacity		0,5	0,58	0,64	0,64
Nominal heating load	Gcal/h	68,04	78,08	74,57	74,57
Fuel consumption	tce/yr	59 818,9	42 054,0	31 402,8	35 750,0
Annual heat energy production, of which	**Gcal/yr**	**233 067,6**	**217 441,1**	**201 480,0**	**201 480,0**
- by the gas-fired boiler-houses	Gcal/yr	-	97 100,0	201 480,0	154 760,0
Annual electric power production	Million kWh	-	-	-	39,2

Before the gas supply and distribution organization majority of the boiler-houses were fired rather by coal, than oil.

Heat-supply of the Kolpasevo city and the Togur village is highly centralized. In 2008[6] **the Kolpashevo city Administration leased** municipal boiler-houses to the following operators:

- LLC “Kolpashevo heating company”;
- LLC “Heating systems and technologies”;
- LLC “Housing and municipal services”.

As mentioned earlier, the Kolpashevo heating company had constructed 14 gas-fired boiler-houses, which commissioned in spring 2008 (Alternative “First stage”) substituted 25 old boiler-houses.

The remaining 14 municipal boiler-houses are also scheduled for future substitution with 6 gas-fired ones (Alternative “Gas-fired boiler-houses”). Thus 20 municipal boiler-houses will be in operation on implementation of the scheduled measures. As of the report issuance however no investor has been identified to support the remaining boiler-houses construction.

Alternative 4 “Mini boiler-houses” envisages 23 boiler-houses altogether, including 12 municipal ones.

Without any change of the original quantity there will remain 11 boiler-houses controlled by industrial entities.

Of the 8 industrial entities of the Kolpashevo city possessing own heat generation sources, the following 4 entities supply heat to the residential consumers:

- Kemerovo Apartment Management Unit (AMU),
- Regional State Unitary Enterprise (RSUE) “Kolpashevo RRD (road-repair department)”,
- LLC “Avtotransportnik”,
- Federal State Unitary Enterprise (FSUE) “Russian post”.

Heating Systems

The existing networks are dead-end (blind), two/four-pipe systems, greatly extended because of the low housing density. Presently the length of the Kolpashevo city heat networks belonging to the municipality and industrial entities makes 62,9 km and 20 km respectively.

The heat networks were mainly constructed in late 1980s, and by now more than half of them (33,8 km, or 53,7%) are much deteriorated with 19,6 km (or 31,2%) worn-out and in need of urgent replacement.

Presented below are heat supply pipelines distributed per diameter sizes and per lifetime duration (Figure 1-2, Figure 1-3).

[6] In 2007 certain municipal boiler-houses were shut down and their lease operators (LLC “Agrostroy”, LLC “Teplotekhnik”) ceased to exist, while facilities operated by LLC “Kolpashevo Community Systems” were leased to LLC “Kolpashevo Heating Company” and converted to gas.

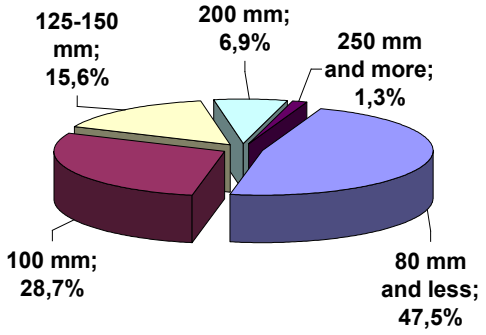


Figure 1-2 Heat supply pipelines per diameter sizes

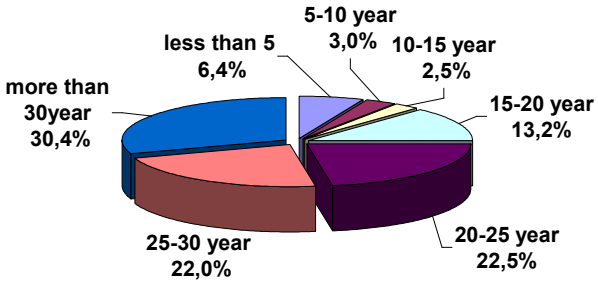


Figure 1-3 Heat supply pipelines per lifetime duration

Great extension of the heating system leads to large heat losses. Today normative losses by municipal heat-supply systems amount at average to **16,8%**[7] of heat energy production and cause increase in production costs.

The operating investment agreement between municipal entity "Kolpashevo Urban Settlement" and LLC "Kolpashevo Heating Company" does not envisage replacement or reconstruction of the heat-supply systems.

1.1.3 Heat Consumption

The residential (59,4%) and state-financed (15,7%) consumers account for the major part of the Kolpashevo city energy consumption (Figure 1-4).

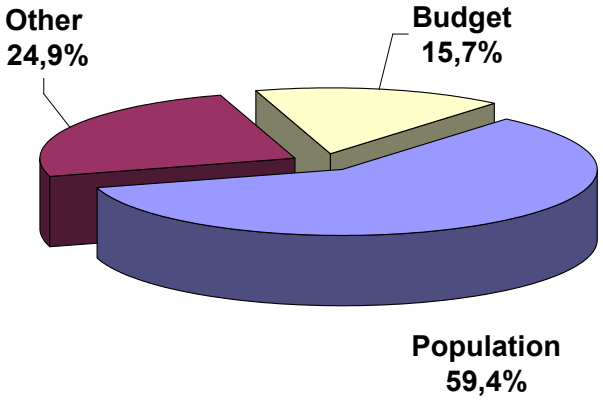


Figure 1-4 Heat energy consumption in the Kolpashevo urban settlement

It is worth mentioning that majority of industrial heat consumers possess and operate own boiler-houses.

[7] The figure is average only, while real losses by boiler-houses vary from 5 to 30%, reaching in some cases 39% or even 52%. For a more detailed data, please refer below (Table 3.7)

1.1.4 Fuel Balance of the Heat-Supply Systems

Figure 1-5 below shows boiler-houses' fuel balance under the examined alternatives.

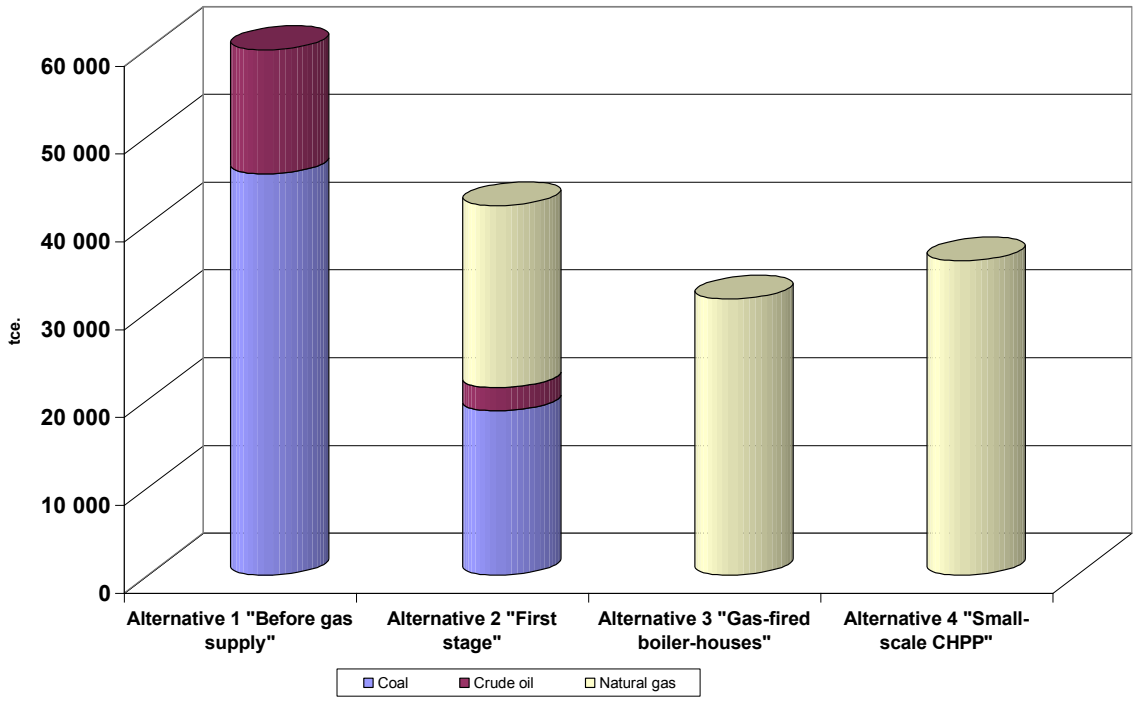


Figure 1-5 Changes in volume and pattern of fuel consumption under the examined alternatives

The figure above demonstrates that gas supply and distribution development drives other fuels out from the boiler houses' fuel balance. Thanks to enhancement of boiler-houses equipment and installation of advanced and more effective equipment the fuel consumption fell by 30 % (to 42 ths. tce from 59,8 ths. tce) on implementing of the first stage of gas supply and distribution. Under Alternative 3 "Gas-fired boiler-houses" fuel consumption will decrease by practically 50% (to 31 ths. tce versus 59,8 ths. tce in 2007). Under Alternative 4 "Mini CHP plants" fuel (natural gas) will be consumed in volumes equal to those under Alternative 2 "First stage" and slightly exceeding those under Alternative 3, feeding at that both heat and electricity production.

The fuel balance pattern requires some additional commenting on. Before gas supply and distribution organization coal was the dominant fuel accounting for 76,4% of the heat supply in the region, while oil accounted for 23,6% (fuel oil (for) ~ 0,1%). Later, on implementing the First stage, the shares of coal and oil decreased to 44% and 6% respectively, while the natural gas began to account for a little less than half of the boiler-houses' consumption in the district (Figure 1-6). For the future the natural gas is seen as exclusive fuel of the district heat supply system.

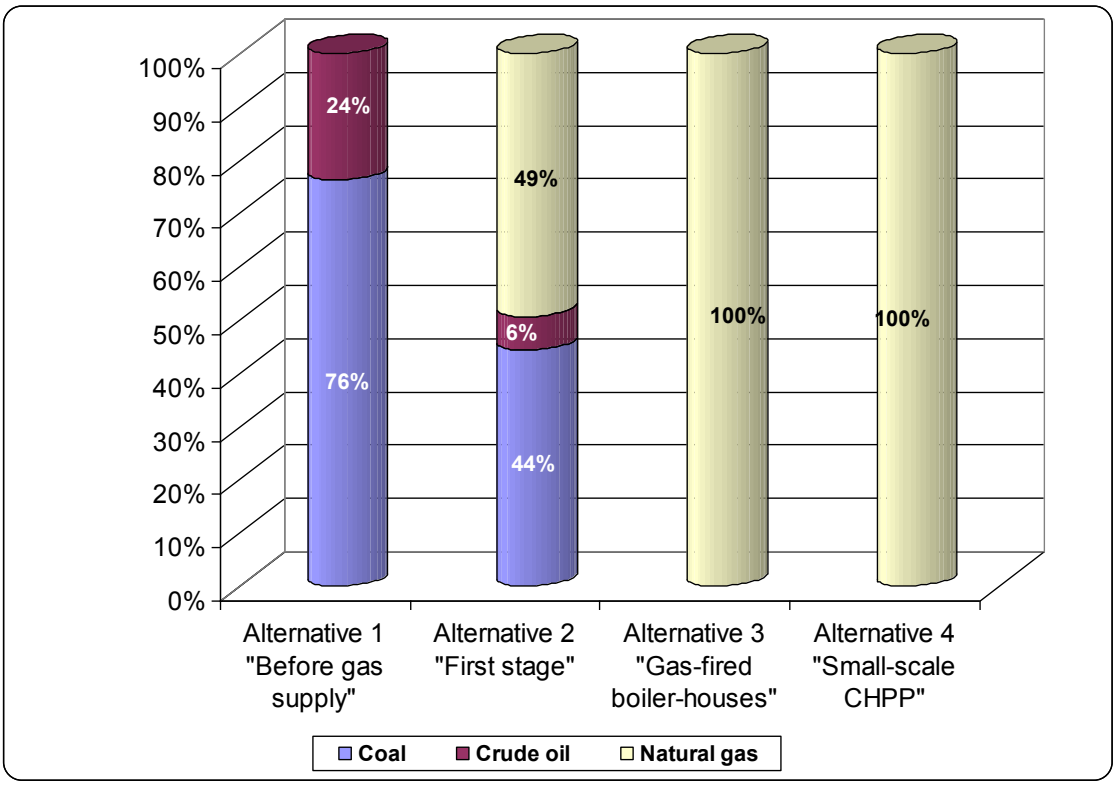


Figure 1-6 Fuel consumption by boiler-houses under the examined Alternatives

1.1.5 Heat Balance of the Heat-Supply Systems

The main heat energy producers in the city of Kolpashevo were and still are municipal (public) boiler-houses. In 2007 their share in total heat energy production was 76,6%.

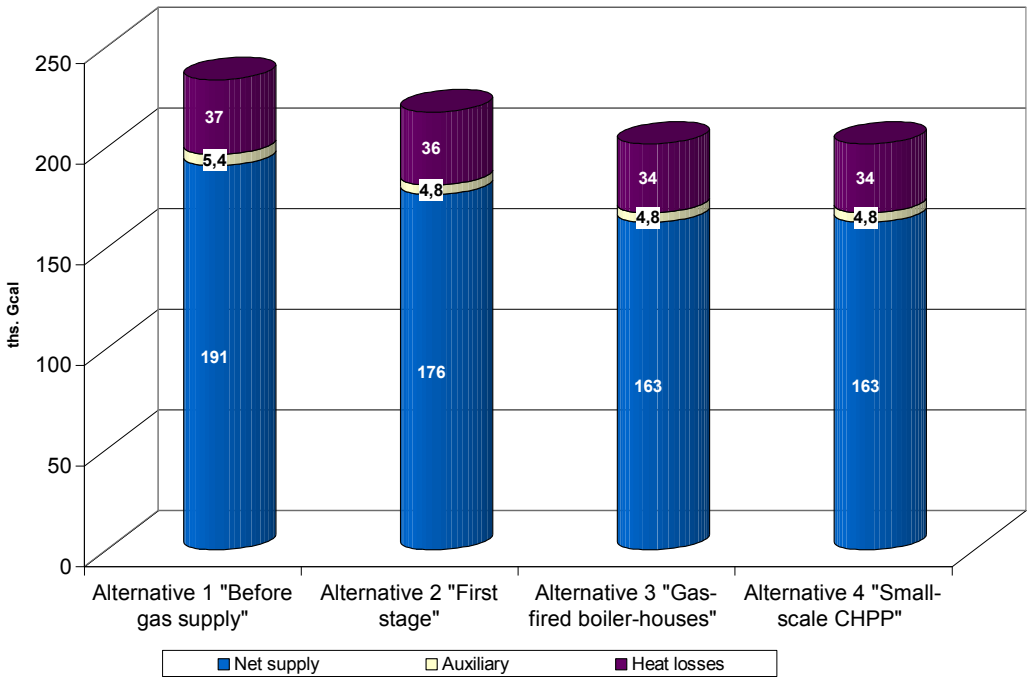


Figure 1-7 Utilization of the produced heat under the examined alternatives (in ths. Gcal)

As it can be concluded from Figure 1-7, and Figure 1-8, integration of boiler-houses and shutting-down of inoperative facilities induced a drop of the productive heat supply under Alternative 2 “First stage” by 10% (alongside with a tantamount decrease of heat energy production) as compared to Alternative 1. Consequent decrease of the productive heat supply is due to the production source location optimization. The heat losses of the heating systems have not decreased however and under all Alternatives, excepting Alternative 1, exceed 17% of the total annual production.

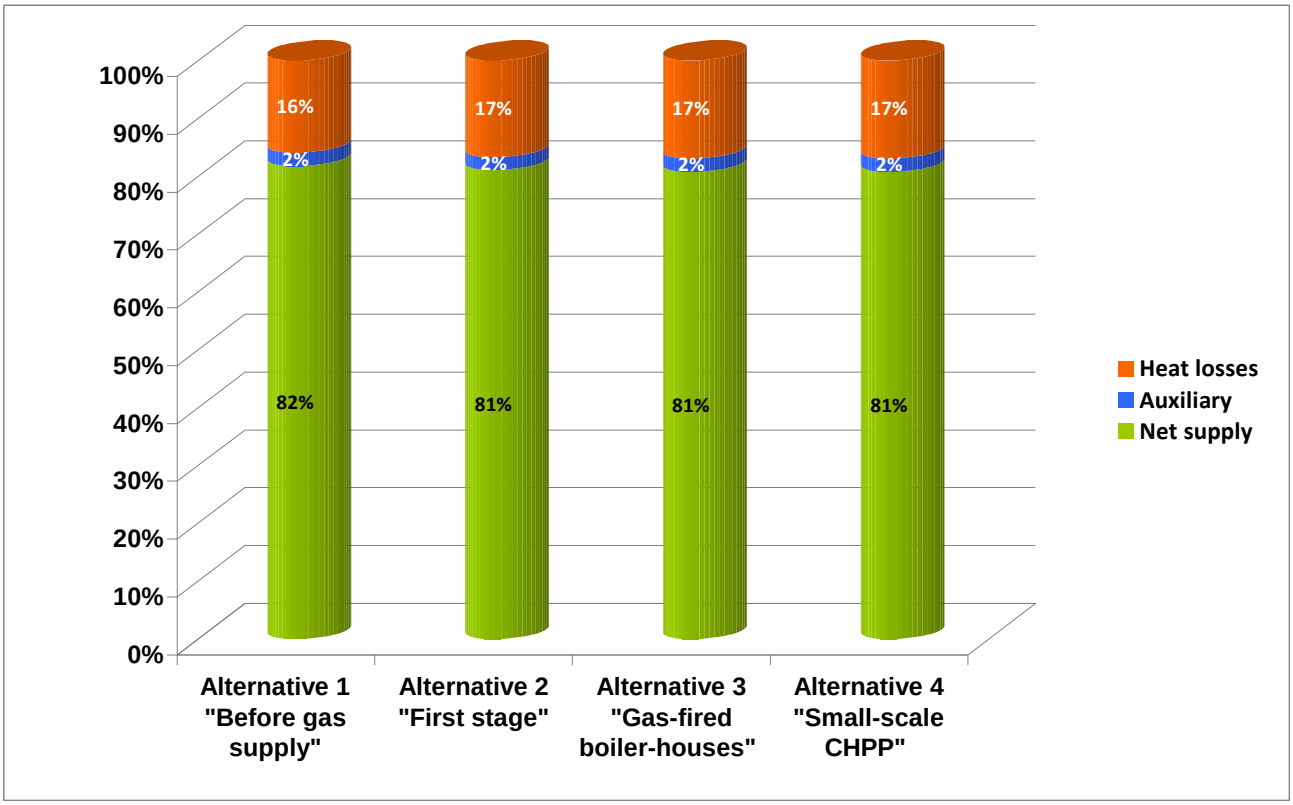


Figure 1-8 Utilization of the produced heat under the examined alternatives (%)

1.1.6 Energy and Environmental Efficiency

In the Table 1.3 presented are average energy and environmental efficiency parameters of the Kolpashevo city heat production facilities operation.

Table 1.3 Energy and environmental efficiency parameters of the assessed Alternatives

№	Item	Unit	Alternative 1 "Before gas supply and distribution"	Alternative 2 "First stage"	Alternative 3 "Gas-fired boiler-houses"	Alternative 4 "Mini CHP plants"
1.	**Fuel consumption efficiency (FCE)**	**%**	**45,6**[8]	**59,9**	**74,1**	**78,2**
	- municipal boiler-houses	%	44,4	64,5	72,7	72,7
2.	**Specific fuel consumption (SFC)**	**tce/Gcal**	**0,256**	**0,193**	**0,157**	**0,160**
	- municipal boiler-houses	tce/Gcal	0,261	0,176[9]	0,155	0,160
	- mini CHPP	tce/kWh	-	-	-	300
3.	**Average weighted efficiency of the municipal boiler-houses**	**%**	**55,7%**	**73,9%**	**91,7%**	**87,0%**
4.	**Specific power energy consumption (SPEC)**	**kWh/Gcal**	**25,19**	**20,4**	**20,49**	**20,49**
5.	**Personnel quantity**	**person**	**505**	**232**	**223**	**200**
	- municipal boiler-houses	person	440	167	159	141
6.	**Harmful emissions**	**tons/year**	**8 152**	**3 387**	**122,3**	**202,2**
	- municipal boiler-houses	tons/year	5 557	1 203	87,9	167,4

[8] Recommended value is 68-70%

[9] Specific fuel consumption by the gas-fired boiler-houses will be 0,155 tce/Gcal

The information above allows for the following conclusions:

1 On the first stage completion fuel consumption efficiency of all the boiler houses in the district has grown by almost 15% to the level of practically **60%.** This increase may reasonably be associated with the installation of advanced equipment at some municipal boiler-houses. Under alternatives 4 and 3 efficiency of fuel consumption exceeds **70%**, which complies with the recommended values.

2 One also expects positive dynamics of the specific fuel consumption (SFC) by the boiler-houses. Prior to organizing gas supply and distribution average SFC in the district equaled 0,256 tce/Gcal, while on completion of the first stage, it is scheduled to make 0,193 tce/Gcal (0,155 tce/Gcal - for gas-fired boiler-houses), which demonstrates considerable improvement of the equipment efficiency. Alternative 4 “Mini CHP plants” envisages the SFC growth due to the combination of heat and power production as normally involves increase in the specific fuel consumption.

3 Alternatives 3 and 4 envisage a considerable efficiency increase (by 1,6 times).

The low values of efficiency factors and consumption efficiency factors as were witnessed prior to the gas supply and distribution organization led to excessive fuel consumption and high energy production costs.

4 Evident and positive changes brought about by installation of a more advanced equipment under Alternatives 3 and 4 include possible drop of the specific power energy consumption from initial 25,19 kWh/Gcal to 20,49 kWh/Gcal.

5 The advanced equipment installation allows for a 2,5-fold personnel reduction and thus ensures lower production costs and means for the material stimulation of the remaining personnel.

6 Reduction of harmful emissions vividly demonstrates advantages of natural gas over other fuels (coal and oil). Harmful emissions of the municipal boiler-houses decreased by more than 4 times on the first stage completion (Alternative 2), and may decrease even by 60 and 40 times on implementing Alternatives 3 and 4 respectively.

1.1.7 Economic Evaluation of the Inter-Fuel Substitution

Estimated Capital Costs

LLC “Octane” and its affiliate LLC “Kolpashevo Heating Company” are business entities independent from the authors of this paper. Financial and economic data of these business entities, winning the investment tender for the boiler-houses construction, can be obtained from the publicly available sources only.

Major technical and economic characteristics of its Kolpashevo project are posted on the website[10] of LLC “Octane”.

According to the website data, the project capital costs amounted to 220 mln. RUR or 8,8 mln. USD at the exchange rate of spring 2008[11]. The installed capacity as stated before (in Table 1.3) totaled 79,53 Gcal/h (83,6 MW), the specific capital costs thus making ~ **110 ths. USD per 1**

[10] http://www.octane.ru/objects_tomsk.html

[11] 25 RUR/1USD.

Gcal of the installed capacity (2,766 mln. RUR for Gcal/h). Costs of design, construction and mounting, and commissioning works are about 2 mln. USD (not included to Leasing Agreement). So, total investments are 10,8 mln. USD.

LLC “Octane” website reads that implementation of the project included a five-year contract with a leasing company, advance payment thereunder amounting to **2,12 mln. USD** and the leasing contract sum totaling 318 mln. RUR (**12,72 mln. USD**). In practice, the leasing scheme application leads to the capital costs increase by 45% against the assets initial cost. Annual leasing payments will make approximately ~ **2,12 USD.**

Within the specified 5-year contract period LLC “Kolpashevo Heating Company” is expected to pay off the contract sum due, assure investments payback and a certain profit margin. On expiration of the Heat Facilities Lease Agreement and after LLC “Kolpashevo Heating Company” has returned invested funds with profit, the constructed gas-fired boiler houses will remain in ownership of the Kolpashevo Urban Settlement Administration which will be under no restraint in selecting contracting parties for these boiler-houses lease and operation.

The specific capital costs evidently vary depending on the equipment installed capacity, namely decreasing with the installed capacity increase. Aiming at the high-level analysis of accepted decisions, the authors believe it reasonable to dispense with minute detail in calculation of capital costs under Alternatives 3 and 4.

Basing on the above said, the summary capital costs of Alternative 3 “Gas-Fired Boiler Houses” will be 102,09 Gcal/h (the gas-fired boiler-houses total installed capacity under Alternative 3) x 110 ths. USD per 1 Gcal (specific capital costs)~11,3 mln. USD. On addition of design, construction and mounting, and commissioning work costs, etc. the sum will make 14,3 mln. USD.

The specific capital costs of constructing a mini CHP station in Russia are presently estimated at 1000 USD/kW of the installed capacity; so, the capital costs of constructing a mini CHP station will amount to 5 450 kW (the mini CHP station total installed electrical capacity) x 1000 USD = 5,45 mln. USD. On addition of design, construction and mounting, and commissioning work costs, etc. the sum will make **7,6 mln. USD**.

The boiler-houses construction aggregated capital costs under Alternative 4 (only municial boiler –houses) will make ~ 70 Gcal/h (installed capacity) x 110 ths. USD per 1 Gcal (specific capital costs) = 7,7 mln. USD. On addition of design, construction and mounting, and commissioning work costs, etc. the sum will make 9,4 mln. USD, the total capital costs of Alternative 4 consequently amounting to ~ 17 mln. USD.

It is reasonable to expect that attracting a leasing company under Alternatives 3 and 4 will result in no less than 50% increase of initial construction investment costs. Estimated investment demand under different Alternatives is presented in Figure 1-9 below, where data are supplied for self-financing and leasing company engagement options.

The diagramme shows (Figure 1-9) that capital costs of Alternative 4 “Mini CHP Plants” are by 20% higher that those of Alternative 3 “Gas-Fired Boiler Houses”.

The presented data evidently prove that Alternative 4 “Mini CHP Plants” requires more capital means than Alternative 3 “Gas-Fired Boiler Houses” and consequently involves higher project risks and more specific problems related to investment attraction.

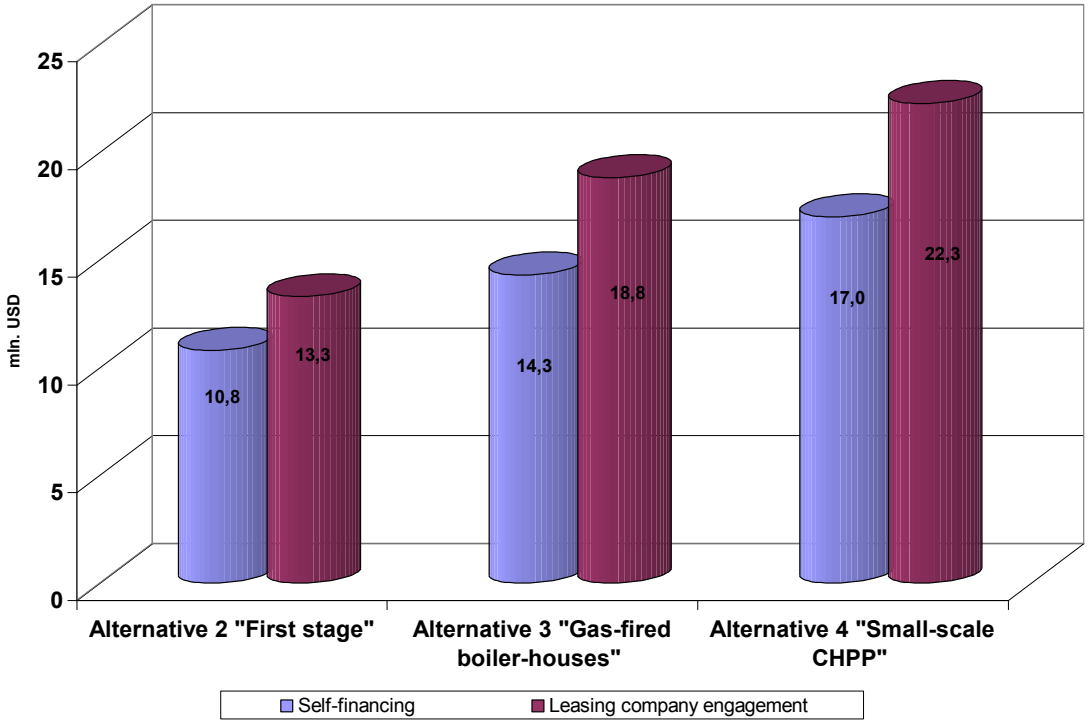


Figure 1-9 Investment Demand under Different Alternatives, VAT inclusive

Heat Tariffs

Energy supply business falls within the scope of natural monopolies' activities, so economic, organizational, legislative frameworks of the state control of energy supply services tariffs is governed by a package of legislative acts as underlaid by **Federal Law №41-FZ of 14 April 1995 "On the State Regulation of Electricity and Heat Tariffs in the Russian Federation".**

At present the natural monopolies' activities are controlled by the Federal Tariff Service (hereinafter FTS) with partial delegation of its authority to the Regional Energy Commissions (hereinafter REC).

The basic principle of the energy supply tariffs government control involves indemnification of the controlled entity for the economically warrantable expenses with securing an allowed profit rate. In practice this principle presents the "cost plus" model of price formation and as far as the natural monopolies tariffs were concerned it had no alternative until July 2008, when amendments to tariffs state regulation entered into force[12]. Under the inured amendments a controlled entity can choose from among the three methods of tariff regulation:

- Method of economically warrantable expenses (cost plus),
- Method of return on the regulatory asset base,
- Method of tariff indexation.

[12] Legal base of the state regulation is described in more detail in another Chapter.

The two newly introduced methods have not so far been widely applied. The method of return on the regulatory asset base is currently used in four electric power supply pilot projects only. The method of tariff indexation has never been applied yet to the authors' knowledge.

In consideration of the facts presented, the study focuses on analyses of the tariffs applied in Kolpashevo and resorts to the method of economically warrantable expenses for calculation of the expected tariff values.

The existing laws provide for the following fundamental principles of heat tariff regulation:

- Economic warrantability of commercial entity expenses for heat and electricity production, transportation, distribution;

- Determination of economic warrantability of planned (rated) production cost and profit values, when calculating tariffs and having them approved;

- Securing financial assets for business development of heat and electricity producers, transporters, distributors by means of loans, private investments, etc. attraction;

- Providing conditions for attracting domestic and foreign investments;

- Evaluation of resources assignable for labour compensation in accordance with the industry tariff agreements;

- Competitive identification of energy equipment suppliers and, energy and electricity network construction contractors;

- Accounting of energy suppliers' business results for the period of earlier approved tariffs validity, etc.

The regulator adjusts tariffs (required gross proceeds value[13]) accounting for existing situation and the below factors, in particular:

- the preceding year financial results (the required gross proceeds value will be increased by the sum of losses suffered in the preceding year or vice versa diminished by the sum in excess of the standard profit level);

- indexation of expense items depending on the price indices growth (raising of personnel compensation, cost increase of contracts with suppliers and contractors);

- increase of prices and tariffs set by the natural monopolies. Unlike the foregoing factor, some prices and tariffs of the natural monopolies, and natural gas price in particular, are subject to the RF Government policy aimed at liquidating price disparity in the domestic fuel market. In other words according to the announced governmental plans natural gas prices will grow faster than price indices;

- the economic entity investment programme, etc.

Thus FTS annually sets heat price growth ratio (applicable to RUR-quoted tariffs), which variation range for 2009 is 10-35% in compliance with FTS Order № 136-e/2 of 08.08.2008. For the Tomsk Region the 2009 heat price growth ratio is 25%.

[13] Required gross proceeds value – a term used by FTS in calculation of the next year tariffs.

Table 1.4 below contains heat supply tariffs for services rendered by some companies of the Kolpashevo Urban Settlement in 2008 and 2009.

Table 1.4 Heat supply tariffs applied in Kolpashevo in 2008 and 2009 (VAT exclusive)[14]

№	Heat suppliers	Fuel	2008 tariff		2009 tariff		Variation, %
			RUR/ Gcal	USD/Gcal	RUR /Gcal	USD / Gcal	
1.	LLC "Kolpashevo Heating Company"	coal, oil, natural gas	1 567	62,7	1 818*	72,7	16
2.	LLC "Teploservice"	coal	1 798	72,0	2 214	88,6	23
3.	LLC "Housing and Municipal Services"	coal	1 812	72,5	2 257,9	90	24
4.	LLC "Teplotechnik"	coal	1 597	64,0	1 939	77,6	21
5.	FSUE "Russian Post"	coal	1 104	44,2	1 376	55,0	25
6.	RSUE "Kolpashevo RRD"[15]	coal	1 074	43,0	1 321	52,8	23

Allowing for the heat supply structure in 2008 and 2009, the average weighted heat tariff makes respectively **70 and 80 USD/Gcal,** thus increasing by ~ 15% on average and by ~ 24-25% (as compatible with the heat price growth ration for the Tomsk Region) in relation to specific heat suppliers, except LLC "Kolpashevo Heating Company".

Below we shall consider production costs of heat generation and the structure of LLC "Kolpashevo Heating Company" tariff before and after conversion to natural gas. Table 1.5 presents estimated consolidated structure of required gross proceeds value underlaying tariff formation and calculation. The presented data were prepared and submitted by LLC "Kolpashevo Heating Company" to the Tomsk REC. LLC "Kolpashevo Heating Company" calculated tariff to reach **45,2 USD/Gcal**. After considering the submitted data the Tomsk REC set the tariff at **47,4 USD/Gcal** that is somewhat above the estimated value.

[14] Fuel is natural gas, the tariff includes investment component.

[15] FSUE «Russian Post" and RSUE "Kolpashevo RRD" provide for about 3,5% of total heat supplied to Kolpashevo.

Table 1.5 Estimated consolidated structure of the required gross proceeds (excluding VAT)

№	Item	2008		2009		Variation (2009 to 2008), %
		ths. USD	%[16]	ths. USD	%	
1.	Materials	108,7	2%	196,9	4,7%	81%
2.	Production operation and services	430,2	6%	583,6	14%	36%
3.	Fuel for the production needs	2 559,9	38%	1 715,2	41%	-33%
4.	Energy for the production needs	239,6	4%	226,7	5%	-5%
5.	Labour Compensation Fund and Uniform Social Tax (operating personnel)	2 660,5	39%	356,3	9%	-87%
6.	Fixed assets depreciation	0		4,7		-
7.	Other shop costs	313,3	5%	382,8	9%	22%
8.	Total shop costs	6 312,1	93%	3 466,1	82,7%	-45%
	Heat productive supply, ths. Gcal	**113,4**		**97,1**		-14%
	Production cost of 1 Gcal, USD/Gcal	**55,7**		**35,7**		-36%
9.	Own consumption cost	15,3	0,2	8,8	0,2%	-42%
10.	Other expenses (including loan interest)	455,4	6,8%	711,0	17%	56%
11.	Total production and sale costs	6 752,1	100	4 168,3	100	-38%

[16] Of the total production and sale costs (line 11).

№	Item	2008		2009		Variation (2009 to 2008), %
		ths. USD	%[16]	ths. USD	%	
12.	**Estimated revenue**	**7 090,9**		**4 376,7**		**-38%**
13.	Leasing	0		2 120[17]		-
	Fiscal effect of the sale operations	338,8		208,4		-38%
	Profit margin, %	5		5		0
	Heat tariff, USD/Gcal	**62,7**		**47,4**		-24%
	Heat tariff plus investment premium, USD/Gcal	**62,7**		**72,7**		16%

[17] Rough estimate

Analysis of the information above prompts the following conclusions:

1 The equipment replacement led to a 36% decrease of the specific production cost mainly due to expenses reduction under items “Labour Compensation Fund and Uniform Social Tax” (by 87%) and “Fuel for Production Needs” (by 33%).

2 Expenditure associated with item “Other expenses” has slightly increased following the loan attraction and posting of interest payable under this item.

3 Aggregate costs of heat production decreased at equipment substitution, which resulted in the base tariff going down by 24% from 62,7 USD/Gcal to 47,4 USD/Gcal. But, finally, after inclusion of the leasing costs (being as good as investment constituent to secure specified return on the funds invested) the tariff was raised to ~ 72,7 USD/Gcal.

Under Federal Law N 210-FZ of 30 December 2004 «On the Major Principles of Utility Complex Tariff Regulation) inclusion of an **investment premium** in the tariff (in the considered case the premium amounted to 25 USD/Gcal) lies in the prerogative power of local executive branch department (Administration of the Kolpashevo Urban Settlement). Approving the investment premium rate the local authorities account for the regulated entity investment programme and local population paying capacity.

It is planned to keep the tariff at the specified level for 5 years, removing the investment premium on expiration of the leasing agreement. As mentioned earlier, the tariff is subject to annual correction depending on the heat price growth ratio as varies in the range of 20-25%. However, only such as do not relate to the leasing contract among LLC “Kolpashevo heating company” expenses (see line 11 of the analyzed Table) will be adjusted by the ratio application.

The tariff quoted in USD may grow by 15% a year. Figure 1-10 below presents expected tariff increase under Alternatives 1 “Before Gas Supply and Distribution Organization” (estimated tariff for energy produced from coal and oil) and Alternative 2 “First Stage”.

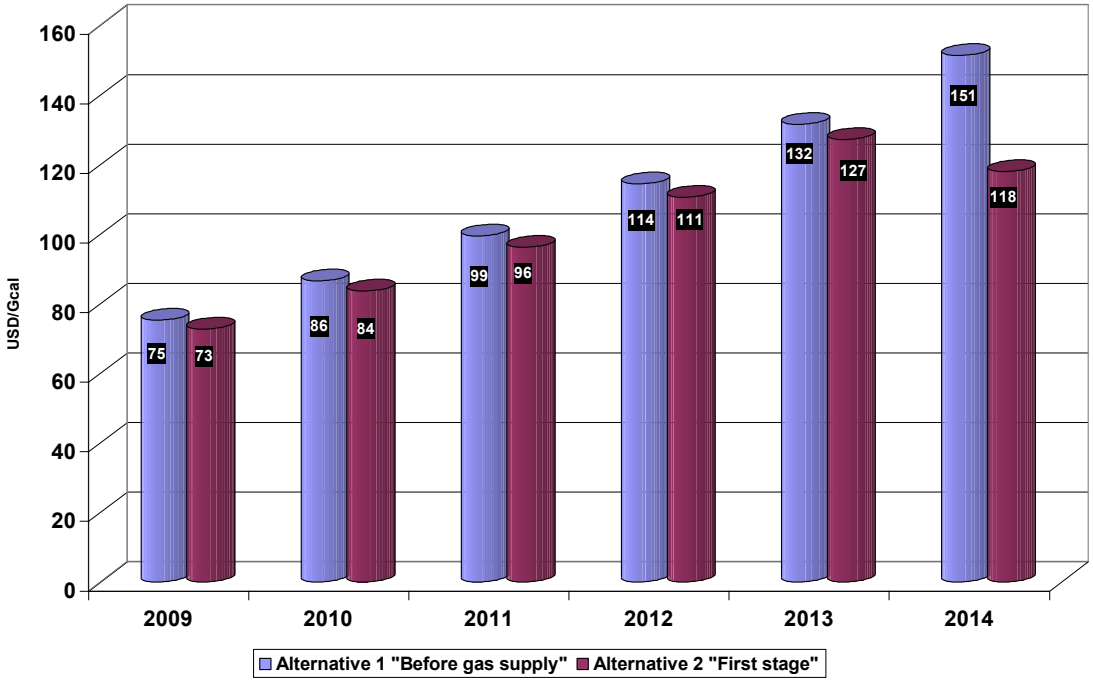


Figure 1-10 Expected Heat Tariff Variation

As the same production cost structure applies to Alternative 3 “Gas-Fired Boiler Houses”, heat tariff values and variation will be practically identical as well.

Considering Alternative 4 “Mini CHP Plants”, it is necessary to take notice of certain legislative issues of heat and electricity prices regulation.

According to Resolution of the Russian Federation Government № 109 of 26 February 2004 “On Price Formation Related to the Electric Power and Heat Energy in the Russian Federation”, heat and electricity tariff (price) system allows for both regulated and non-regulated prices (tariffs). The free-of-control (non-regulated) prices of electric power (capacity) include prices determined by price bids competition or by agreement between the parties of the wholesale and retail markets. As the greater part of electricity produced by the considered mini CHP plants will go to meet the local demand, it seems reasonable here to focus only on the regulated market, where price ceilings are subject to the regulator’s approval.

Electric power sector is more intricate in terms of technology and organization than the heat production and supply industry. The procedures of the heat and electricity tariffs formation differ considerably. Regional tariffs and price ceilings depend on the production process peculiarities, specifics of electricity transmission and local consumption. In other words, calculation of prices (tariffs) and price ceilings is preceded and underlaid by collection and analysis of data characterizing technical and economic features of the local electricity market participants. The tariffs are determined on the basis on these data in a way securing an allowed profit margin of the suppliers’ economic activities.

The legislation base of CHP plants regulating price and tariffs formation in the Tomsk Region in 2009 include:

- Electric power: FTS Order №127-e/1 of 5 August 2008 “On Electric Power and Heat Energy Tariff Ceilings in 2009”. The Order sets average electricity tariff for the Tomsk Region consumers at approximately **6 USD/kW-h** (without VAT),

- Heat energy: FTS Order № 135-e/1 of 8 August 2008 “On Tariff Ceilings for Heat Energy Produced by Combined Heat and Power Plants in 2009”. The Order sets average tariff for the Tomsk Region consumers at approximately **14 USD/Gcal (without VAT).**

In the changing environment (prices, tariffs, production output and sale volumes, etc.) prices (tariffs) of the considered mini CHP plants can vary. It seems nevertheless advisable for the purpose of the present study to use the above prices as indicative.

Considering the data presented, the average weighted heat tariff for Kolpashevo urban settlement consumers will under Alternative 4 “Mini CHP Plants” reach about **54 USD/Gcal**.

Figure 1-11 shows heat average weighted tariffs (in current prices) for Kolpashevo urban settlement consumers under different Alternatives.

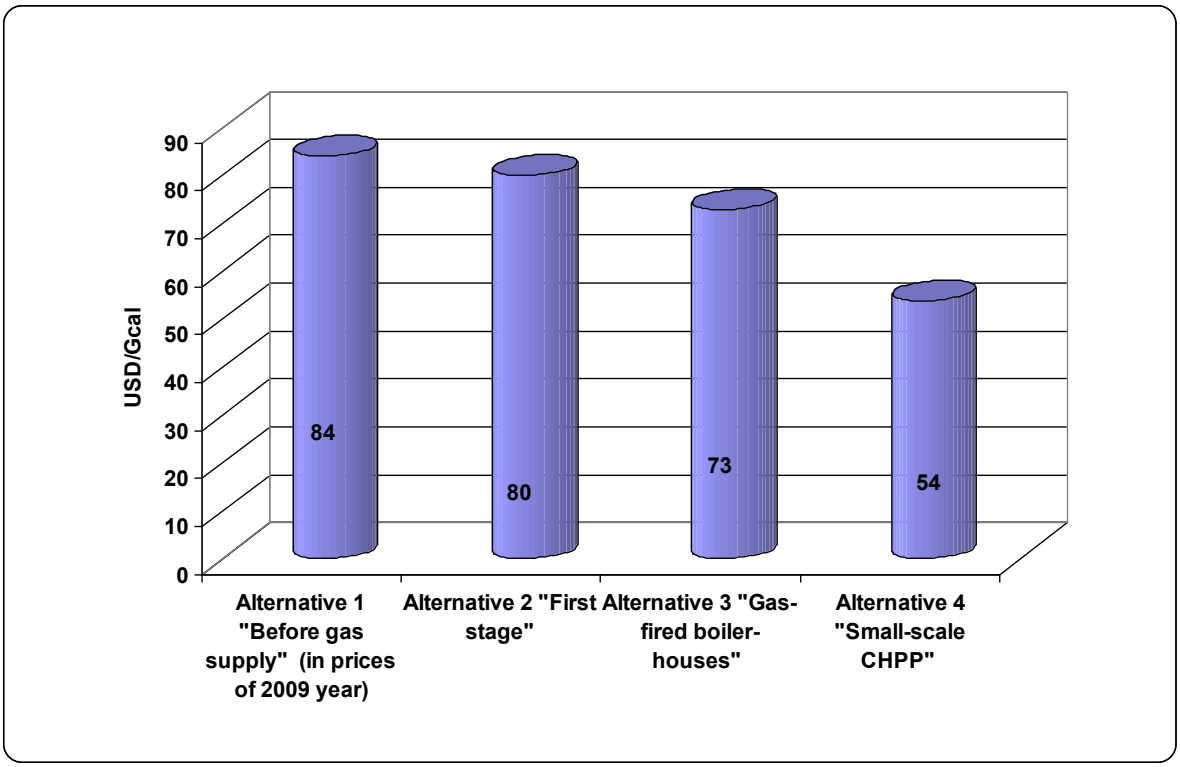


Figure 1-11 Comparison of the average weighted tariffs under different Alternatives

For the purpose of comparison the average weighted tariff under Alternative 1 “Before Gas Supply and Distribution Organization” is quoted in 2009 prices.

The diagramme above allows to conclude that natural gas substitution for solid fuel results in reduced heat tariffs. Besides, mini CHP plants introduction provides not only for the better energy efficiency, but for nearly 30%-reduction of the weighted average tariff as well.

The Alternatives Implementation: Estimated Economic Impact

By way of estimating economic effect of the inter-fuel substitution we shall compare the average prices of primary FER in Kolpashevo in 2008.

Table 1.6 Comparison of natural gas and alternative FER prices in Kolpashevo

№	Energy resources	Price, USD/tce	Price for physical volume
1.	Coal	123	88 USD/tons of natural fuel (tnt)
2.	Oil	354	480 USD/tnt
3.	Natural gas	96	115 USD /ths. m^3.

The data above demonstrates price disparity of fuels used in the Russian Federation.

To assess the inter-fuel substitution economic effect the following groups of FER consumers were identified:

Table 1.7 Economic impact on different FER consumers brought about by natural gas substitution for oil and coal in the Kolpashevo urban settlement

№	Consumers	Impact description	Outcome
Use of primary FER by way of fuel			
1.	(Municipal and industrial) boiler-houses	Decrease of heat production cost (~ 40%) due to replacing morally outdated equipment with more effective one, fuel price drop and personnel reduction	1. Capital investment in re-equipment 2. Reduction of the boiler-house expenses and consequent decrease of tariff for the energy produced
2.	Residential consumers	Natural gas substitution for coal and firewood resulting in a (~ twofold) decrease of the household expenses due to: - fuel expenditure reduction; - dispensing with direct labour of fuel production, treatment and burning. - improving of living conditions and comforts. Fuel subsidies reduction resultant in local budget resources saving.	1. Household budget saving 2. Regional budget saving
Use of primary FER by way of raw resources			
3.	Industry	Fuel procurement costs reduction of ~ 20%	1. Capital investment in re-equipment 2. Improvement of product profitability and competitiveness
Use of secondary FER (heat and electricity)			
4.	Residential consumers	Heat tariffs reduction	Household budget saving
5.	Subsidized consumers (schools, hospitals, municipal organizations, etc.)	Heat tariffs reduction	Saving of regional and local budgets allowing for the saved funds use in social programmes or for development of organizations dependant on the relevant budget
6.	Commercial sector	Heat tariffs reduction	Improved cost-efficiency and competitive advantages of products and services
7.	Industrial enterprises	Heat tariffs reduction Reduced production costs of products and services.	Improved cost-efficiency and competitive advantages of products and services.

Assessment of Investment Efficiency

For the purpose of analyzing feasible financial schemes certain combinations of finance sources and heat tariffs have been identified.

Finance sources:

- Equity capital (EC),
- Leasing (L).

Tariff:

- Tariff set by REC of the Tomsk Region as based on 5% rate of business return – (T),
- Tariff inclusive of the investment premium 72,7 USD/Gcal (IP).

Due to similarity of Alternatives 2 and 3, only Alternative 2 should be considered.

Thus, we come to the following combinations:

Alternative 2 «First Stage»	**Alternative 4 «Mini CHP Plants»**
Alternative 2 EC - T	Alternative 4 EC - T
Alternative 2 EC - IP	Alternative 4 OF – IP
Alternative 2 L - T	Alternative 4 L - T
Alternative 2 L – IP (being implemented)	Alternative 4 L - IP

Results of the investment efficiency analysis of each Alternative are shown below:

Table 1.8 Analysis of the Considered Alternatives Commercial Viability

Index	**EC – T**	**EC – IP**	**L – T**	**L – IP**
Alternative 2 «First Stage» (estimated period of 10 years)				
Demand for investment, mln. USD	10,8	10,8	13,3	13,3
Tariff value, USD/Gcal	60	72,7	47,4	72,7
PP, years	7	4	-	5
DPP, years	12	6	-	6
IRR	7%	17%	-	27%
Alternative 4 «Mini CHP Plants»				
Demand for investment, mln. USD	17,0	17,0	22,3	22,3

Index	EC – T	EC – IP	L – T	L – IP
Tariff value, USD/Gcal	54	65	54	65
PP, years	7	5	7	4
DPP, years	10	6	9	5
IRR	9%	19%	11%	31%

These data allows to conclude as follows:

Alternative 2:

1 Alternative 2 EC – T: the investor own funds constituting the only investment source with the basic tariff set at 60 USD/Gcal[18], economic efficiency remains quite low, IRR, for instance making only 7%. Such low profitability index obviously seriously hinders investment financing of the heat supply sector.

2 Alternative 2 EC – IP: financing exclusively from the investor own funds with the basic tariff set at 72,7 USD/Gcal secures positive economic efficiency indices, which witnesses improvement of the investment value with the investment premium introduction. However, in case if big investment needs (over 10 mln. USD) the housing and utility sector entities can encounter substantial difficulties.

3 Alternative 2 L – T: this investment programme inclusive of a leasing scheme will not pay back within 10 years (considered life cycle) with the tariff of 47,4 USD/Gcal as set by FTS for LLC “Kolpashevo Heating Company”. As the standard service life of the boiler-houses is 7-10 years, the Alternative does not seem practicable at all.

4 Alternative 2 L – IP: an investment programme inclusive of a leasing scheme can be economically feasible provided tariff of 72,7 USD/Gcal as is currently applied by LLS “Kolpashevo Heating Company”.

Alternative 4 can be characterized as follows:

5 Provided tariff formation under the current legislation, the investment project will have a low profit margin. Raising tariff by ~ 20% will ensure higher profit and a shorter pay-back period.

6 Investment demand is higher than under other Alternatives envisaging boiler-houses construction, the fact not to be trifled with in this economic sector.

7 The Alternative implementation makes it necessary to resolve the issue of excess electricity utilization, a problem not unusual in industrially underdeveloped regions. Excess electricity produced can be sold at the wholesale electric power market, but it involves overcoming a number of technological difficulties and bureaucratic obstructions.

Summing up the arguments above, we can state that projects of constructing gas-fired-boiler houses in small and medium sized municipalities of the Russian Federation is a more preferable investment option compared to mini-CHP plants construction. In absence of support or impelling by

[18] Tariff calculated in accordance with the operating FTS method

governmental authorities, investment funds will be directed to construction of gas-boiler houses lacking in energy efficiency as they are.

The data set out above in relation to the economic impact of the coal and oil interfuel substitution with gas allows the following conclusions:

1 Re-equipment of heat facilities involves considerable investment funds not always easily obtainable by the housing and communal entities, which lack financial stability and borrowing power.

2 Comparison of the four Alternatives proves that mini CHP plants construction requires by ~20% more investment than gas-fired boiler-houses construction.

3 In the medium and long term heat tariffs are expected to go down following the obsolete equipment replacement, fuel price and personnel costs decrease, production automation.

4 Addition of an investment premium to the tariff and loan attraction promotes the project effectiveness and risk mitigation.

1.2 Study of Factors Hindering Investments in Energy Saving and Energy Efficiency Activities

Analysis of the inter-fuel substitution in the city of Kolpashevo allowed to identify the following factors impeding investments in energy efficiency and energy saving in Russia:

1 Inadequacy of the existing energy saving legal and regulative frameworks,

2 Low prices and gas quota allocation mechanism,

3 High capital intensity and low profitability of energy-saving projects,

4 Insufficient governmental support of energy saving,

5 Low borrowing power of the municipal utility sector enterprises,

6 Low paying capacity of public services residential consumers,

7 Scarce public awareness of the Russian economy energy efficiency characteristics and lack of energy saving immediacy consciousness.

Interdependence of the certain above factors makes feasible to have them classified and analyzed by groups.

Before commencing analysis as such, we think it necessary to mention that following an order of RF President D. Medvedev[19] the Government prepared several legal acts aimed at amending existing laws on energy saving and efficiency as have been already enacted by now or submitted for approval to the RF State Duma.

1.2.1 Group of Legal Factors

- Inadequacy of the existing energy saving legal and regulative frameworks,
- Low natural gas prices,
- Annually confirmed natural gas quotas for RF constituent entities,
- Insufficient governmental support of energy saving.

On March 7th 1995 the RF Government issued Resolution # 239 “On measures streamlining state price (tariff) regulation” determining which goods and services fell within the regulation scope. Some of these regulated goods and services are listed below:

- Natural gas, oil gas and stripped dry gas (for JSC “Gazprom” affiliates), etc.
- Power and heat energy produced by wholesale electric power suppliers, electricity network transmission, operation and dispatcher services, etc.

The main legal acts determining legislative frameworks of energy sector enterprises operation include:

- Federal Law # 69-FZ of March 31st 1999

[19] Order of RF President # 889 of June 4th 2008 “On certain measures increasing energy and environmental efficiency of the Russian economy”

"On gas supply in the Russian Federation"

- Resolution of the RF Government # 1021 of December 29th 2000

"On the state regulation of gas prices and tariffs on gas transportation within the Russian Federation"

- Resolution of the RF Government # 333 of May 28th 2007

"On improving state regulation of the gas prices"

- Federal Law # 35-FZ of March 26th 2003

"On the electric-power industry"

- Federal Law # 41-FZ of April 14th 1995

"On the state regulation of electric power and heat energy tariffs in the Russian Federation"

- Federal Law # 28-FZ of April 3rd 1996

"On energy saving"

Regulation of Natural Gas Prices

According to Article 21 of Federal Law # 69-FZ of March 31st 1999 "On gas supply in the Russian Federation" natural gas prices and transportation tariffs are regulated by the state.

Pursuant to this law Resolution of the RF Government # 1021 "On the state regulation of gas prices and tariffs on gas transportation within the Russian Federation" was adopted on December 29th 2000.

This Resolution enacted "Guidelines of formation and regulation by the state of the gas price … within the RF territory" according to which the state regulates among others:

- wholesale gas prices;
- tariffs for independent companies on gas transportation via gas mains;
- tariffs on gas transportation via pipelines belonging to independent gas transporters;
- tariffs on gas transportation via gas-distribution networks;
- charges for the gas suppliers' procurement and sales services to final consumers (in case of the wholesale gas prices regulation);
- retail gas prices for the residential consumers.

The domestic natural gas market in Russia has a regulated price segment (70%) mainly supplied by Gazprom group companies and a deregulated price segment (30%) supplied by Gazprom companies and independent gas producers. In the deregulated (commercial) segment prices are by 30-35% higher than in the regulated sector.

Existence of regulated and deregulated segments of the domestic natural gas market preconditions the necessity to annually agree allocations (quotas) of natural gas supplied to the RF constituents. Natural gas quotas are allocated depending on the consumption in the preceding year. In case of the consumption reduction gas quotas will be reduced accordingly. Gas for consumption beyond the allocated quota is purchasable at commercial prices. Such mechanism can motivate to save gas neither consumers nor regional governments.

All natural gas consumers (excluding residential consumers) can be divided into two categories, of which Category 1 will include consumers prices (tariffs) for whose production and services are not regulated by the state, and Category 2 will include consumers prices (tariffs) for whose production and services are state regulated.

To the 1st Category consumers belong light, chemical, metallurgical industries, etc. These consumers have no incentive to save gas in the situation when gas allocations are cheap and especially in comparison to domestic and international prices for alternative FER.

The heat and electricity producers making the 2nd Category are influenced in their attitude to gas saving by legislation defining pricing of their services and products, but on this we shall focus a bit later.

By way of concluding this chapter it deserves mentioning that on May 28th 2007 the RF Government adopted Resolution # 333 "On improving the state regulation of gas prices" promoting market mechanisms of domestic gas prices formation. This Resolution stipulates that beginning with 01 January 2011 Gazprom and affiliates will supply all consumers (except residential) at wholesale prices definable according to the formula providing for equal profitability of domestic and export gas supplies. Thus it establishes legal base for introduction of market mechanisms of forming prices for natural gas in the Russian Federation and consequently has positive effect on the gas consumption efficiency improvement.

Regulation of Heat and Power Energy Prices

The main legal acts constituting legislative frameworks of heat and electricity tariffs regulation include:

- Federal Law # 35-FZ of March 26th 2003 "On the electric-power industry";
- Federal Law # 41-FZ of April 14th 1995 "On the state regulation of electric power and heat energy tariffs in the Russian Federation";
- Resolution of the RF Government # 109 of February 26th 2004 "On pricing applicable to the electric power and heat energy in the Russian Federation".

Compensation of the regulated entity's economically feasible expenses is fundamental for the state regulation of the energy suppliers' tariffs. This pricing approach presents in fact a "cost plus" model and prior to July 2008 was the only option of forming natural monopolies' tariffs. Following enactment of certain legal amendments in July 2008 a regulated entity has the right to choose one of the following methods of tariff calculation:

- method of economically warrantable costs (cost plus),
- method of return on the Regulatory Asset Base (RAB method),
- method of tariff indexation.

But the new methods are not widely applied yet. The RAB method is applied only in four pilot (lighthouse) projects in the power energy sector, and yet there is no information at all about using the method of tariff indexation.

The current heat energy tariffs legislation is based upon the below principles:

- ensuring economically warrantable expenses of commercial enterprises on production, supply and distribution of heat and power energy;
- controlling feasibility of scheduled (rated) production cost and profit in tariff calculation and approval;
- ensuring accumulation of funds for heat and power producers, suppliers and distributors development by attraction of loans, private investments, etc.;
- facilitating attraction of domestic and foreign investments;
- determining quantity of funds assignable for labour compensation compliant with the industry tariff agreements;
- selecting on the competitive basis of power-generating equipment suppliers and energy facilities/grid construction contractors;
- analysis of energy suppliers' activity in the period of earlier enacted tariffs operation, etc.

It should be mentioned that the regulator adjusts tariff (required value of gross proceeds) with regard to a number of factors, including:

- financial result of the enterprise's activity in the previous year, which means that the required value of gross proceeds will be increased by the amount of losses suffered in the year preceding the regulation period, and, on the contrary, decreased by the sum of profits beyond the set profit margin;
- indexation of expense items allowing for the price index growth (personnel compensation increase, raising value of contractual agreements with suppliers and contractors);
- increase of prices and tariffs set by the natural monopolies. Unlike the foregoing factor, some prices and tariffs of the natural monopolies, and natural gas price in particular, are influenced besides inflation by the RF Government policy against disparity of prices in the domestic fuel market. In other words according to the announced governmental plans natural gas prices will grow faster than the price indices;
- the economic entity investment programme, etc.

FTS annually defines value of the heat energy price growth index.

Information stated above allows to conclude as follows:

- The regulator will include such costs as are economically warrantable (not deviating much from the standard index) in the consumer payable heat tariff. With no supply competition in the heat market the only alternative open to the consumer will be to pay, thus compensating the economically warrantable supplier expenses.

- The profit margin of a regulated entity will increase with growth of its overall expenses as the former is calculated as a given share (5-12%) of the total production and sales expenses.

- Driven by saving of resources reduced production and sales expenditure automatically leads to a lower tariff for the next year. Hence absence of producers' interest in cost reduction.

- Depreciation of fixed assets makes one of the budget items accounted for in the "cost plus" method. Compliant with legislation requirements, depreciation is calculated at the base of the balance sheet value (balance cost) as does not correspond to the market value of the fixed assets. Depreciation is a proprietary means of own fund generation financing and in case of old equipment with low depreciation value (as is normally owned and operated by communal services) the equipment owners have little chance to use depreciation means for own fund generation. On the other hand, a major investment payback source calculated regarding assets useful life, depreciation is accrued for a period much longer than an investor acceptable payback time.

As mentioned before a number of legislative amendments were enacted in August 2008 providing for:

- heat tariff markup by setting an investment premium computable depending on the regulated entity's investment programme and allowing for an investment repayment fund accumulation and a shorter payback period;

- retention of the resource saving value in the tariff structure allowing like the above measure for a shorter payback period and greater profit margin;

- application of RAB method, which advantages over "cost plus" include such investment facilitating factors as calculation with regard not to the balance-sheet value of assets but to the employed capital value and regional differentiation of investment return.

The measures above aim at improving investment attractiveness of heat and power energy sector and providing means for replacement of outdated and deteriorated equipment.

So far assessment of so recently originated reforms would have been premature.

Federal Law "On energy saving" envisages a number of incentives and preferences to support energy saving, but economic effect of these incentives and preferences falls short of adequately compensating for their introduction. In this situation the RF Ministry of Energy has prepared and submitted to the State Duma a new draft of the law "On energy saving".

1.2.2 Group of Economic Factors

1 High capital intensity and low profitability of energy-saving projects;

2 Low borrowing power of public (municipal) sector enterprises;

3 Low paying capacity of residential consumers.

As already shown in this paper investments associated with Alternative 4 "Mini-CHP plants" envisaging introduction of higher efficiency energy equipment considerably exceed investments associated with Alternative 2 "Gas-fired boiler-houses". So, to satisfy heat energy demand any prospective investor unconstrained in his choice of equipment will rather resort to gas-fired boiler-houses than to the mini-CHP Alternative. It should be also noted that mini-CHP construction in

smaller RF towns is often made dearer by investments in construction of hot-water grid necessary to ensure acceptable efficiency indices of mini-CHP operation.

Low profitability of the heat-supply sector is consequent of the heat-supply business margins state control, precluding abuse of monopolist position and alert to social importance of ensuring heat supply of a north country consumers in the context of the economic difficulties faced by RF after the USSR disintegration.

Low borrowing capacity of the majority of communal service enterprises is rooted in the hardships of the RF economy transition state associated in particular with low paying capacity of residential and other consumers not always able to meet their bills in full. Unstable cash inflow combined with small profit margins had negative effect on the repayment timeline and the very recoverability of investments. Discouraging investment climate resulted in heavy deterioration of assets and as a consequence in decrease of heat-supply enterprises' assets value and liquidity.

1.3 Recommendations on Retraining and Professional Development of Personnel

Lack of skilled personnel remains a major problem of communal service enterprises.

Low salaries, vague professional and personal development outlook, negative image of the sector as such – all these factors determined degradation of requirements to personnel skills and consequent drop in labour efficiency and quality. In the Tomsk region 40% of the processes flow failures and emergencies occur through the personnel fault.

Personnel skills improvement requires for application of human resources management and incentive pay plans.

The main directions of the personnel management are:

- estimation of enterprise's personnel requirements;
- elaboration of skilled personnel hire and motivation programme.

Below (Table 1.9) are presented estimated demand for personnel to manage, operate and service municipal heat-supply facilities.

Table 1.9 Personnel demand

Item	Alternative 1 "First stage"	Alternative 2 "Gas-fired boiler-houses"	Alternative 3 "Mini CHP plants"
Administrative and executive staff (AES)			
Director	1	1	1
Engineer	2	2	3
Power engineer	2	2	3
Economist	2	3	3
Accountant	2	3	3
Human resources	2	2	2

Item	Alternative 1 “First stage”	Alternative 2 “Gas-fired boiler-houses”	Alternative 3 “Mini CHP plants”
manager			
Secretary	1	1	1
Total AES	12	14	16
Engineers and technicians (ET)			
Boiler-house operator	4	4	2
Heat-supply network operator	3	3	3
Boiler-house maintenance operator	2	2	2
Gas service foreman	1	3	2
Engineer of production and technical department (PTD)	3	3	3
Head of PTD	1	1	1
Health and safety engineer	3	1	1
Software engineer	1	1	1
Supply department engineer	2	2	2
Total ET	20	20	17
Workers			
Safety and control automatics mechanic	15	20	14
Heat-supply network mechanic	16	20	20
Boiler-house mechanic	17	20	12
Boiler-house machinist	42	0	0
Electric welder	8	8	6
Gas-fired boiler-house operator	8	20	12
Electrician	10	12	18
CHP plant operator	0	0	12

Item	Alternative 1 “First stage”	Alternative 2 “Gas-fired boiler-houses”	Alternative 3 “Mini CHP plants”
Total workers	116	100	94
Other employees	18	27	14
TOTAL	**167**	**159**	**141**

Implementation of programmes on retraining and professional development of personnel is one of the most important aspects of personnel motivation.

Below you can see recommended schedule of personnel retraining and professional improvement.

Table 1.10 Preliminary programme of municipal boiler-houses personnel professional improvement

Item	Alternative 1 «First stage»	Alternative 2 «Gas-fired boiler-houses»	Alternative 3 «Mini CHP Plants»	Training organization and programme
AES (Professional development programmes lasting from 2 weeks to 2 months)				
Accountant	1 person/year	1 person/year	1 person/year	Training college (TC) №9 (Kolpashevo)
Economist	1 person/year	1 person/year	1 person/year	Tomsk Polytechnic University (TPU) (Engineering and economy faculty) Tomsk State University (TSU) Tomsk State University of Architecture and Building (TSUAB)
ET (Professional development programmes lasting from 2 weeks to 2 months)				
Heating engineer	1 person/year	1 person/year	1 person/year	TSUAB Continuing Education TPU (Thermal power engineering faculty)
Electrician	1 person/year	1 person/year	1 person/year	TPU (Institute of Electrical Engineering)
Heating technician (heat-supply and heat-production equipment)	1 person/year	1 person/year	1 person/year	Tomsk College of Public Facilities Construction
Gas service technician (installation of gas equipment and mounting of gas-supply systems)	1 person/year	1 person/year	1 person/year	Tomsk College of Public Facilities Construction

Health and Safety engineer	1 person/year	1 person/year	1 person/year	TSUAB
Software engineer	1 person/year	1 person/year	1 person/year	TPU (Automatics and computer engineering faculty) Tomsk State University of Control Systems and Radioelectronics (TUCSR)
Workers of basic professions (Professional development programmes lasting from 2 weeks to 2 months)				
Safety and control automatics mechanic	2 persons/year	2 persons/year	2 persons/year	Tomsk State Industry-and-Arts College TC №10 (Seversk)
Service technician (repair man)	4 persons/year	4 persons/year	4 persons/year	TC №9 (Kolpashevo) TC №29 (Kolpashevo) Radio-Mechanic Professional School №16 TC №27 (Tomsk) Tomsk State Industry-and-Arts College
CHP plant operator	-	-	4 persons/year	Tomsk State Industry-and-Arts College
Boiler-house installations operator	4 persons/year	4 persons/year	4 persons/year	Tomsk State Industry-and-Arts College
Electric welder	1 person/year	1 person/year	1 person/year	TC №29 (Kolpashevo)

1.4 Recommendations on Implementing Inter-fuel Substitution in Urban and Other Settlements of the Russian Federation in View of the Kolpashevo Project Outcomes

As this paper proves Russian economy is characterized by high energy intensity and low FER consumption efficiency.

At present natural gas is the main fuel used for heat and power energy production in Russia. Gas share in the fuel and energy balance of the country exceeds 50% with coal and oil fuel accounting for about 35-36% of total energy consumption.

While big urban settlements account for the majority of gas consumption, coal and fuel oil remain dominant fuels in rural districts, small towns and such northern areas of the country where gas-supply and distribution is scarce.

The Russian energy strategy includes such major element as presently implemented programme of establishing gas-supply and distribution in the country regions. By joint effort of JSC "Gazprom" and Federal and Regional Government authorities average gas-supply and distribution scale in RF increased by 20 percents – from 41% up to 62% (as by 2007 data).

In 2005-2007 JSC "Gazprom" invested over 1,7 bln. USD in organizing gas-supply and distribution in the Russian regions. As is expected for 2008, Gazprom's investments in gas-supply and distribution in Russia will exceed 900 mln. USD.

Considerable financing is required for re-equipment and new construction associated with connecting such major consumers as housing and communal service entities and residential consumers to gas supply.

Income of housing and communal service entities is ensured by tariff for the services they provide. Tariff increase is impeded by legal and economic constraints also hampering investments.

Undertaken analysis of factors hindering investments in energy saving allows also to suggest ways of discovered hindrances elimination.

№	Hindrance	Remedy
1.	Imperfection of legal and regulatory base of energy saving	Reformation of legal and regulatory base of energy saving
2.	Insufficient state support of energy saving	State support of technical re-equipment and renovation of power equipment, development and introduction of energy efficient technologies
3.	Low prices and allocation of natural gas quotas	Differentiation of natural gas prices depending on gas use efficiency and development of a secondary regional gas market model
4.	High capital intensity and low profitability of energy-saving projects	Design of schemes ensuring investments payback and profitability
5.	Low credit capacity of public (municipal) sector enterprises	Setting a structure (entity) capable of attracting investments in the communal services sector Implementation of investment schemes with borrowed capital (credit, leasing)

№	Hindrance	Remedy
6.	Low paying capacity of communal services residential consumers	Granting of privileges and subsidies to low-income consumers
7.	Insufficient community awareness of energy efficiency of the RF economy and lack of energy saving urgency comprehension	Shaping of public opinion on energy saving necessity

Many of the proposed remedies are being discussed with governmental authorities preparing and approving decisions in energy saving. As shown in the chapter analyzing energy saving barriers, some barriers are interdependent and consequently should be cured by measures also having a complex effect on the investment climate in energy saving. Some of such curative measures are described below:

1 **Measures to reform legal and regulatory base of energy saving**

The RF Ministry of Energy has prepared a **new Law on energy saving** and submitted it for approval to the State Duma. It is also necessary **to improve the system of FER consumption regulation**, and introduce a **mechanism of FER consumers obligatory and routine energy audit** as means of this regulation compliance control. Feasible seems establishing of **a federal authority with affiliates in the regions** entrusted with these measures implementation.

2 **State support of technical re-equipment and renovation of power equipment, development and introduction of energy efficient technologies**

Consumer economic interest is the main driver of energy saving and the state must ensure frameworks turning energy saving to the consumer profit. It relates primarily to regulated enterprises, while enterprises selling their products in the competitive market are in lesser need of the like stimulation.

To achieve this goal it is advisable to establish state funds to facilitate investments in energy-saving and provide (besides allocation of credits) consulting and expert services to FER consumers. In practice it means organization of public ESCOs at the Federal and regional scales.

3 **Differentiation of natural gas prices depending on gas use efficiency and development of a secondary regional gas market model**

Another important energy-saving incentive is **introduction of differentiated natural gas wholesale prices** depending the efficiency of gas use. Several West-European countries practice graded certification of FER consumers and energy equipment. Depending on the certificate grade a FER consumer either receives discount of the gas wholesale price or vice versa is fined for FER consumed in excess of the established norm.

To promote energy saving in the regions and avoid curtailing of regional gas quota it seems advisable to establish a system re-allocating the saved gas within the constituent entity and including local Gazprom affiliates, gas saving enterprises, regional authorities and enterprises seeking additional gas supply.

Such system is proposed with the double goal of, first, ensuring stakeholders' economically based commitment to gas consumption reduction, and, second, of preserving gas quotas undiminished.

4 **Design of schemes ensuring investments payback and profitability**

5 **Setting a structure (entity) capable of attracting investments in the communal services sector**

6 **Implementation of investment schemes with borrowed capital (credit, leasing)**

Enacted in July 2008 amendments to electricity and heat tariffs formation guidelines are aimed at establishing transparent and predictable schemes of returning investments with ensured margin beyond the currently existing norms.

- **Inclusion of investment premium in the tariff structure**

As proven here including investment premium in the tariff structure allows to plan and guarantee investment return timeline as well as investment profitability.

As share of expenses in the tariff structure goes down with application of improved energy equipment and optimized heat supply schemes, it becomes possible to achieve quicker pay-back of investments by slightly increasing the tariff. As can be gathered from above, such tariff increase does not cumber consumers, presenting no great burden especially when compared to cost of other services rendered by suppliers operating obsolete equipment. Besides, in due time (when investments are paid back) the tariff will go down providing for positive social and economic effects.

- Maintaining share of rated expenses in the tariff structure at the same level as before implementing resources conservation for another two years beyond the investment pay-back timeline.

This measure provides for additional cash incomes assignable for investment recovery.

- **Tariff formation accounting for the region-specific rate of return** facilitates leveling of profitability of different economy branches.

- Tariff formation of the basis of the assets market value instead of book value.

This new pricing algorithm may become essential means of reforming the existent tariff making system in the situation of considerably depreciated fixed assets, though the methodology frameworks of estimating value of the so-called regulated assets remains incomplete and uncertified yet.

Implementation of such schemes is possible only given investment agreements between business entities and executive authorities, conclusion of which will be propelled by social importance of the energy supply. Regional (local) authorities as owners of housing and communal facilities often act a co-investor or loan guarantor to facilitate investment inflow.

ESCO affiliated with energy companies or equipment producers could be important means of facilitating energy-efficiency and energy-saving projects. As a rule such ESCOs are financially successful and command considerable expert resources for rendering energy services. ESCOs' contribution to energy efficiency projects could include efficient equipment and technologies, as well as investment funds or investment return guarantees.

The Kolpashevo project presents in fact an example of organizing an ESCO (LLC "Kolpashevo heating company"), affiliated with an equipment producer (LLC "Octane") and resorting to a loaner (leasing company).

An ESCO can employ different operation schemes current in western countries and including performance contracting, as well as longer term contracts like BOOT[20] or Chauffage.

Thus we can acknowledge existence of adequate background for implementing energy-saving and efficiency projects in the regions of Russia.

By different estimations some 40-45% of energy now yearly consumed in Russian can be saved. Expected annual saving of gas only exceeds 100 bln. m^3. Analysis of the Kolpashevo case makes it clear that the housing and communal sector with some 95÷110 mln. tce conservable at the country scale will account for a greater part of the energy saving opportunities.

Expertise gained with the Kolpashevo project allows to conclude that its replication in the regions of Russia can be very beneficial for energy use efficiency improvement provided economic inducement of fuel and energy consumers and facilitation of investments in energy saving.

[20] BOOT – Build Own Operate Transfer

2 The Kolpashevo district social and economic situation

2.1 General Description

Municipal entity “Kolpashevo District” is situated in the southeast part of West-Siberian Plain. It belongs to the group of northern districts of the Tomsk Region.

In the north, northwest, and west, the district borders with the Parabel, in the east – with the Verkhneketsky, in the south – with the Molchanovsky, Chainsky, Bakcharsky Districts (Figure 2-1). The total district area equals to 17,112 sq. km including 266 sq. km of the Kolpashevo city.

Distance of the district center from Tomsk exceeds 300 km. The land of the municipal entity is crossed by the Ob River almost in the middle, from the southwest to the northeast.

The climate of the Kolpashevo District is continental with long cold winter and short summer. Average annual air temperature is below zero and varies between –1.4° C and 2° C. The absolute minimal temperature falls on January and equals to 54° C, the absolute maximal air temperature falls on June and reaches +36° C.

The Kolpashevo city is the administrative center of municipal entity “Kolpashevo District”. Among rural settlements having population over 1 thousand residents, the Togur village is the largest.

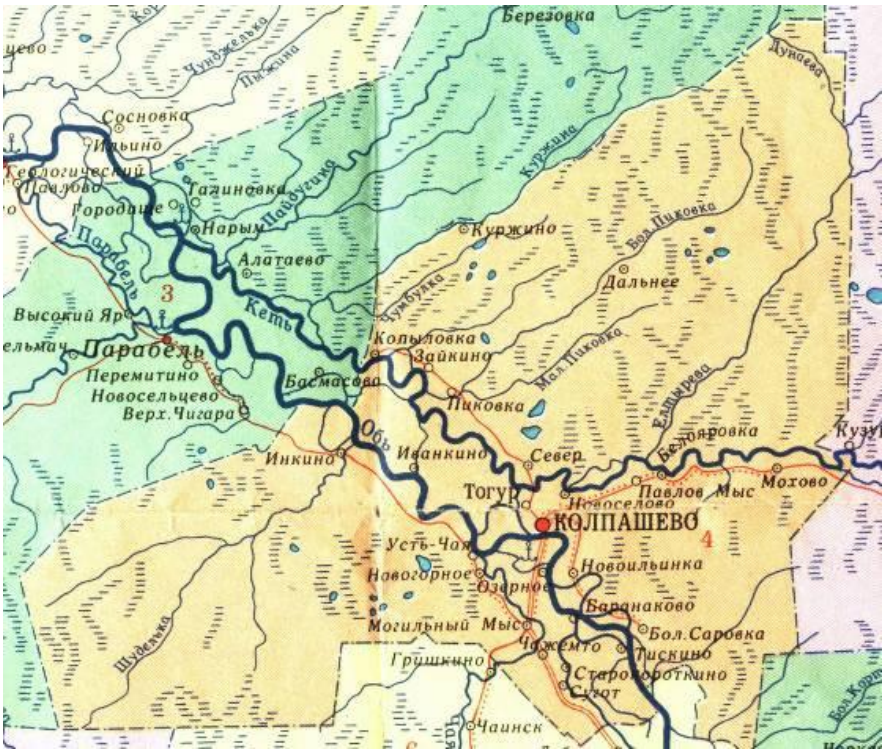


Figure 2-1 Territorial location of the Kolpashevo District

As of the beginning of 2007, the permanent population of municipal entity “Kolpashevo District” equaled to 44,072 people including 25,815 people who were urban residents and lived in the administrative center – the Kolpashevo city, and 18,257 people who were rural residents. More than ¾ of the district population are concentrated within the Kolpashevo urban municipality.

The Kolpashevo District economy was basically formed after the war in order to support exploration and production of raw oil and gas in the north of the Tomsk Region. The district has a diversified economy structure which is its big advantage compared to many municipal entities of the Tomsk Region since it provides certain stability and independence of its economy from various

industrial factors. In the district, there are businesses of different industries: forestry, woodworking and food, machine-building and metal-working, geological prospecting, agricultural, civil engineering, wholesale and retail trade, catering; though some of them are experiencing crisis.

Almost all businesses and infrastructure facilities are located in the Kolpashevo city and the nearby village of Togur.

2.2 Population

2.2.1 Demography

The demography is an indicator of the processes going on in the economy and social sphere of the district. In 2006-2007 it was characterized by the on-going process of decrease of district population resulting from natural and migration diminution.

During the period between 2004 and 2007, the permanent population of the district decreased by 1,890 persons. The largest decrease of the population took place in the Kolpashevo urban municipality. The dynamics of the Kolpashevo District demography is shown in Table 2.1

Table 2.1 Dynamics of the Kolpashevo District Residents (persons) As Of Year End

Indices	2004	2005	2006	2007	Deviation of 2007 Relative To 2004
The Kolpashevo District permanent population	45,790	44,816	44,072	43,900	- 1,890
Including the Kolpashevo urban municipality	35,308	34,168	33,780	33,490	- 1,818

2.2.2 Employment

Basic employment indices for the Kolpashevo District are given in Table 2.2. Most significant is the 4.8% growth of employed population in 2007 versus 2004.

Table 2.2 Basic Indices of the Kolpashevo District Employment

Indices	2004	2005	2006	2007
Mean annual employment in economy, persons	15,322	15,256	15,812	16,061
Percentage of mean annual employment in economy relative to the total population, %	33.5	34.0	36.0	36.6
Economically active population, persons	23,000	23,000	23,400	24,000
The number of officially registered unemployed people, persons	2,671	2,844	2,034	1,446

Indices	2004	2005	2006	2007
Unemployment level, % (ratio of the number of unemployed to economically active population)	11.6	12.4	8.7	8.9

The biggest number of employees is employed in large and mid-size organizations and small companies: 9,689 persons or 60.3% of the total population occupied in the economy. In 2007, a 1.7% growth of the number of people in the said district businesses relative to 2006 level is observed (Table 2.3).

Table 2.3 Distribution of the Number of Employees of Large and Mid-Size Organizations, Small Companies By Types of Economic Activities

Type of Economic Activity	2006	2007	Growth Rate, %
Total District	9,525	9,689	101.7
Including:			
Agriculture, Hunting and Forestry	237	228	96.2
Processing Businesses	227	317	139.6
Steam Generation, Transmission and Distribution of Electric Power, Gas, and Hot Water	675	659	97.6
Wholesale and Retail Trade	441	542	123.0
Civil Engineering	160	222	138.8
Transport and Communication	1,313	1,252	95.4
Financial Mediation	174	207	119.0
State Management and Defense	1,111	1,114	100.3
Healthcare and Social Services	1,682	1,683	100.1
Other Communal, Social and Personal Services	413	343	83.1
Education	2,179	2,042	93.7
Other Activity Types	913	1,080	118.3

For the first time during the last 5 years the dynamics of the basic employment indices improved in 2007. The level of registered unemployment decreased by 48.4% on average for the district in 2007 versus 2006 but it still remains relatively high and 1.58 times exceeds the mean regional index that equaled to 3.8 % for 2007.

2.2.3 Population Income and Living Standard

Income of the population is one of the most important indices of the living standard. The population income dynamics is given in Table 2.4 below.

Table 2.4 Dynamics of Population Income For Years 2004 – 2007

Indices	2004	2005	2006	2007
Monthly average accrued salary of employees of businesses and organizations, USD	308,1	367,6	422,3	521,4
Average per capita income of the population, USD per month	107,0	142,5	217,1	262,3
Percentage of the population having income below living wage, %	47,0	48,0	47,0	43,0
Living wage value (4th quarter), USD per month	130,2	148,4	178,6	189,4
Purchasing capacity[21]	2,4	2,5	2,4	2,9

Salary growth per one employee for all district businesses in 2007 amounted to 181.0% relative to 2004 level.

Living wage in the district per capita of the population in the 4th quarter of 2007 grew by 6.1% relative to 4th quarter of 2006 and amounted to 189 USD. Purchasing capacity increased by 20.8% in 2007 relative to 2006.

2.3 Economy Structure By Sectors

2.3.1 Industry

Industrial production within the Kolpashevo District was represented in 2007 by the following activities: food production, woodworking and manufacture of wood products, manufacture of finished metal products, machines and equipment, electric equipment, printing; generation, transmission and distribution of electric power, gas and steam; mining operations.

According to the city statistics department, about 14% of the population employed in large and mid-size organizations and small companies of the district are occupied in industrial production. In 2006 industrial production accounted for 21.6% of the total shipment of in-house products, works and services.

In 2007 the total volume of shipped in-house products, works and services done by own efforts amounted to 18,5 mln. USD or 134.4 % relative to 2006. The growth of shipped products volume was achieved thanks to the products of processing businesses. The specific weight of the products of processing businesses in 2007 equaled to 58.0%. The predominant position in the products of processing businesses belongs to manufacture of electric equipment – 54.2% (Table 2.5)

[21] Ration of average salary to living wage

As of 01.01.2008, the volume of industrial products produced in the district amounted to 422 USD per one resident.

Table 2.5 Structure of Industrial Products in % To Total Volume of Industrial Production

Industrial Product	2004	2005	2006	2007
Industrial Products, Total	100.0	100.0	100.0	100.0
including processing businesses:				
Food Production	2.4	4.3	8.2	6.8
Woodworking and Manufacture of Wood Products	23.5	9.9	7.6	9.8
Printing	1.0	1.7	5.9	6.4
Manufacture of Finished Metal Products[22]	-	-	1.9	3.4
Manufacture of Electric Equipment	18.5	17.8	29.9	31.4
Manufacture of Transport Means	5.2	1.6	0.1	-
Other Production Businesses	5.2	1.6	0.1	0.2
Generation and Distribution of Electric Power, Gas and Steam	49.4	64.7	46.3	42.0

The second significant type of activity is generation and distribution of electric power, gas and water; it accounts for 42.0% of the total industrial production volume.

In the Kolpashevo District territory, branches of regional businesses supplying gaseous fuel are carrying out their activity; these are: Chazhemetovsky industrial site of Tomsk line section of LLC “Tomskransgaz” trunk gas pipelines; the Kolpashevo section of LLC “Severmezhraigaz”; Chazhmetovsky section of LLC “Severmezhraigaz”. The main consumer of gas is the population; the basis of consumption is liquefied gas.

The fuel and energy sector of the district is represented by power suppliers – “Northern Electric Grids”, a branch of JSC “Tomsk Distributing Company”; the Northern Branch of JSC “Tomsk Energy Sale Company”; MUE “Energosnab”. The businesses render the services of electric power transmission and distribution, connection of new users to electric grids.

Municipal Unitary Enterprise “Energosnab” deals with generation and distribution of electric energy from self-contained diesel power stations for remote villages of Kolpashevo District. Northern Electric Grids branch of JSC “Tomsk Distributing Company” is occupied with providing stability of power supply facilities, construction of backup power supply lines, repair of worn-out and faulty electric lines. Steam and water production and distribution is handled by the district utility companies, which render heat supply services to the population; and also water supply companies (LLC “Vodocanal – 1”, LLC “Agrostroi”, LLC “KSK”, LLC “TST”, LLC “ZhKO” and other organizations.)

[22] Production of finished metal products for the years 2004 and 2005 is included in production of electric equipment according to statistic data.

In 2007 the total volume of electric power, gas and water production and distribution amounted to 7,8 mln. USD, 1,4 mln. USD more than in 2006.

The communal sector is a most important component of the district economy.

The annual volumes of utility services rendered are decreasing due to decline of the district population, setback in industrial production, and refusal of part of consumers with low level of income, for which the burden of paying for the services has become unaffordable, from using utility services.

The housing and communal sector of the Kolpashevo District has been unprofitable during recent years almost for all types of rendered services save for centralized electric power supply, housing and other services.

This situation increases the risks for repayment of investments.

2.3.2 Agriculture

In the district, 3 businesses are occupied with agriculture. 25 farms (peasant holdings) are registered, of which 14 are carrying out production activity and report to the state statistics bodies.

The main specialization of agricultural businesses and farms (peasant holdings): production of plant growing products – vegetables and grain, dairy stockbreeding.

Today, the majority of agricultural products produced in the district are produced in personal subsidiary plots, in so-called small economic types. Personal subsidiary plots of the population account for the major part of the total agricultural products produced in the district which is related to decrease of production in other economic types rather than increase of production in personal subsidiary plots.

Manufacturers of agricultural products are characterized by unstable financial situation due to shortage of their own turnover funds.

2.3.3 Forestry

The Kolpashevo District possesses sufficient potential for stable development of logging sector. The estimated logging block equals to 1432.5 mln. cubic meters including coniferous logging of 378.4 thousand cubic meters.

In 2007, an estimated logging block recovery equaled to 36 thousand cubic meters (2.5%), including coniferous logging – 13 thousand cubic meters – (3.4%). Failure to recover from an estimated logging block is made up of several factors: absence of large loggers (logging over 20 thousand cubic m a year and more) and complex transportation pattern.

If during pervious years, most part of cut wood was sold unprocessed, now large loggers are trying to sell processed cut wood, which allows raising sale prices for the products and improving financial situation of businesses.

2.3.4 Civil Engineering

Since industrial and civil construction is not carried out in the district now, the activity of such businesses during the analyzed period is aimed at capital and routine repairs of buildings and facilities, mostly, at the expense of local budgets, also repair of detached residential houses.

Residential development was carried out solely by individual developers without involvement of civil engineering companies. During recent years, construction of detached residential houses has been carried out mostly in the Kolpashevo city and Chazhemto village (

Table 2.6).

Table 2.6 The Volume of Work done in "Pure" Construction Activity Type (mln. USD)

Index	2005	2006	2007 год
The Kolpashevo District	3.52	51.7	45.7

A tendency is clearly observed towards increased commissioning of detached residential houses within the Kolpashevo urban and Chazhemto rural settlements and in the region in general connected with commenced construction of a gas pipeline in the Kolpashevo city and gas distributing systems in Chazhemto village.

2.3.5 Consumer Market

In the recent years, the Kolpashevo District consumer market is developing at a fast rate. This happens thanks to trade and catering businesses, which hold the first positions in the list of most profitable sectors of economy.

Steady growth of real cash income creates favorable conditions for development of wholesale and retail trade, catering services, consumer services (Table 2.7).

Table 2.7 Basic Indices of Retail Trade

Indices	2005	2006	2007	2007 Vs 2006, %
Catering Turnover, mln. USD	0,8	1,8	2,1	114,3
Retail Turnover, mln. USD	31,6	50,1	64,4	128,7
Volume of Chargeable Services, mln. USD	13,0	14,1	19,3	136,5

In 2007 the retail trade volume amounted to 64,4 mln. USD, which is 28.7% higher than the 2006 index.

The existing tendency of consumer market development evidences rather stable nature of market richness in goods. The demand of the population for the main essential foodstuffs and consumer goods is fully satisfied.

Retail trade turnover per capita equaled to 1 400 USD approximately, the increase by 2006 was 38.5 %.

Positive dynamics of the sector, along with growth of goods turnover indices, is also characterized by catering network development. Over the previous year, the turnover of catering services grew 1.1-fold and amounted to 2,1 mln. USD.

The network of consumer services is developing at a steady pace. Due to large distances of rural settlements and villages to the district center and, consequently, low profitability, consumer services' businesses are concentrated mostly in the district center.

2.4 Investments

Starting from 2003 there is continuous growth of investments into fixed capital (Figure 2-2, Figure 2-3).

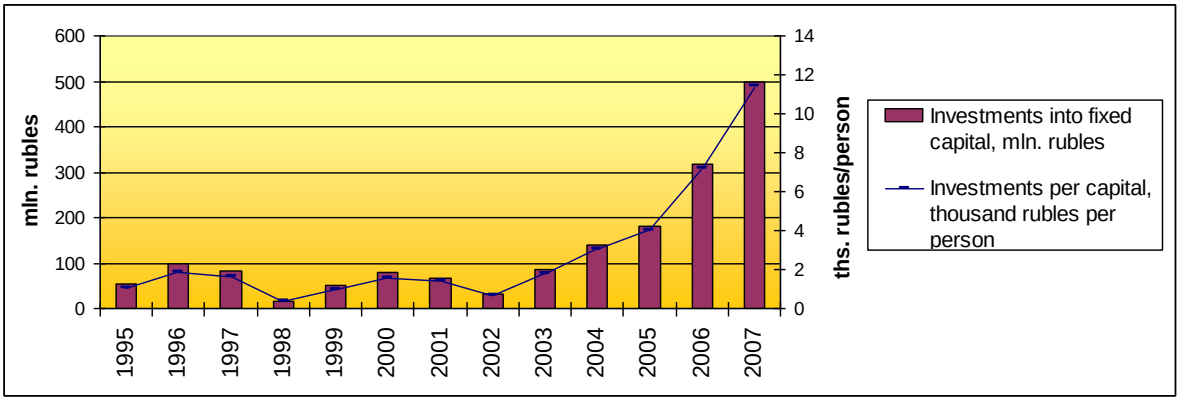


Figure 2-2 Investments into fixed capital in actual effective prices

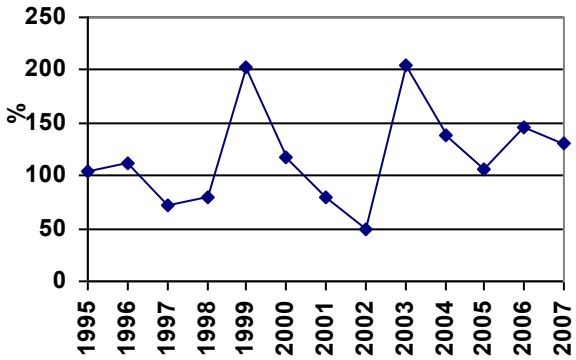


Figure 2-3 Investments in comparable prices as percentage versus previous year

In the structure of investments into fixed assets for large and mid-size businesses in 2006, the largest portion of them fell on the economy activity type of "state management, mandatory social support" (31.4%) and "transactions with immovable property" (27.9%).

For large and mid-size companies, the main source of financing investments into fixed capital is raised money. For 2006, the own funds of large and mid-size companies amounted to 1,98 mln. USD (16.5%), and raised money – to 10,0 mln. USD (83.5%).

The predominant form was investments into buildings (save for residential) and facilities. For 2006, 5,8 mln. USD, or 48.0% of the total volume of investments, were invested into buildings and facilities. 5,5 mln. USD (45.5%) were invested in machines, equipment, tools, implements; 306,6 mln. USD (2.6%) were invested in housing, 473,3 mln. USD (3.9%) fall on other investments.

Investments into small companies made a bit more than 1% of the total volume.

In 2007, growth of investment activity was observed related to construction of the district gas transport system and making heat-and-power engineering facilities ready to receive gas. So, in 2007, the growth of investments has achieved a record value for the last decade of 20 mln. USD.

3 Status of heat-and-power engineering systems of the Kolpashevo urban municipality

3.1 Energy Balance

The Kolpashevo urban municipality is the largest consumer of fuel and power resources in the district.

The energy balance of the settlement for the year 2007 can be regarded an attempt to integrate data obtained from different sources (Table 3.1).

Table 3.1 Energy Balance of the Kolpashevo Urban municipality for the Year 2007

Energy Type	Firewood, thou. log cub. m	Coal, thou. ton	Electric Power, mln. kW-hr	LHCG, thou. ton	Natural Gas, mln.m^3	Oil, thou. ton	Black Oil, thou. ton	Heat, thou. Gcal	Total, thou. fuel equiv. ton
Primary Energy	199.51	75.34	58.70	1.07	0.00	10.41	0.03	0.00	128.87
Own Production	199.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.87
Coming-in	0.00	75.34	58.70	1.07	0.00	10.41	0.03	0.00	77.00
Heat-and-Power Engineering	0.00	-63.99	-7.40	0.00	0.00	-10.41	0.00	190.88	-33.29
Municipal Boiler Houses	0.00	-47.15	-5.98	0.00	0.00	-9.54	0.00	178.79	-21.62
Industrial Boiler Houses	0.00	-16.84	-1.42	0.00	0.00	-0.87	0.00	54.65	-5.58
Own Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-5.42	-0.78
Losses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-37.14	-5.31
End Use	199.51	11.34	51.30	1.07	0.00	0.00	0.03	190.88	95.26
Population	199.51	11.34	27.90	0.21	0.00	0.00	0.00	112.60	79.82
Domestic Utilities	0.00	0.00	18.38	0.00	0.00	0.00	0.00	29.92	6.54
Industrial & Other Users	0.00	0.00	5.02	0.86	0.00	0.00	0.03	48.36	8.9

Primary energy consumption within the Kolpashevo urban municipality equals to 128.87 thousand tons of fuel equivalent per year. Local production of primary energy is considerable and amounts to 51.87 thousand tons of fuel equivalent. This is mostly firewood used by the population.

Incoming primary resources (brought from elsewhere) equals to 77.00 thousand of fuel equivalent: 59.8% of the total primary energy consumption. Coal, raw oil and oil products, liquefied hydrocarbon gas, electric energy are brought from outside.

Consumption of fossil fuels in heat-and-power engineering sector equals to 59.8 thousand of fuel equivalent. End use amounts to 95.26 thousand tons of fuel equivalent.

The structure of energy resources end use by types of energy resources and use fields is given below (Figure 3-1; Figure 3-2).

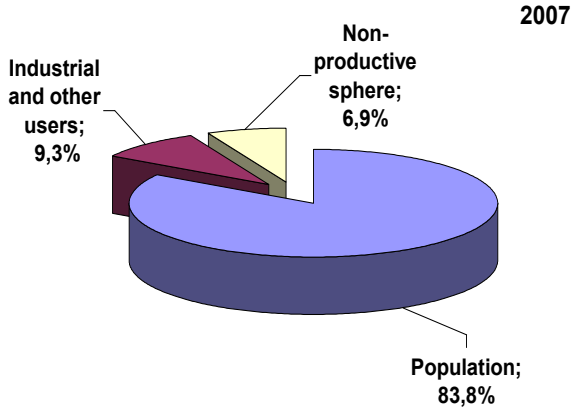


Figure 3-1 The structure of end use by use types

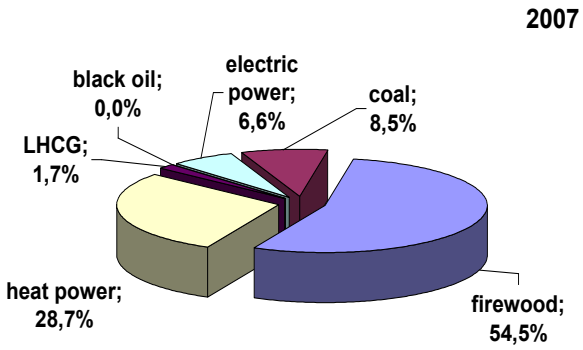


Figure 3-2 The structure of end use by types of energy resources

Among energy resources, firewood fuel (54.5%) and heat power (28.7%) prevail; electric power and coal are used approximately in equal shares (6.6 and 8.5%, respectively).

The largest energy user is the population (83.8%) followed by industrial users (9.3%) and non-productive sphere (6.9%).

3.2 General Description of Electric Power Supply

3.2.1 Electric Power Supply

The energy sector plays an important role in the economy of the Kolpashevo District. Power engineering makes 42% in total in the structure of district's industrial production.

The Kolpashevo urban population is provided with electric power via two 100kW lines: C-57 "Bely Yar-Kolpashevo" and C-40 "Chazhmeto – Kolpashevo". These lines feed the 110/35/10kV two-transformer station, each transformer having the installed capacity of 40MVA. Outgoing 35kV lines KT3501 and KT3502 feed the two-transformer station of Togur village having the installed capacity of 2×10 MVA. The structure of 110, 35 kV network and 110/35/10kV Kolpashevo and 35/10 kV Togur stations ensure sufficient level of stable power supply for 35 and 10 kV bus-bars [4].

The Kolpashevo city 10kV electric networks comprise 10kV overhead and cable lines and 3 distributing points. 10kV overhead lines have the total length of 122.5km. 10kV cable lines have the total length of 22.06km. The reliability level of 10kV feeding and distributing networks in some parts of the city is insufficient and requires their further development.

In the Kolpashevo urban municipality, the services of electric power transmission and distribution as well as connection of new users to electric grids are rendered by power suppliers: Northern Electric Grids, a branch of JSC |"Tomsk Distributing Company", Northern branch of JSC "Tomsk Energy Sale Company".

3.2.2 Heat Supply

The largest specific weight in the total volume of energy products falls on heat-and-power companies providing heat supply to the Kolpashevo urban municipality.

The economy crisis of the 90th resulted in significant change of heat consumption structure in the Kolpashevo District heat supply systems, the greatest changing taking place in the Kolpashevo city and Togur village where the main produces and users were factory-farm, food and woodworking enterprises.

The process of heat supply reconstruction was mostly spontaneous, based on the understanding of the necessity to reduce irrational fuel expenditures.

For the last five years, the number of boiler houses providing heat to the population, domestic utilities and satisfying process needs of businesses have become a bit smaller thanks to shut-down of 5 unprofitable coal municipal boiler houses. As of 1.01.2007, heat supply in the settlement was provided by 50 boiler houses having the aggregate installed capacity of 147.94 Gcal/hr, of which 39 boiler houses were municipal and 11 were departmental (Table 3.2).

Table 3.2 2007 Characteristics of the Kolpashevo Urban municipality Heat Supply

Main heat supply sources (boiler houses), pcs.	50
Installed heat capacity, Gcal/hr	147.94
Design heat duty, Gcal/hr	68.04
Utilized fuel	Oil. Coal
Fuel consumption, tons of fuel equivalent/year	59 818.9
Yearly generation, Gcal/year	233 067.6
Installed capacity utilization factor	0.46
Length of two-pipe heat supply networks, km	82.9

The heat supply system of the Kolpashevo city and Togur village features high degree of centralization. The objects of heat supply are housing, budget sector, and services sector.

3.3 The Kolpashevo Urban municipality' Heat Supply Systems

3.3.1 Heat Supply Sources

The municipal heat supply system of the Kolpashevo urban municipality is based on 39 boiler houses that have the aggregate installed capacity of 127.5 Gcal/hr; 32 of them are located in the

Kolpashevo city and 7 - in Togur village. A brief description of the boiler houses is given below (Table 3.3 Table 3.4)

Table 3.3 Characteristics of Kolpashevo Urban municipality Municipal Boiler Houses

#	Boiler House Name	Boiler Brand	Qu-ty, Pcs.	Performance, Gcal/hr	Fuel	Installed Capacity, Gcal/hr
1	Boarding School	KSV-0.8	2	0.65	coal	1.7
		NR-18	1	0.4	coal	
2	TGT	AVVA-4	3	1.6	oil	4.8
3	RTP	KSV-0.8	5	0.65	coal	4.05
		MMZ-0.8	1	0.8	coal	
4	Vodnik	NR-18	3	0.4	coal	1.2
5	RMM	KSV-0.8	3	0.65	coal	1.95
6	UYUT No.1 (Pobedy)	KSV-1.28	4	0.95	coal	5.5
		KSV-0.8	2	0.65	coal	
		NR-18	1	0.4	coal	
7	Uyut No.2 (Kirova)	KSV-0.8	3	0.65	coal	3.15
		NR-18	3	0.4	coal	
8	Laundry	KSV-0.8	1	0.65	coal	0.65
9	Mira 4	NR-18	2	0.4	coal	0.8
10	DPO	KSV-1.28	5	0.95	coal	5.39
		E 1/9	1	0.64	coal	
11	Bath-house No.1	KSV-1.28	1	0.95		5.1
		KSV-1.28	3	0.95	coal	
		KSV-0.8	2	0.65	coal	
12	Geolog	KV-1.6	3	1.6	oil	8
		AVVA-4	3	2	oil	
13	Pedagogical College	KSV-1.28	3	0.95	coal	4.75
		KSV-1.28	2	0.95		
14	City Hospital	KSV-1.28	2	0.95	coal	3.85

#	Boiler House Name	Boiler Brand	Qu-ty, Pcs.	Performance, Gcal/hr	Fuel	Installed Capacity, Gcal/hr
		KSV-0.8	3	0.65	coal	
15	Agrostroi	KSV-0.8	4	0.65	coal	2.6
16	Sanitary & Epidemiological Station SES “Elis”	DKVR-6.5	1	4.16	coal	14.75
		KE-10	1	6.4	coal	
		KSV-1.28	1	0.95	coal	
17	Urozhai	NR-18	4	0.4	coal	1.6
18	River-Boat Station	KSV-1.28	1	0.95	coal	1.35
		NR-18	1	0.4	coal	
19	Tech. Point	NR-18	2	0.4	coal	0.8
20	Medical College	KSV-0.8	5	0.65	coal	3.25
21	Uyut No.3 (TV Center)	NR-18	2	0.3	coal	0.6
22	Uyut No.5 (NGSS)	KSV-1.28	5	0.95	coal	4.75
23	Phoenix	NR-18	2	0.4	coal	0.8
24	Kerch (Shipyard)	NR-18	2	0.4	coal	0.8
25	Matrosova	NR-18	3	0.4	coal	1.2
26	2/2 Chenysjevskogo	NR-18	1	0.4	coal	1.7
		KSV-0.8	2	0.65	coal	
27	School No.4	NR-18	3	0.4	coal	1.2
28	KONGRE	KSV-0.8	3	0.65	oil	2.59
		E1/9	1	0.64	oil	
29	Novy 1	KSV-0.8	3	0.65	oil	1.95
30	TISTO Lazo	KSV-1.28	3	0.95	oil	9.39
		KB-1.68	1	1.68	oil	
		KSV-1.86	1	1.86	oil	
		KE-2.5	2	1.5	oil	
31	Rechnik	KSV-1.28	1	0.95	coal	5.7

#	Boiler House Name	Boiler Brand	Qu-ty, Pcs.	Performance, Gcal/hr	Fuel	Installed Capacity, Gcal/hr
		KSV-1.28	5	0.95	coal	
32	DEU	NR-18	1	0.4	coal	1.69
		E1/9	1	0.64	coal	
		KSV-0.8	1	0.65	coal	
	Total Kolpashevo		**125**	**56.81**	**coal/oil**	**107.61**
1	Centralnaya	KVV-1	1	0.86	oil	2.16
		NR-18	3	0.4		
2	Sovetskaya	KSV-1.4	3	1.4	oil	4.2
3	Zavodskaya	KVV-3	2	2.58	coal	5.16
4	Sovkhoznaya	KVVp-1	1	0.86	coal	2.16
		NR-18	3	0.4		
5	Shkolnaya	KVV-1	1	0.86	coal	2.06
		NR-18	3	0.4		
6	Orphan Asylum	KVV-1	2	0.86	coal	1.72
7	Chapaeva	NR-18	4	0.6	coal	2.4
	Total Togur		**23**	**9.22**	**coal/oil**	**19.86**
	Total Municipal Boiler Houses of the Kolpashevo Urban municipality		**148**	**66.03**	**coal/oil**	**127.47**

In addition to municipal sources, 11 departmental boiler houses functioned in the city.

Table 3.4 Characteristics of Departmental Boiler Houses in the Kolpashevo City

Seq. No.	Name of the Owner Company of Boiler Houses	Fuel	Yearly Output, ton/en, 2007, Gcal/year	Design Duty Gcal/year	Design Duty, Subscribers Gcal/h	Design Duty, Boiler House Gcal/h
			fact	calculation		
1	Kolpashevo DRSU	coal	2096.9	2472.9	0.75	0.94
2	Kemerovo KECh, military base	coal	28500	28959.9	9.5	11.18

Seq. No.	Name of the Owner Company of Boiler Houses	Fuel	Yearly Output, ton/en, 2007, Gcal/year	Design Duty Gcal/year	Design Duty, Subscribers Gcal/h	Design Duty, Boiler House Gcal/h
			fact	calculation		
	No.14174[23]					
3	FGUP 'Mail of Russia'	coal	3100	3044.8	0.93	1.16
4	JSC "Avtotransportnik"	coal	4250	4430	1.5	1.68
5	JSC "Metallist"	coal	3870	3870.4	1.29	1.47
6	CJSC "ZPN"	oil	1150	1150	0.42	0.44
7	Kolpashevo GORPO	coal	1100	1100	0.41	0.42
8	IZ No.66/2	coal	5112	5111.9	1.75	1.94
9	REB of Fleet	oil	5463.9	6133.1	1.83	2.33
	Total Departmental Boiler Houses	**coal/oil**	**54643**	**56273**	**16.55**	**19.22**

In the total number of the Kolpashevo urban municipality municipal boiler houses, the majority are small boiler houses having the capacity of up to 3 Gcal/hr, which share equals to 59%. The installed capacity of the Kolpashevo urban municipality municipal boiler houses varies within the range between 0.65 to 14.75 Gcal/hr, the maximal loads per hour varying within the range of 0.21 to 6.3 Gcal/hr.

Analysis of the correlation of installed capacity and rational consumption evidences excessive capacities of the heat supply sources. The mean installed capacity utilization factor for municipal boiler houses is low and reaches 0.5; wherein for the Kolpashevo city it equals to 0.48 on average and for Togur village – to 0.6, which is a rather low figure even in spite of the necessity of generating capacity backup typical for northern regions. At the same time, there is a deficit of capacity for a number of boiler houses (to a greater extent, for the Kolpashevo city: TGT, Novy 1; and for Togur village: the Orphan Asylum); for some boiler houses there is significant reserve leading to higher operating expenditures and thermal energy cost.

As the base equipment, low-efficient homemade boilers of NR and KSV type are used; their share exceeding 83%. In some boiler houses, outdated factory-made boilers of AVVA, MMZ type and better factory-made boilers of KV, DE, KE, KVV types are used. Long-term operation of boilers without mode adjustment tests and absence of part of auxiliary boiler house equipment does not allow maintaining sufficient level of boilers' performance.

In most boiler houses there is no draught equipment, necessary control and measuring apparatuses. Combustion gas treatment is not performed. In all boiler houses there is no water treatment equipment, which results in scale formation on the internal surfaces of furnace tubes.

[23] The Kemerovo flat operating unit of military base No.14174 operates three boiler houses.

The network and boost pumps used are console-type installations featuring a narrow range of power regulation and insufficient energy efficiency. There is considerable excess over the installed pump equipment capacity.

The volumes of makeup water and thermal energy released into the system are not recorded.

Fuel handling facilities in solid-fuel boiler houses include open live storages, which results in fuel over-wetting and weathering. Fuel is fed mostly manually.

Fuel handling facilities of oil boiler houses include live tanks. No provision is made for oil heating equipment.

Electric power supply to boiler houses is centralized from the networks of JSC “Tomsk Distributing Company”, branch «Northern Electric Networks». Electric power supply is three-phase, 380V.

Boiler houses belong to electric power supply category III, though no power backup in the boiler houses is provided for. To account electric power consumption, boiler houses are equipped with electric power meters.

For make-up, boiler houses use mostly the centralized water supply system whereto treated water after de-ironing is fed. Some boiler houses use untreated water from artesian wells.

In the boiler houses there is no equipment to treat source boiler water, which, in the situation of high salinity of source water and presence of a significant amount of iron ions (for well water), leads to intensive scale formation on the internal surfaces of convective boiler tubes and is a factor reducing fuel combustion efficacy. Absence of water treatment affects also the rate of internal corrosion of heating conduits. In this connection, one can state that application of water-treatment equipment in the heat supply sources is essential for normal operation and stable heat supply.

The volume of makeup water is not accounted. The aggregate regulatory yearly level of water consumption by municipal boiler houses of the Kolpashevo urban municipality amounts to 196.85 thousand m^3. The actual water consumption is 10-15% higher than the regulatory level due to unauthorized withdrawal of heat carrier from the heating system by users and also due to level of leakages caused by considerable wear of heat networks.

3.3.2 Heat Networks

Heat networks are spur two- and four-pipe networks featuring considerable length due to low built-up density. At present, within the Kolpashevo urban municipality, 62.9 km of municipal and about 20 km of departmental heat networks are operated. At that, most of municipal networks (90.5%) are situated in the Kolpashevo city.

Pipelines of heat networks are laid underground in channels and above ground on supports. Mineral wool and sawdust are used as insulation material. The condition of thermal insulation of some underground pipelines is unsatisfactory. No insulation of the fittings of heat networks is provided for.

Many users were connected to networks haphazardly, there are heating conduit sections laid in parallel, in a number of heat network sectors the pipeline diameters were chosen without hydraulic calculation which is one of the reasons for hydraulic disadjustment of heat networks and a breach of the end user heat mode.

Since most heat networks were built in the end of the 80s, by now more than half of heating conduits (33.8km – 53.7%) are considerably worn out and 19.6km (31.2%) are dilapidated and require urgent replacement.

Distribution of heat network pipelines by diameters is shown in Table 3.5 and Figure 3-3 and Figure 3-4.

Table 3.5 Characteristics of Municipal Heat Networks in the Kolpashevo Urban municipality

Pipeline Diameter, mm	80mm and less	100mm	125-150 mm	200mm	250mm	300mm	Total:	Including Dilapidated and Worn-out
The Kolpashevo city	25.47	16.83	9.39	4.33	0.31	0.59	56.91	30.6
The Togur village	4.33	1.21	0.43	0.00	0.00	0.00	5.98	3.2
Total:	29.80	18.04	9.82	4.33	0.31	0.59	62.89	33.8
%	47.4	28.7	15.6	6.9	0.5	0.9	100.0	53.7

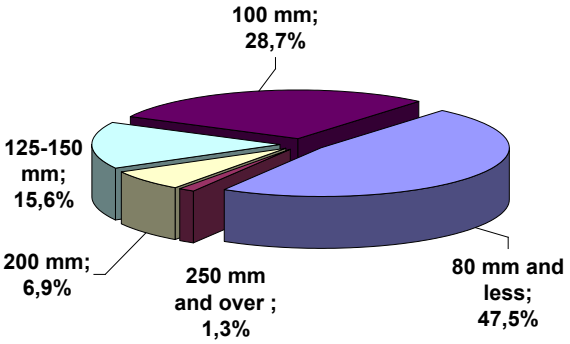


Figure 3-3 Distribution of heat networks by diameters

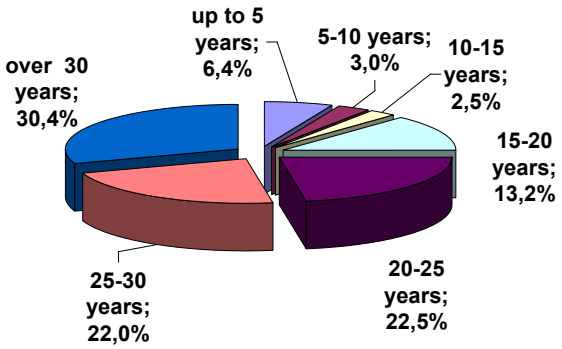


Figure 3-4 Distribution of heat networks by run life

Deterioration of heat network pipelines and insulation adversely affects performance of the heat supply system; hence, in order to avoid interruption in heat power supply, it is necessary to replace the worn-out heat networks before long.

High length of networks leads to significant heat losses; consequently, at present, the regulatory losses in municipal heat network make 16.8% of produced heat power on average, which results in higher cost of heat power.

3.3.3 Heat Consumption Systems

In the Kolpashevo urban municipality, heat power is used by sanitary engineering systems of the buildings. Only some consumers' heat inlets are equipped with heat meters and pressure and temperature control and measurement instruments.

Heating systems of buildings are connected directly to heat networks, based on elevator-free contour.

Heaters of convection radiation action, mostly cast-iron radiators, bare tube batteries and steel convectors, are used.

Very few buildings are equipped with hot water supply systems. The share of hot water supply in the total released heat equals to 3.4%. To satisfy the need in hot water, part of the population undertakes unauthorized water withdrawal straight from the heating systems.

The main users of municipal heat supply systems in the Kolpashevo urban municipality are the population – 69.6% and budget sector 20.5 % (Figure 3-5 and Figure 3-6).

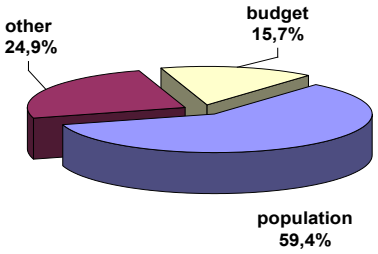


Figure 3-5 The structure of heat consumption in the Kolpashevo urban municipality

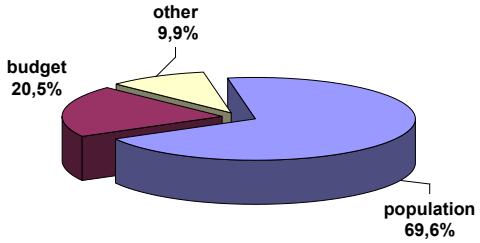


Figure 3-6 The structure of heat consumption in the Kolpashevo urban municipality municipal systems

3.3.4 Fuel Balance of Heat Supply Systems

The volume of fuel consumption by boiler houses for 2007 is shown in below (Table 3.6)

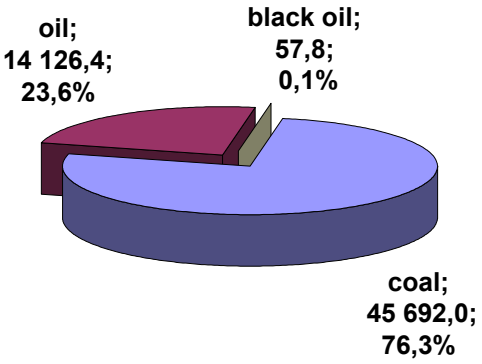
Table 3.6 The Volume of Fuel Consumption of Boiler Houses in the Kolpashevo Urban municipality

Seq. No.	Boiler House	Fuel Consumption		
		Coal, ton	Oil, ton	Total, ton of fuel equivalent
Municipal Sources				
1	Boarding School	590.0	0.0	421.3
2	TGT	0.0	1930.0	2619.0
3	RTP	1060.0	0.0	756.8
4	Vodnik	320.0	0.0	228.5
5	RMM	410.0	0.0	292.7
6	Pobedy	2980.0	0.0	2127.7
7	Kirova	2100.0	0.0	1499.4
8	Laundry	340.0	0.0	242.8
9	Mira	520.0	0.0	371.3
10	DPO	2250.0	0.0	1606.5

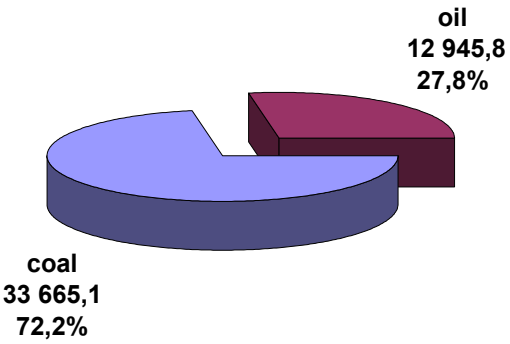
Seq. No.	Boiler House	Fuel Consumption		
		Coal, ton	Oil, ton	Total, ton of fuel equivalent
11	Bath-house 1	4000.0	0.0	2856.0
12	Geolog	0.0	2750.0	3731.8
13	Pedagogical College	3500.0	0.0	2499.0
14	City Hospital	2000.0	0.0	1428.0
15	Agrostroi	1200.0	0.0	856.8
16	SES	2800.0	0.0	1999.2
17	Urozhai	830.0	0.0	592.6
18	Station	240.0	0.0	171.4
19	Tech. Point	350.0	0.0	249.9
20	Medical College	1470.0	0.0	1049.6
21	TV Center	400.0	0.0	285.6
22	NGSS	1850.0	0.0	1320.9
23	Phoenix	440.0	0.0	314.2
24	Shipyard	1100.0	0.0	785.4
25	Matrosova	380.0	0.0	271.3
26	Chernyshevskogo	690.0	0.0	492.7
27	School No.4	550.0	0.0	392.7
28	KONGRE	0.0	780.0	1058.5
29	Novy 1	0.0	990.0	1343.4
30	Lazo 6	0.0	1920.0	2605.4
31	Rechnik	3800.0	0.0	2713.2
32	DEU	680.0	0.0	485.5
	Total Kolpashevo City	**36850**	**8370**	**37669**
1	Centralnaya	0.0	760.0	1031.3
2	Sovetskaya	0.0	410.0	556.4
3	Zavodskaya	1500.0	0.0	1071.0

Seq. No.	Boiler House	Fuel Consumption		
		Coal, ton	Oil, ton	Total, ton of fuel equivalent
4	Sovkhoznaya	2400.0	0.0	1713.6
5	Shkolnaya	2200.0	0.0	1570.8
6	Orphan Asylum	2900.0	0.0	2070.6
7	Chapaeva	1300.0	0.0	928.2
	Total Togur village	**10300.0**	**1170.0**	**8941.9**
	TOTAL Municipal Boiler Houses of Urban municipality	**47150.0**	**9540.0**	**46610.9**
Departmental Sources				
10	Kolpashevo DRSU	795.0	0.0	567.6
11	Kemerovo KECh, Military base No.14174	9000.0	0.0	6426.0
12	FSUE “Mail of Russia”	1300.0	0.0	928.2
13	Avtotransportnik	1800.0	0.0	1285.2
14	JSC "Metallist	1700.0	0.0	1213.8
15	CJS “ZPN“	0.0	150.0	203.6
16	Kolpashevo GORPO	450.0	0.0	321.3
17	IZ No.2	1800.0	0.0	1285.2
18	REB of Fleet	0.0	720.0	977.0
	Total Departmental	**16845**	**870.0**	**13208**

In the fuel balance structure of the urban municipality boiler houses, the predominant fuel is coal – 76.4%. For municipal boiler houses, coal share is lower and equals to 72.2%. Some boiler houses use raw oil as fuel (27.8%). Distribution of the volumes of fuel consumption by boiler houses by types is given below (Figure 3-7).



Boiler Houses of the Kolpashevo urban municipality



Municipal Boiler Houses of the Kolpashevo urban municipality

Figure 3-7 The structure of fuel consumption by boiler houses of the Kolpashevo urban municipality in 2007

It is a negative factor that oil is used as fuel. Further change of the fuel balance structure should be aimed at oil replacement, higher efficiency of coal combustion, and, in future, use of ecologically pure natural network gas.

3.3.5 Thermal Balance of Heat Supply Systems

The main producers of heat in the Kolpashevo urban municipality are municipal boiler houses, which account for 76.6% of total generation.

In total, in 2007 municipal boiler houses of the urban municipality produced 178.79 thousand Gcal of heat power. Thermal balance of the heat supply systems is given below (Table 3.7)

Table 3.7 Thermal Balance of Municipal Boiler Houses in the Kolpashevo Urban municipality in 2007

Seq. No.	Boiler House	Actual, 2007, Gcal/Year		Estimated Yearly Yield	CH	Losses in Heat Networks[24]		Useful Supply, Gcal/Year
		Generated	Totally Supplied		Gcal/Year	Gcal/Year	%	
1	Boarding School	1472.4	1224	1450.7	29	215.7	14.6	1206
2	TGT	12935	10548.6	13540	270.8	2227.2	17.2	11042
3	RTP	2643.9	1910.4	2394.2	47.9	616.3	23.3	1730
4	Vodnik	781.2	563	765.9	15.3	198.6	25.4	552
5	RMM	1007.6	673.3	1046	20.9	326.1	32.4	699

[24] Regulatory level

Seq. No.	Boiler House	Actual, 2007, Gcal/Year		Estimated Yearly Yield	CH	Losses in Heat Networks[24]		Useful Supply, Gcal/Year
		Generated	Totally Supplied		Gcal/Year	Gcal/Year	%	
6	Pobedy	7357.5	6407.4	7261.7	145.2	792.5	10.8	6324
7	Kirova	5116.3	4233.1	5501.7	110	839.7	16.4	4552
8	Laundry	842.1	564	825.6	16.5	256.1	30.4	553
9	Mira	1277.7	1160.5	1268.4	25.4	91	7.1	1152
10	DPO	5584	4727.6	5563.3	111.3	742	13.3	4710
11	Bath-house 1	9991.5	8539.9	10216.2	204.3	1279.9	12.8	8732
12	Geolog	17983.1	15811.7	18019.8	360.4	1815.4	10.1	15844
13	Pedagogical College	8504.9	6175.2	8116.2	162.3	2060.9	24.2	5893
14	City Hospital	4900.6	3946.3	4804.6	96.1	839.5	17.1	3869
15	Agrostroi	2875.9	2667.6	2808.1	56.2	147.2	5.1	2604.7
16	SES	6569.7	5632.7	6418.5	128.4	787.1	12	5503
17	Urozhai	2072.8	1657.7	2129.5	42.6	383.9	18.5	1703
18	Station	598.8	407	587	11.7	176.3	29.4	399
19	Tech. Point	873.5	738.5	856.3	17.1	115.2	13.2	724
20	Medical College	3675.4	2546.9	3603.4	72.1	1034.3	28.1	2497
21	TV Station	995.6	676.2	976.1	19.5	293.6	29.5	663
22	NGSS	4573	3296.6	4483.4	89.7	1161.7	25.4	3232
23	Phoenix	991.7	706	968.4	19.4	259.6	26.2	689.4
24	Shipyard	2734.9	2187	2670.4	53.4	481.5	17.6	2135.5
25	Matrosova	879.2	613	891.1	17.8	251.9	28.7	621.4
26	Chernyshevskogo	1713.5	751.8	1673.1	33.5	905.5	52.8	734.1
27	School No.4	1321.8	1178.3	1290.6	25.8	114.3	8.6	1150.5
28	KONGRE	4645	3956.9	4623.2	92.5	592.4	12.8	3938.4
29	Novy 1	6207.9	5366.7	6178.8	123.6	713.7	11.5	5341.5
30	Lazo 6	12607.2	10112.4	12547.8	251	2232	17.7	10064.8
31	Rechnik	9515.8	8341.9	9291.5	185.8	960.4	10.1	8145.3

Seq. No.	Boiler House	Actual, 2007, Gcal/Year		Estimated Yearly Yield	CH	Losses in Heat Networks[24]		Useful Supply, Gcal/Year
		Generated	Totally Supplied		Gcal/Year	Gcal/Year	%	
32	DEU	1592	1365.1	1554.5	31.1	190.5	12	1332.9
	Total Kolpashevo City	**144841**	**118688**	**144326**	**2887**	**23102**	**15.9**	**118337.4**
1	Centralnaya	4897.8	3625	4910.3	98.2	1177.8	24	3634.3
2	Sovetskaya	2647.7	1770.9	3374.5	67.5	1050	39.7	2257
3	Zavodskaya	4803.3	3441.4	4709.2	94.2	1241	25.8	3374
4	Sovkhoznaya	5781.4	4187	5668.2	113.4	1449.8	25.1	4105
5	Shkolnaya	5432.7	4319.8	5407.8	108.2	999.6	18.4	4300
6	Orphan Asylum	7152.9	6375.1	5270.5	105.4	467.7	6.5	4697.4
7	Chapaeva	3235.6	2571.5	3128.2	62.6	579.5	17.9	2486.1
	Total Togur Village	**33951.4**	**26290.8**	**32468.6**	**649.4**	**6965.4**	**20.5**	**24853.8**
	Total Municipal Boiler Houses of the Kolpashevo Urban municipality	**178792.4**	**144978.4**	**176794.6**	**3535.9**	**30067.4**	**16.8**	**143191.2**

About 65.4 % of heat power generation by municipal sources falls on coal boiler houses. About 34.6 % of heat power is generated in oil boiler houses.

3.3.6 Heat Supply Technical & Economic Indices

Energy Efficiency. The indices characterizing energy efficiency of heat source operation are specific consumption of fuel and electric power for generation of heat unit, and for the system in general – fuel useful consumption factor (UCF), which value for the Kolpashevo urban municipalitys on average equals to 45.6%, for municipal systems – to 44.4%, which is much lower than the recommended value of 68-70% and is related mostly with low efficiency of sources (Table 3.8).

Table 3.8 Efficiency of Fuel Consumption by Boiler Houses in the Kolpashevo Urban municipality in 2007

Seq. No.	Boiler House	Specific Fuel Equivalent Consumption, tons of fuel equivalent /Gcal	Weighted Mean Efficiency, %	Specific Electric Power Consumption kW hr/Gcal
Municipal Boiler Houses of the Kolpashevo City				
1	Boarding School	0.286	49.9	21.6
2	TGT	0.202	70.6	21.6
3	RTP	0.286	49.9	21.6
4	Vodnik	0.292	48.8	26
5	RMM	0.291	49.2	22
6	Pobedy	0.289	49.4	21.6
7	Kirova	0.293	48.7	21.6
8	Laundry	0.288	49.6	21.6
9	Mira	0.291	49.2	21.6
10	DPO	0.288	49.7	21.6
11	Bath-house 1	0.286	50	21.6
12	Geolog	0.208	68.8	21.6
13	Pedagogical College	0.294	48.6	21.6
14	City Hospital	0.291	49	21.6
15	Agrostroi	0.298	48	27.3
16	SES	0.304	46.9	21.6
17	Urozhai	0.286	50	21.6
18	Station	0.286	49.9	21.6
19	Tech. Point	0.286	49.9	21.6
20	Medical College	0.286	50	21.6
21	TV Station	0.287	49.8	21.6
22	NGSS	0.289	49.5	21.6
23	Phoenix	0.317	45.1	23.7
24	Shipyard	0.287	49.7	21.6

Seq. No.	Boiler House	Specific Fuel Equivalent Consumption, tons of fuel equivalent /Gcal	Weighted Mean Efficiency, %	Specific Electric Power Consumption kW hr/Gcal
25	Matrosova	0.309	46.3	22.3
26	Chernyshevskogo	0.288	49.7	21.6
27	School No.4	0.297	48.1	24.7
28	KONGRE	0.228	62.7	36.7
29	Novy 1	0.216	66	32
30	Lazo 6	0.207	69.1	23.1
31	Rechnik	0.285	50.1	32.57
32	DEU	0.305	46.8	21.6
	Total (municipal boiler houses of Kilpashevo city)	**0.26**	**54.9**	**26.12**
Municipal Boiler Houses of Togur Village				
1	Centralnaya	0.211	67.8	21.6
2	Sovetskaya	0.21	68	21.6
3	Zavodskaya	0.223	64.1	21.6
4	Sovkhoznaya	0.296	48.2	21.6
5	Shkolnaya	0.289	49.4	21.6
6	Orphan Asylum	0.289	49.4	21.6
7	Chapaeva	0.287	49.8	21.6
	Total Togur Village	**0.263**	**54.2**	**21.6**
	Including Municipal Boiler Houses of Urban municipality	**0.261**	**54.8**	**25.19**
Departmental Boiler Houses of the Kolpashevo City				
1	Kolpashevo DRSU	0.269	53.1	
2	Kemerovo KECh of military base No. 14174 (3 boiler houses)	0.224	63.7	
3	FSUE “Mail of Russia”	0.298	48	
4	JSC «Avtotransportnik»	0.301	47.5	
5	JSC "Metallist"	0.312	45.8	

Seq. No.	Boiler House	Specific Fuel Equivalent Consumption, tons of fuel equivalent /Gcal	Weighted Mean Efficiency, %	Specific Electric Power Consumption kW hr/Gcal
6	CJSC “ZPN“	0.177	80.7	
7	Kolpashevo GORPO	0.29	49.2	
8	IZ No.66/2	0.25	57.1	
9	REB of Fleet	0.179	79.9	
	Total (departmental boiler houses)	**0.242**	**57.8**	
	Total Kolpashevo City	**0.255**	**56**	
	Total Boiler Houses of Kolpashevo Urban municipality	**0.256**	**55.7**	

Extremely low efficiency and, consequently, useful consumption factor of the systems finally results in excessive fuel consumption and high cost of heat power. This problem can be resolved only through technological refurbishment of boiler houses: equipping them with modern boiler equipment and changing the fuel balance towards use of natural gas.

The specific electric power consumption for heat generation by boiler houses exceeds the regulatory value, which, with the cost of electric power being high, significantly raises the cost of heat power generation. One of the reasons for excessive electric power consumption is excessive capacity of the pumping equipment.

There is excessive consumption of make-up water, which is connected with unauthorized withdrawal of heat carrier from heat consumption systems and leakages caused by extensive wear of heat networks.

Reliability. The necessary condition for heat supply systems’ functioning is reliable provision of users with heat power of necessary quality in required quantity and prevention of situations constituting a hazard to people and environment[25]. The data on the number of accidents in municipal heat supply systems of the Kolpashevo urban municipality for the year 2007 are given below (Table 3.9).

Table 3.9 Accident Rate of Municipal Heat Supply Systems of the Kolpashevo Urban municipality for Year 2007[26]

Number of Accidents	2003	2004	2005	2006	2007	2007
Total	**3**	**69**	**9**	**14**	**6**	**67**
In Sources	**0**	**1**	**0**	**6**	**5**	**6**

[25] Saprykin G.S. Reliability of Heat Power Station Equipment. - Saratov: Publishing House of Saratov Polytech. Institute, 1972. -121 pp.

[26] Statistics Bulletin “On Provision of Population with Heat Power” Tomsk: Tomsk Stat. 2003-2008

Number of Accidents	2003	2004	2005	2006	2007	2007
In Networks	**3**	**68**	**9**	**8**	**1**	**61**

SNiP 41-02-2003 “Heat Networks” regulates normative (minimal permissible) indices of faultless operation probability equal to 0.97 for the heat source and to 0.90 for heat networks;

On the whole, the sources are reliable enough because backup of the main equipment creates the necessary level of reliability. Still, availability of backup capacities does not always guarantee good quality of heat supply to all users since absence of heating mains loopback does not allow switching subscribers, when necessary, between heat supply sources. One of the main problems consists in the absence of electric power supply backup, which becomes not only a reason for large economic losses, but also a real hazard to life support stability.

The least reliable element in heat supply systems is pipelines. The length of heat supply networks per 1000 residents of the settlement equals to 6.1km while on average for Russia the specific length equals to 0.8 - 1 km per one thousand of residents. That means that for the Kolpashevo urban municipality, provision with networks 6 times exceeds the mean Russian value. This is explained by the nature and type of building up. Large specific length of networks determines additional costs on their maintenance and also losses and leakages. Deterioration of networks exceeds 53%. For the 2007 heating period, there were 61 accidents in the heating mains, i.e. about 0.5 accidents per 1km of network, which twice exceeds the regulatory figure (0.2-0.3) on average. As a rule, 10% of losses are connected with leakages through flaws and fractures in the pipelines. Losses in networks reach 20%. In order to normalize the situation, annual replacement of at least 4-5% of networks is required rather than 1-1.5%.

Quality. Along with discussion of efficiency and reliability, it is necessary to pay attention to ensuring quality characteristics of heat supply systems’ operation since the main purpose of such systems finally consists in provision of consumers with utility services of required quality.

At present, the majority of heat supplying systems in the Kolpashevo urban municipality function other than in the design mode of operation. Due to the shortage of money to buy the required quantity of fuel, energy suppliers have to decrease the heat supply temperature schedule, which leads to irreparable technological and finally economic damage both to heat consumers and producers.

The boiler houses’ heat supply schedule is based on a quality regulation diagram. The actual and design heat supply schedules in case of quality regulation are given below (Figure 3-8)

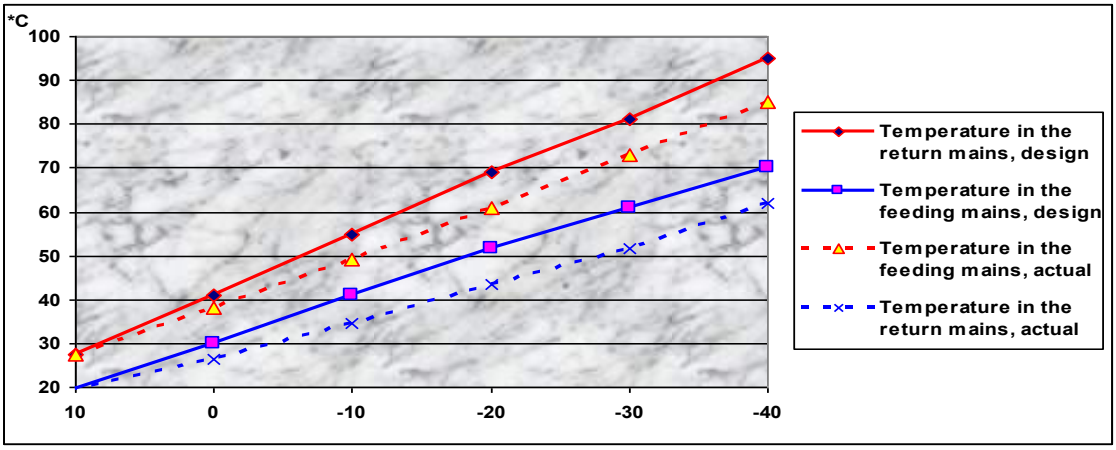


Figure 3-8 Actual (averaged) and design schedule of heat supply by boiler houses of the Kolpashevo urban municipality

The ultimate quality indices of heating services are the room microclimate parameters: indoor air temperature and air change rate. The quality of hot water supply service is determined by water temperature and head.

Heat undersupply adversely affects the microclimate parameters of buildings: decreased indoor temperatures take place, the regulatory air exchange rate in heated premises being 1.2. For the Kolpashevo urban municipality available housing provided with centralized heat supply, the averaged figures of quality parameters for heating and hot water supply services are given below (Table 3.10)

Table 3.10 Quality Parameters of Heat Supply in the Kolpashevo Urban municipality for Year 2007

Index	Design Balance		Actual with Regulatory Losses		Adjusted Actual[27]	
		%		%		%
Primary fuel energy, thou. Gcal	415.2	100	388.7	100	388.7	100
Heat generation, thou. Gcal	230.1	55.4	215.3	55.4	215.3	55.4
Heat supply to network, thou. Gcal	224.77	54	211.59	54.4	211.59	54.4
Useful supply, thou. Gcal	191.18	45.7	190.88	45.6	176.76	42.2
Microclimate parameters: Air t/ air change rate	20/1.2		19/1.2		18/1.2	
Hot water temperature, °C	55		55		51	

[27] Including adjustment for heat losses in networks

So, a conclusion can be drawn that at present the level of services rendered in the centralized heat supply systems in the Kolpashevo urban municipality does not meet the requirements.

Ecological Compatibility. Federal Law "On Environmental Protection"[28] defines the notion of ecological safety as «a condition of safety for vitally important interests of the individual, society, protection of natural environment from hazards arising as a result of man-induced and natural impacts thereon».

In communities of the Kolpashevo urban municipality, the sources of hazardous emissions located in close proximity to residential communities are vehicles and boiler houses. Combustion products of boiler houses contain substances that can adversely affect human health: carbon monoxide, nitrogen oxides, sulfur oxides, solid particles in case of solid and liquid fuel combustion.

In addition to the listed impacts, there are emissions of greenhouse gases (nitrogen oxides, sulfur, carbonic acid), leading to disruption of the ozone layer of Earth.

According to 2006 reports[29], for the Kolpashevo District, hazardous emissions to air amounted to 25.45 thousand tons, which is greater than year 2005 mostly due to replacement of oil fuel with coal.

At present, in the settlement communities, black coal and oil are used in large quantities as fuel, which are far from the ecologically purest fuels. The main consumers of the said resources and, consequently, sources of harmful emissions, are boiler houses.

The 2007 yearly hazardous emissions to air[30] from stationary sources (boiler houses) of the Kolpashevo urban municipality, estimated by the developers of this report following the specified methods, are given below (Table 3.11).

Table 3.11 2007 Yearly Emissions of Hazardous Substances and Greenhouse Gases to Air from Stationary Sources (Boiler Houses) of the Kolpashevo Urban municipality[31]

Municipal Entity	Yearly Hazardous Emissions to Air, ton/year									
	NO_2	NO	SO_x	CO	Coal Ashes	Vanadium Ashes	Soot	Benza-pilene	Total:	CO2
Municipal	549.27	89.26	211.17	1139	766.84	2.11	1492.76	0.0015	4250.41	25068.25
Departmental	265.62	43.16	103.94	569.74	386.71	0.2	756.25	0.0008	2125.64	9784.49
Kolpashovo city	**814.9**	**132.42**	**315.12**	**1708.74**	**1153.55**	**2.31**	**2249.01**	**0.0023**	**6376.05**	**34852.73**
Municipal	164.85	26.79	64.18	350.2	237.16	0.27	463.19	0.0005	1306.64	6490.16

[28] Federal Law dated 10 January 2002 No.7-FZ "On Environmental Protection" (revised 22.08.04, 29.12.04, 9.05.05, 31.12.05.)

[29] Ecological Monitoring. Tomsk Region Environmental Condition in 2006, Tomsk, 2007.

[30] Methods of Determining Emissions of Contaminants to Air During Fuel Combustion in Boilers Having the Performance of At Least 30 Tons of Steam/Hr Or Less than Gcal/Hr. Approved 9.06.1999. RF CC On Environmental Protection. M.:1999

[31] Calculations were made by the authors.

Municipal Entity	Yearly Hazardous Emissions to Air, ton/year									
	NO_2	NO	SO_x	CO	Coal Ashes	Vanadium Ashes	Soot	Benza-pilene	Total:	CO2
Togur village	**164.85**	**26.79**	**64.18**	**350.2**	**237.16**	**0.27**	**463.19**	**0.0005**	**1306.64**	**6490.16**
Total	**979.74**	**159.21**	**379.3**	**2058.94**	**1390.71**	**2.58**	**2712.2**	**0.0028**	**7682.69**	**41342.9**

Emissions of contaminants increase non-manufacturing costs of businesses on payment of environmental fines and also render adverse influence on the health of the population. Thus, a conclusion can be made that it is necessary to reduce hazardous emissions to air from boiler houses by way of changing fuel, or by equipping them with combustion products treatment equipment.

Thermal power engineering stands out among the fields of economic activities by the scale of its negative impact on the environment. Organic fuel combustion is accompanied with emission of greenhouse gases to air. As for fuels, 80% of emission is caused by use of coal and liquid fuel. The possibility of the change is directly related to settlement gas supply and distribution.

3.3.7 Problems of Heat Supply Systems

Analysis of heat supply systems of the Kolpashevo urban municipality has allowed to identify the main problems including:

1) Utilization of expensive oil as boiler furnace fuel;

2) Low-efficient coal combustion leading to greater fuel component in the cost structure and significant contamination of environment;

3) Low reliability of systems due to high level of heating network pipelines' wear and absence of backup for exterior supply of resources to boiler houses;

4) Moral and physical wear, excessive capacity of the main and auxiliary equipment of boiler houses;

5) Absence of cold water supply, automation facilities, meters of resources in the sources;

6) Considerable heat losses in the networks due to extensive length and wear;

7) Inobservance of the heat supply temperature schedule and, consequently, lower quality of heat supply services;

8) Breach of hydraulic mode of heat networks;

9) High cost of heat power production at low-efficient use of fuel & energy resources;

10) Existence of unauthorized water withdrawal from consumers' heating systems.

3.4 Conclusions

1 The Kolpashevo urban municipality (the Kolpashevo city, Togur village, Volkovo village, Sever village) is the largest municipal entity of the Kolpashevo District in terms of the number of population (33.49 thousand people), which is the residence of more than 3/4 of

the population. The demographic situation in the settlement is characterized by decrease of the population resulting from natural and migration diminution. The registered unemployment level remains relatively high and 1.58 times exceeds the mean region index. Average income of the population per capita and the living wage have grown 2.5-fold and 1.5-fold, respectively, for the last 4 years.

2 The Kolpashevo urban municipality economy was basically founded and formed after the war and at present is represented with the following types of activity: production of foodstuffs, woodworking, manufacture of finished metal products, machines and equipment, electric equipment, printing; generation, transmission and distribution of electric power, gas and steam. In the recent years, the growth of the shipped products volume has been achieved thanks to the products of processing businesses, which specific weight in the total volume of industrial products in 2007 amounted to 58.0%. The second significant type of activity is production and distribution of electric power, gas and water; this accounts for 42.0% of the total volume of industrial production.

3 In 2007, growth of investment activity was observed that was related to construction of the district's gas transport system and preparing heat and power engineering facilities to receive gas. For 2007, the volume of investments reached an unprecedented over the last decade value of 499.588 million rubles.

4 Primary energy consumption within the Kolpashevo urban municipality equals to 128.87 thousand tons of fuel equivalent a year. Local production of primary energy is significant and amounts to 51.87 thousand tons of fuel equivalent. The largest fuel and energy consumer is the population (83.8%). The greatest specific weight in the total volume of energy products falls on heat and power engineering businesses operating 39 municipal boiler houses having the aggregate installed capacity of 127.5 Gcal/hr, 32 of which are located in the Kolpashevo city and 7 – in Togur village; they account for 76.6% of the total output. Besides, 11 departmental boiler houses are functioning in the settlement. In the fuel balance structure of municipal boiler houses, the predominant fuel is coal 72.2%, some boiler houses use raw oil as fuel (27.8%). Boiler houses are equipped with boilers of outdated design and homemade boilers.

5 The main user of municipal heat supply systems in the Kolpashevo urban municipality is the population – 69.6% and budget facilities – 20.5 %. 62.9 km of municipal and about 20km of departmental heat networks are operated; more than half of heat pipelines (33.8km – 53.7%) are considerably worn out and 19.6 km (31.2%) are dilapidated and require urgent replacement.

6 The performance of heat supply systems is characterized by low efficiency and reliability: fuel useful consumption factor equals to 45.6 %, for municipal systems – 44.4%, the accident rate in the heat network twice exceeds the regulatory figures. Ecological compatibility and quality of services do not meet the requirements.

7 The main direction for heat supply development is improvement of the fuel balance structure thanks to replacement of coal and oil with natural gas, modernization of boiler houses and heat networks using modern energy-efficient equipment and materials, organization of co-generation of thermal and electric energy.

4 Efficiency assessment of fuel substitution in heat-and-power sector of the Kolpashevo urban municipality

4.1 Main Directions and Stages of Gas Supply and Distribution

Municipal entity “Kolpashevo urban municipality” accommodates almost all industrial businesses, infrastructure and social facilities, administrative institutions and over 70 percent of the population of the district.

With the existent level of transport accessibility of the territory for industrial and social sectors of the Kolpashevo urban municipality, the task of forming an optimal fuel and energy balance is extremely topical to ensure maximal city independence on fuel and energy resources brought from elsewhere.

The problem of district provision with fuel is particularly urgent and manifests in the following aspects:

– The existent transport pattern for fuel delivery to the district requires significant simultaneous allocation of money from the regional budget;

– Low quality and high price of supplied coal;

– Use of expensive oil as furnace fuel.

For the last eight years, coal prices have grown five-fold and oil prices – 14-fold; all this finally results in outrunning growth of tariffs on heat energy (Figure 4-1).

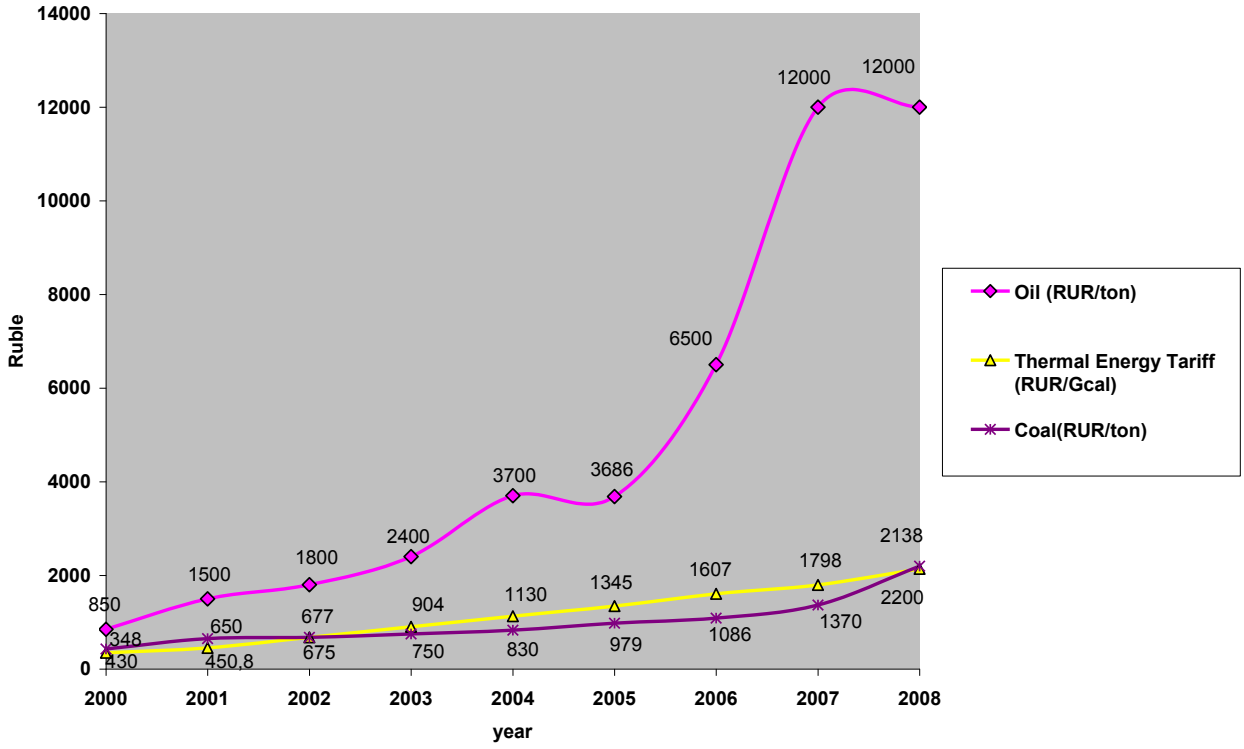


Figure 4-1 Dynamics of Prices on Fuel and Thermal Energy

A way out from the current situation consists in gas supply and distribution that will largely allow resolving the economic and social tasks the district is facing.

To resolve this problem, in 2007 and in the beginning of 2008, the first and second stages of the Kolpashevo urban municipality gas supply and distribution was implemented through construction of branch pipeline “Chazhemto-Kolpashevo”, gas networks within villages and conversion of some boiler houses to gas. A detailed list of gas supply and distribution projects is given below (Table 4.1)

The main scope of work for stages 1 and 2 was completed in March 2008; its completion was commemorated with 14 gas boiler houses being put into operation. Gas supply and distribution of private sector with receipt of gas by users - 1036 private households – is planned at best for the end of 2008.

The general layout plan of modular gas boiler houses is given below (Figure 4-2 and Figure 4-3)

Gas supply and distribution of Kolpashevo City in 2008

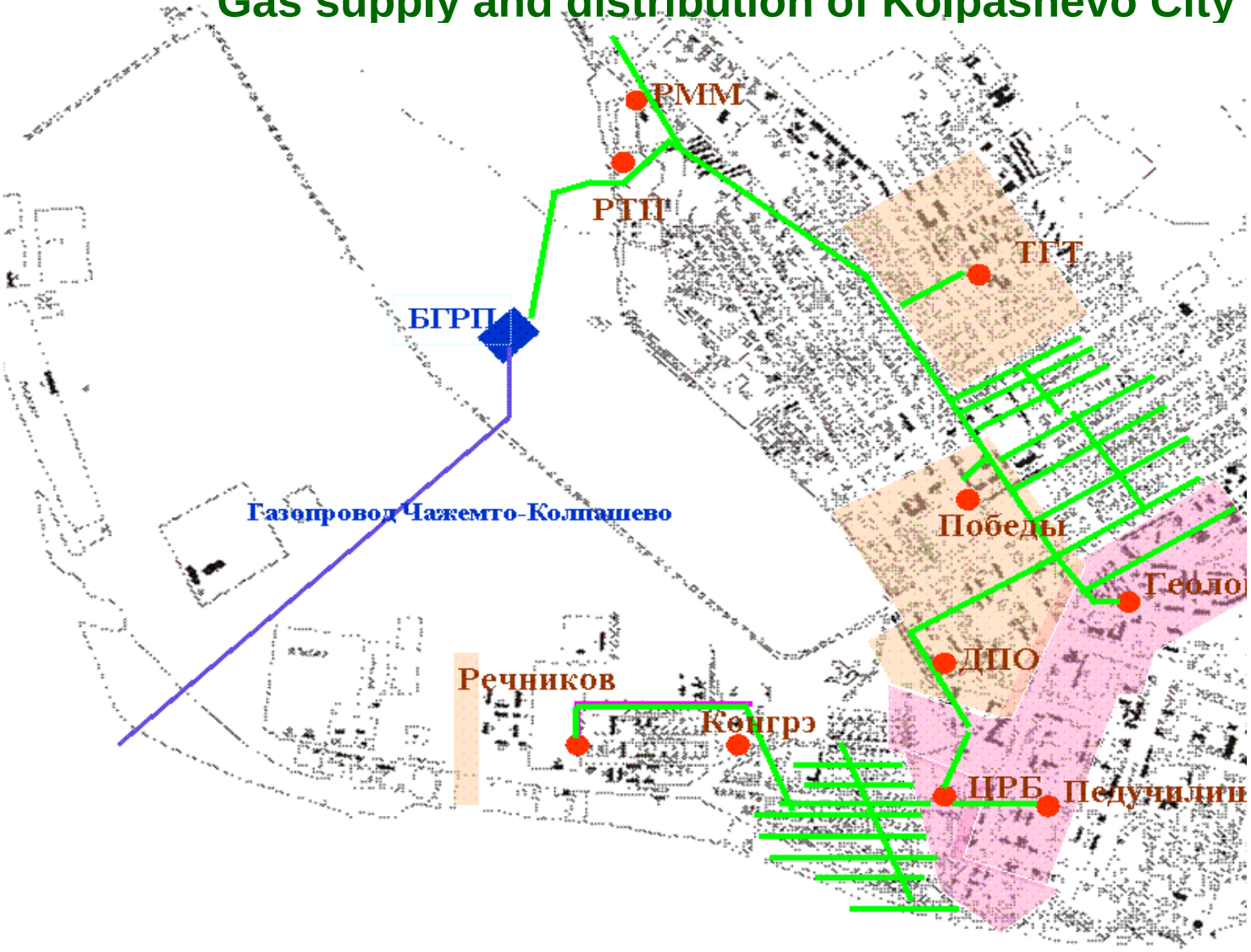


Figure 4-2 General Layout Plan of Gas Modules in the Kolpashevo City

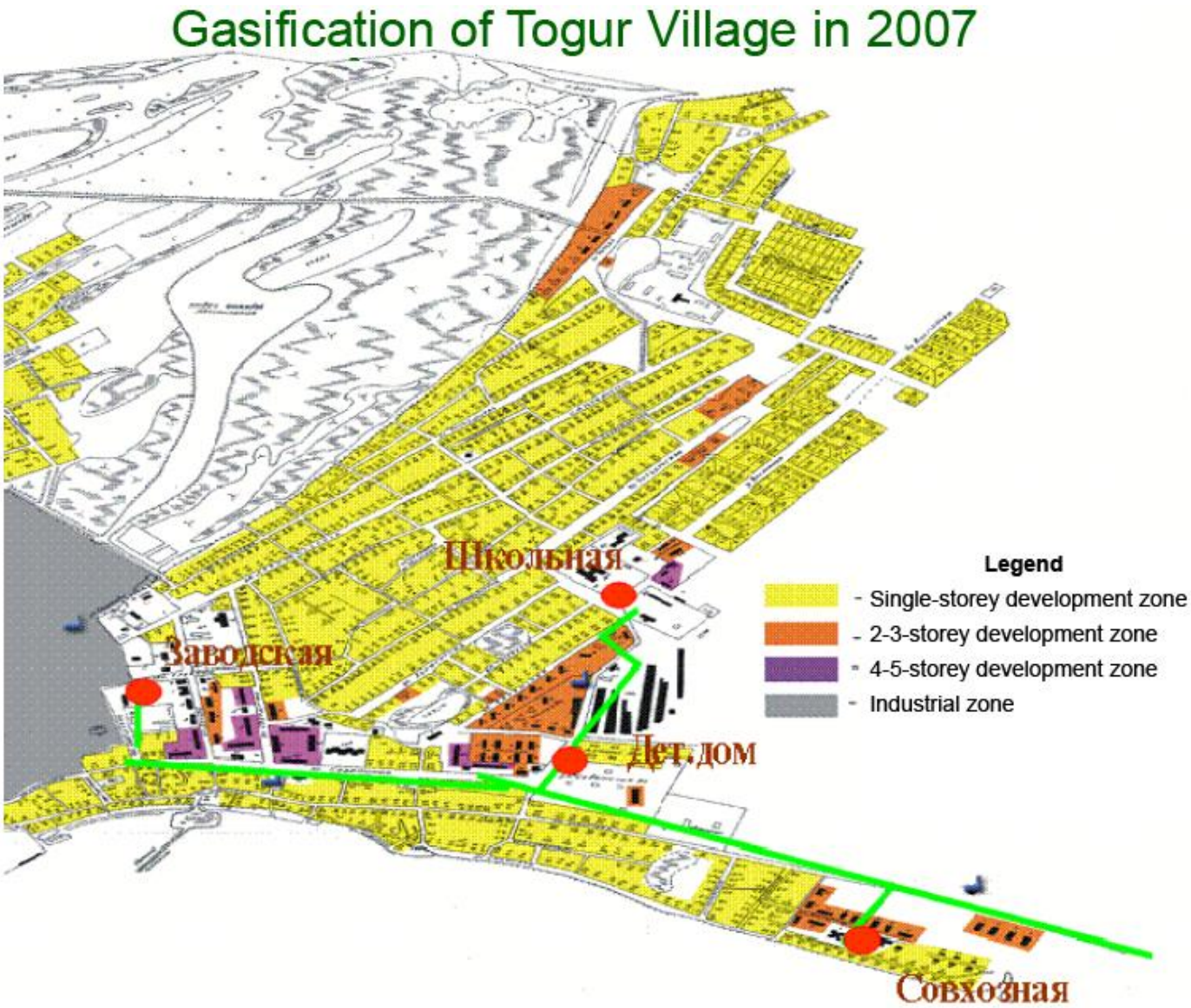


Figure 4-3 General Layout Plan of Gas Modules in Togur Village

4.2 Heat Supply Condition and Technical and Economic Indices After Implementation of the First Stage of Gas supply and distribution

4.2.1 Heat Supply Sources

In 2008, centralized heat supply in the Kolpashevo urban municipality was done from 28 municipal boiler houses having the aggregate installed capacity of 101.3 Gcal/hr. In accordance with the plan of the first stage of gas supply and distribution, in the beginning of 2008, 14 gas boiler houses having the aggregate heat capacity of 70 Gcal/hr were assembled and put into operation, 10 of them in the Kolpashevo city and 4 boiler houses – in Togur village.

A brief description of the equipment of municipal boiler houses is given in Table 4.1

Table 4.1 Characteristics of Municipal Boiler Houses of the Kolpashevo Urban municipality

No.	Boiler House	Boiler Brand	Qu-ty, pcs	Performance Gcal/hr	Fuel	Installed Capacity, Gcal/hr	Installed Capacity Use Factor
1	Boiler House "Geolog"	KVSA-4 KVSA-5	1 2	3.44 4.3	gas	12.04	0.68
2	Boiler House "City Hospital"	KVSA-2 KVSA-3	1 2	1.72 2.58	gas	6.88	0.69
3	Boiler House "DPO"	KVSA-2	2	1.72	gas	3.44	0.63
4	Boiler House "Pedagogical College"	KVSA-2	2	1.72	gas	3.44	0.69
5	Boiler House "Pobeda"	KVSA-2 KVSA-3	1 2	1.72 2.58	gas	6.88	0.49
6	Boiler House "RMM"	KVSA-0,4 KVSA-0,2	1 1	0.344 0.172	gas	0.52	0.48
7	Boiler House "RTP"	KVSA-1	2	0.86	gas	1.72	0.55
8	Boiler House "TGT"	KVSA-2 KVSA-3	1 2	1.72 2.58	gas	6.88	0.74
9	Boiler House "KONGRE"	KVSA-1,5	2	1.29	gas	2.58	0.38
10	Boiler House "Rechnik"	KVSA-2 KVSA-3	1 2	1.72 2.58	gas	6.88	0.54

No.	Boiler House	Boiler Brand	Qu-ty, pcs	Performance Gcal/hr	Fuel	Installed Capacity, Gcal/hr	Installed Capacity Use Factor
11	Boiler House "Urozhai"	NR-18	4	0.4	coal	1.6	0.48
12	Boiler House "Station"	KSV-1.28 NR-18	1 1	0.95 0.4	coal	1.35	0.16
13	Boiler House "Tech. Point"	NR-18	2	0.4	coal	0.8	0.39
14	Boiler House "Medical College"	KSV-0.8	5	0.65	coal	3.25	0.40
15	Boiler House "TV Center"	NR-18	2	0.3	coal	0.6	0.60
16	Boiler House "NGSS"	KSV-1.28	5	0.95	coal	4.75	0.35
17	Boiler House "Phoenix"	NR-18	2	0.4	coal	0.8	0.44
18	Boiler House "Shipyard"	NR-18	2	0.4	coal	0.8	1.23
19	Boiler House "Matrosova"	NR-18	3	0.4	coal	1.2	0.28
20	Boiler House "Chernyshevskogo"	NR-18	1	0.4	coal	1.7	0.36
		KSV-0.8	2	0.65	coal		
21	Boiler House "School No.4"	NR-18	3	0.4	coal	1.2	0.39
22	Boiler House "Novy 1"	KSV-0.8	3	0.65	oil	1.95	1.16
23	Boiler House "Lazo 6"	KSV-1.28	3	0.95	oil	9.39	0.49
		KV-1.68	1	1.68	oil		
		KSV-1.86	1	1.86	oil		
		КЕ-2,5	2	1.5	oil		
24	Boiler House "DEU"	NR-18	1	0.4	coal	1.69	0.34
		E1/9	1	0.64	coal		

No.	Boiler House	Boiler Brand	Qu-ty, pcs	Performance Gcal/hr	Fuel	Installed Capacity, Gcal/hr	Installed Capacity Use Factor
		KSV-0.8	1	0.65	coal		
	Total Kolpashevo City		**70**	**46.08**	**gas/ coal/oil**	**82.34**	**0.57**
	Togur Village						
1	Orphan Asylum	KVSA-3	2	2.58	gas	5.12	0.55
2	Shkolnaya	KVSA-2	1	1.72	gas	3.44	0.60
3	Sovkhoznaya	KVSA-2	1	1.72	gas	3.44	0.59
4	Zavidskaya	KVSA-2 KVSA-3	1 2	1.72 2.58	gas	6.88	0.75
	Total Togur Village		**7**	**10.32**	**gas**	**18.88**	**0.64**
	Total Municipal Boiler Houses of the Kolpashevo Urban municipality		**77**	**56.396**	**gas/coal/ oil**	**101.22**	**0.58**

In addition to municipal sources, 11 departmental boiler houses of industrial businesses continued functioning; 6 of them supplied heat power to the population.

In spite of significant reduction of sources in the course of gas supply and distribution, the share of small boiler houses having the capacity of up to 3 Gcal/hr decreased insignificantly from 59% to 51%. Mean installed capacity use factor for municipal boiler houses grew from 0.5 to 0.58; at that, it equaled to 0.57 for the Kolpashevo city and 0.64 for Togur village on average.

The gas boiler houses having the heat capacity of 0.52 to 12.04 Gcal/hr, which were put into operation, are of modular make. Modules are small-size frame-panel structures 8000×3000×3100mm in size accommodating the main and auxiliary boiler equipment as well as automation facilities.

Each unit of the boiler house accommodates two-three boilers of KVSA type. The specific feature of these boilers' design is its compact three-way structure. The design efficiency is 92% for liquid fuel and 93% for gas. The boilers are fitted with burners from CIBUNIGAS Spa (Italy).

The boiler house was connected to the heat network following two-pressure process via heat exchangers "GEA Ecoflex" (MASHIMPEX, Russia). As line, make-up and circulation pumps, equipment from Grundfos is used. Make-up water treatment is done using the one-stage sodium cation exchange. The automation system starts and stops boiler aggregates, provides two-stage (40 and 100%) regulation of heat generation and protection in case of failure to observe the specified operation mode. Each boiler is connected with gas flue to the common metal chimney located outside the boiler house building. Provision is made for possible increase of heat generation by the boiler house through adding on an extra modular unit of boiler aggregates.

To reduce operation maintenance expenditures, the automated control and management system is applied enabling centralized monitoring over the parameters of functioning of the equipment, assembly units and aggregates of boiler houses without continuous presence of operators. The equipment used is modern hardware and software complex “BARS” manufactured by LLC “Oktan”.

Dispatcher supervisory control is done from the central dispatcher station. The dispatcher station is an operator’s automated working place linked by communication channels with the facilities (heating boiler houses). Such system allows monitoring of the condition of boiler house equipment, heat carrier parameters, fuel consumption, and real-time recording of generated heat, which is necessary to take decisions in order to prevent accidents and abnormal situations and respond fast to equipment failure and breached operating practices.

The composition of equipment in non-gasified boiler houses has not changed except for boiler house ”Lazo”, which is currently under reconstruction.

Transit mains of heat networks were laid above ground. The insulation material used was mineral wool and in some cases – foamed polyurethane.

4.2.2 Fuel Balance of Heat Supply Systems

The forecast values of fuel consumption volumes for the year 2009 are given in below in Table 4.2.

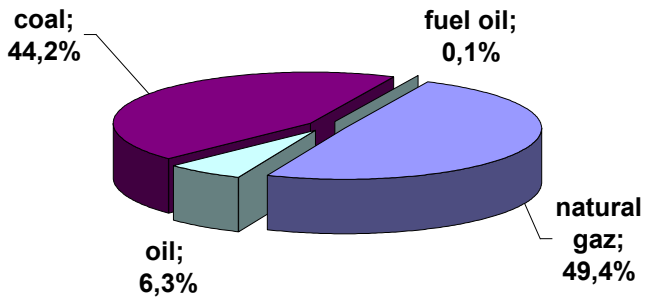
Table 4.2 Forecast Fuel Consumption Level of Boiler Houses in the Kolpashevo Urban municipality in 2009

Seq. No.	Boiler House	Fuel Consumption			
		Coal, ton	Oil, ton	Gas, thou. m^3	Total, ton of fuel equivalent
MUNICIPAL SOURCES					
1	"Geolog"	0.0	0.0	2900.5	3489.3
2	"City Hospital"	0.0	0.0	1679.6	2020.6
3	"DPO"	0.0	0.0	762.6	917.4
4	"Pedagogical College"	0.0	0.0	846.2	1018.0
5	"Pobeda"	0.0	0.0	1198.0	1441.2
6	"RMM"	0.0	0.0	89.2	107.3
7	"RTP"	0.0	0.0	335.7	403.8
8	"TGT"	0.0	0.0	1809.7	2177.1
9	"KONGRE"	0.0	0.0	351.1	422.4
10	"Rechnik"	0.0	0.0	1325.4	1594.5

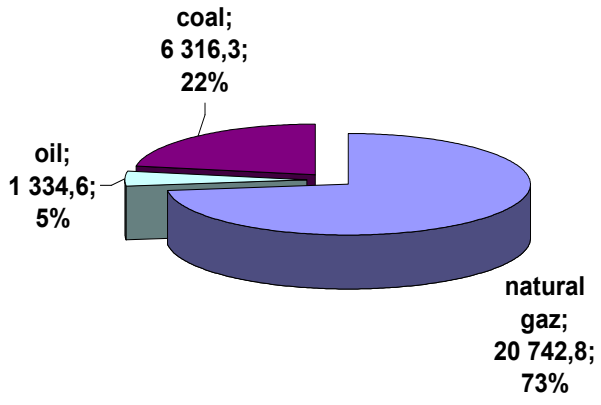
Seq. No.	Boiler House	Fuel Consumption			
		Coal, ton	Oil, ton	Gas, thou. m^3	Total, ton of fuel equivalent
MUNICIPAL SOURCES					
11	"Urozhai"	853.0	0.0	0.0	609.0
12	"Station "	235.1	0.0	0.0	167.9
13	"Tech. Point"	343.0	0.0	0.0	244.9
14	"Medical College"	1443.4	0.0	0.0	1030.6
15	"TV Center"	392.4	0.0	0.0	280.1
16	"NGSS"	1814.7	0.0	0.0	1295.7
17	"Phoenix"	429.9	0.0	0.0	307.0
18	"Shipyard"	1073.4	0.0	0.0	766.4
19	"Matrosova"	385.6	0.0	0.0	275.3
20	"Chernyshevskogo"	674.8	0.0	0.0	481.8
21	"School No.4"	536.9	0.0	0.0	383.3
22	"Novy 1"	0.0	983.5	0.0	1334.6
23	"Lazo 6"	0.0	0.0	1637.6	1970.0
24	"DEU"	664.0	0.0	0.0	474.1
	Total Municipal in the Kolpashevo City	**8846.3**	**983.5**	**12935.6**	**23212.4**
1	"Orphan Asylum"	0.0	0.0	1016.3	1222.6
2	"Shkolnaya"	0.0	0.0	733.9	882.9
3	"Sovkhoznaya"	0.0	0.0	720.1	866.3
4	"Zavodskaya"	0.0	0.0	1836.6	2209.4
	Total Togur Village	**0.0**	**0.0**	**4306.9**	**5181.2**
	TOTAL Municipal Boiler Houses of the Kolpashevo Urban municipality	**8846.3**	**983.5**	**17242.5**	**28393.6**
DEPARTMENTAL BOILER HOUSES					

Seq. No.	Boiler House	Fuel Consumption			
		Coal, ton	Oil, ton	Gas, thou. m^3	Total, ton of fuel equivalent
MUNICIPAL SOURCES					
1	Kolpashevo DRSU	938.6	0.0	0.0	670.2
2	Kemerovo KECh	9126.0	0.0	0.0	6516.0
3	FGUP “Mail of Russia’	1275.1	0.0	0.0	910.4
4	Avtotransportnik	1873.8	0.0	0.0	1337.9
5	JSC "Metallist"	1702.1	0.0	0.0	1215.3
6	CJSC “ZPN“	0.0	150.0	0.0	203.6
7	Kolpashevo GORPO	449.9	0.0	0.0	321.2
8	IZ No.66/2	1797.0	0.0	0.0	1283.1
9	REB of Fleet	0.0	809.0	0.0	1097.8
	Total Departmental	**17162.4**	**959.0**	**0.0**	**13555.4**
	Total Boiler Houses of the Kolpashevo Urban municipality	**26008.7**	**1942.5**	**17242.5**	**41949.0**

The structure of fuel consumption by boiler houses is given in the Figure 4-4



Boiler Houses of the Kolpashevo Urban municipality



Municipal Boiler Houses of the Kolpashevo Urban municipality

Figure 4-4 Structure of fuel consumption by boiler houses in 2009

In the fuel balance structure of the urban municipality boiler houses, gas is becoming the predominant fuel (49.4%). For municipal boiler houses, the share of gas is higher and equals to

(73.1%). Some boiler houses of the settlement continue using raw oil (6.3%) and coal (44.2%) as fuel. For municipal boiler houses, the share of oil and coal is lower and equals to 4.7% and 22.2%, respectively.

Use of oil as well as considerable volumes of coal use by boiler houses of industrial businesses still remains a negative factor.

4.2.3 Heat Balance of Heat Supply Systems

In total, in 2009 municipal boiler houses of the urban municipality will produce 161,168.2 thousand Gcal of heat power. The thermal balance structure of heat supply systems is given in below (Table 4.3)

Table 4.3 Heat Balance of the Kolpashevo Settlement Municipal Boiler Houses

Seq. No.	Boiler House	Generation, Gcal/Year	CH, Gcal/Year	Losses in heat Networks		Useful Supply, Gcal/Year
				Gcal/Year	%	
1	"Geolog"	22471	539.31	2 467.33	11.25	19465
2	"City Hospital"	13012	312.29	2 569.15	20.23	10131
3	"DPO"	5907.7	141.78	743.8	12.9	5022.1
4	"Pedagogical College"	6555.6	157.33	1 669.94	26.1	4728.3
5	"Pobeda"	9281.1	222.75	1 105.11	12.2	7953.2
6	"RMM"	691.4	16.59	246.96	36.6	427.8
7	"RTP"	2600.5	62.41	644.68	25.4	1893.4
8	"TGT"	14020	336.48	2 134.64	15.6	11549
9	"KONGRE"	2719.9	65.28	598.88	22.56	2055.7
10	"Rechnik"	10268	246.43	2 260.89	22.56	7760.8
11	"Urozhai"	2129.5	42.6	383.9	18.52	1703
12	"Station "	587	11.7	176.3	29.44	399
13	"Tech. Point"	856.3	17.1	115.2	13.19	724
14	"Medical College"	3603.4	72.1	1 034.30	28.14	2497
15	"TV Center"	976	19.5	293.6	29.49	663
16	"NGSS"	4483.4	89.7	1 161.70	25.4	3232
17	"Phoenix"	968.4	19.4	259.6	26.18	689.4
18	"Shipyard"	2670.4	53.4	481.5	17.61	2135.5
19	"Matrosova"	891.1	17.8	251.9	28.65	621.4
20	"Chernyshevskogo"	1673.1	33.5	905.5	52.85	734.1

Seq. No.	Boiler House	Generation, Gcal/Year	CH, Gcal/Year	Losses in heat Networks		Useful Supply, Gcal/Year
				Gcal/Year	%	
21	"School No.4"	1290.6	25.8	114.3	8.65	1150.5
22	"Novy 1"	6178.8	123.6	713.7	11.5	5341.5
23	"Lazo 6"	12548	251	2 232.00	17.7	10065
24	"DEU"	1554.5	31.1	190.49	11.97	1332.9
	Total Municipal Boiler Houses of the Kolpashevo City	**127938**	**2909**	**22755.4**	**17.7**	**102273**
1	"Orphan Asylum"	7841.5	189	976	12.7	6708.7
2	"Shkolnaya"	5662.4	136.5	1109.8	20	4303.1
3	"Sovkhoznaya"	5556.1	133.9	1290.5	23.7	4154.6
4	"Zavodskaya"	14171	341.5	3069.1	22.1	10818
	Total Togur Village	**33231**	**800.8**	6445.3	19.3	**25984**
	TOTAL Municipal Boiler Houses of the Kolpashevo Urban municipality	**161168**	**3709.8**	**29200.7**	**18.1**	**128258**

Enlargement of systems through merge of boiler houses and liquidation of low-efficiency units will lead to reduction of useful heat supply by 10% and corresponding decrease of generation. At that, the portion of heat losses will rise by 4%. The structure of heat consumption will remain unchanged.

The main users in the centralized heat supply systems of the Kolpashevo urban municipality will remain the population - 69.6%, and budget sector – 20.5 %; at that, 96.6% of heat will be provisionally used for heating needs.

4.2.4 Heat Supply Technical & Economic Indices

Energy Efficiency. Gas supply and distribution of some boilers together with equipping them with modern boiler equipment will allow largely increasing the energy efficiency of boiler houses.

The forecasted indices of the Kolpashevo settlement heat supply systems' energy efficiency for year 2009 are given below (Table 4.4).

Table 4.4 Energy Efficiency of Heat Supply Systems

Seq. No.	Boiler House	Specific Consumption Of Fuel Equivalent, tons of fuel equivalent /Gcal	Weighted Mean Efficiency, %	Specific Electric Power Consumption kW hr/Gcal	Useful Consumption Factor of the System, %
Municipal Boiler Houses of the Kolpashevo City					
1	"Geolog"	0.155	92	18	79.7
2	"City Hospital"	0.155	92	18	71.6
3	"DPO"	0.155	92	18	78.2
4	"Pedagogical College"	0.155	92	18	66.4
5	"Pobeda"	0.155	92	18	78.8
6	"RMM"	0.155	92	18	57
7	"RTP"	0.155	92	18	67
8	"TGT"	0.155	92	18	75.8
9	"KONGRE"	0.155	92	18	69.5
10	"Rechnik"	0.155	92	18	69.5
11	"Urozhai"	0.286	50	21.2	39.9
12	"Station "	0.286	50	71.8	34
13	"Tech. Point"	0.286	50	21.9	42.2
14	"Medical College"	0.286	50	30.1	34.6
15	"TV Center"	0.287	49.8	46.2	33.8
16	"NGSS"	0.289	49.4	63.3	35.6
17	"Phoenix"	0.317	45.1	32.2	32.1
18	"Shipyard"	0.287	49.8	21.2	39.8
19	"Matrosova"	0.309	46.2	17.7	32.2
20	"Chernyshevskogo"	0.288	49.6	21.3	21.8
21	"School No.4"	0.297	48.1	31.9	42.9
22	"Novy 1"	0.216	66.1	18.4	57.2

23	"Lazo 6"	0.157	91	20	73
24	"DEU"	0.305	46.8	32.3	40.2
	Total Municipal Boiler Houses of the Kolpashevo City	**0.181**	**78.7**	**21**	**62.9**
Municipal Boiler Houses of Togur Village					
1	"Orphan Asylum"	0.155	92	18	78.4
2	"Shkolnaya"	0.155	92	18	71.8
3	"Sovkhoznaya"	0.155	92	18	68.5
4	"Zavodskaya"	0.155	92	18	69.9
	Total Togur Village	**0.155**	**92**	**18.1**	**72**
	Including Municipal Boiler Houses of Urban municipality	**0.176**	**81.1**	**20.4**	**64.6**
Departmental Boiler Houses of the Kolpashevo City					
1	Kolpashevo DRSU	0.271	52.7		42.4
2	Kemerovo KECh, military base No. 14174 (3 boiler houses)	0.225	63.5		54
3	FSUE “Mail of Russia”	0.299	47.8		38.4
4	JSC “Avtotransportnik“	0.302	47.3		42.1
5	JSC "Metallist"	0.314	45.5		40
6	CJSC “ZPN“	0.177	80.7		77.1
7	Kolpashevo GORPO	0.292	48.9		47.9
8	IZ No.66/2	0.251	56.9		51.2
9	REB of Fleet	0.179	79.8		62.7
	Total (departmental boiler houses)	**0.242**	**59**		**50.6**
	Total Kolpashevo City	**0.2**	**71.6**		**58.4**
	Total Kolpashevo Urban municipality	**0.193**	**74.1**		**60.1**

Specific fuel consumption by gas and coal boiler houses will equal to 0.155 and 0.261 tons of fuel equivalent/Gcal, which corresponds to weighted mean efficiency of 91 and 54.7%. For departmental sources, efficiency will amount to 59.0%. For the settlement in general, specific fuel consumption will decrease from 0.256 down to 0.193 tons of fuel equivalent/Gcal.

Sources modernization using modern pumping equipment and bringing its capacity in correspondence with duty will allow decreasing specific electric power use to 20.4 kW hr/Gcal.

Fuel useful consumption factor, which value equaled in 2007 to 45.6% for the Kolpashevo urban municipality and to 44.5% for municipal systems, will rise to 60.1% and 64.6%, respectively.

Reliability. The least reliable element of heat supply systems is pipelines. Compared to 2007, the planned scope of re-laying will remain unchanged and won't significantly influence reliability improvement.

Quality. Automation of heat supply process regulation will allow maintaining the design temperature schedule, which, of course, will result in improved heat supply quality. At the same time, a number of users will experience breach of the temperature conditions due to hydraulic disadjustment of heat networks because networks conversion during boiler houses enlargement was carried out without hydraulic calculations and adjustment.

Ecological Compatibility. The forecasted emissions of hazardous contaminants and greenhouse gases to air[32] from stationary sources (boiler houses) of the Kolpashevo urban municipality for year 2009 calculated within the frames of this work are given below (Table 4.5)

Table 4.5 Forecasted Emissions of Hazardous Contaminants and Greenhouse Gases to Air from Stationary Sources

Municipal Entity	Yearly Hazardous Emissions to Air, ton/year							
	NO_2	NO	SO_x	CO	Coal Ashes	Vanadium Ashes	Soot	Benzapilene
Municipal	154.42	25.09	55.1	346.32	203.66	0.23	397.79	0.00041
Industrial	270.91	44.02	105.97	580.68	394.07	0.22	770.59	0.00079
The Kolpashevo City	**425.33**	**69.12**	**161.08**	**927**	**597.74**	**0.45**	**1168.38**	**0.00119**
Municipal	4.3	0.7	0	15.18	0	0	0	0
Togur Village	**4.3**	**0.7**	**0**	**15.18**	**0**	**0**	**0**	**0**
Total	**429.63**	**69.81**	**161.08**	**942.18**	**597.74**	**0.45**	**1168.38**	**0.00119**

Decrease of the number of coal heat sources, construction of new gas boiler houses will allow decreasing the yearly hazardous emissions to air twice from 7682.7 to 3369.2 tons. Emission of greenhouse gases will decrease from 41343 to 24918 tons/year, i.e. 1.7-fold.

[32] Methods of determining emissions of contaminants to air during fuel combustion in boilers with capacity of less than 30 tons of steam/hr or less than Gcal/hr. Approved 9.06.1999. RF CC on Environmental Protection. M.:1999.

4.3 Fuel and Energy Balance

Implementation of the first stage of gas supply and distribution will change the Kolpashevo urban municipality's energy balance structure (Table 4.6).

Table 4.6 Energy Balance of the Kolpashevo Urban municipality (2009 Forecast)

	Firewood, thou. logs. cub. m	Coal, thou. ton	Electric Power, mln.kW-hr	LNG, thou. ton	Natural Gas, mln. m3	Oil, thou. ton	Black Oil, thou. ton	Heat, thou. Gcal	Total, thou. Ton fuel equivalent
Primary Energy	167.09	37.35	55.71	1.06	20.7	1.94	0.03	0	106.24
Own Generation	167.09	0	0	0	0	0	0	0	43.44
Coming-in	0	37.35	55.71	1.06	20.7	1.94	0.03	0	62.8
Heat and Power Engineering	0	-26.01	-4.76	0	-17.24	-1.94	0	176.38	-17.36
Municipal boiler houses	0	-8.85	-3.29	0	-17.24	-0.98	0	161.17	-5.79
Industrial boiler houses	0	-17.16	-1.46	0	0	-0.96	0	56.27	-5.71
Own needs	0	0	0	0	0	0	0	-4.84	-0.69
Losses	0	0	0	0	0	0	0	-36.22	-5.18
End Use	167.09	11.34	50.96	1.06	3.46	0	0.03	176.38	88.88
Population	167.09	11.34	27.25	0.2	3.46	0	0	103.72	74.2
Communal Social Sector	0	0	18.38	0	0	0	0	26.32	6.02
Industrial and other users	0	0	5.33	0.86	0	0	0.03	46.35	8.65

Primary energy consumption within the Kolpashevo urban municipality will amount to 106.24 tons of fuel equivalent decreasing by 22.47 thousand ton of fuel equivalent. Local generation of primary energy thanks to replaced in private sector of firewood with natural gas will equal to 43.44 thousand tons of fuel equivalent decreasing by 16%. Receipt of primary energy resources brought from elsewhere will equal to 62.8 thousand ton of fuel equivalent – 59% of the total primary energy consumption. Partial replacement of coal and oil with natural gas will take place. Fuel consumption in heat and power engineering sector will amount to 28.39 thousand ton of coal equivalent, or 61%

versus 2007 index. End use will reach the level of 88.88 thousand ton of fuel equivalent, i.e. will decrease by 6.6%.

The structure of end use by types of energy resources and use fields will change (Figure 4-5, Figure 4-6)

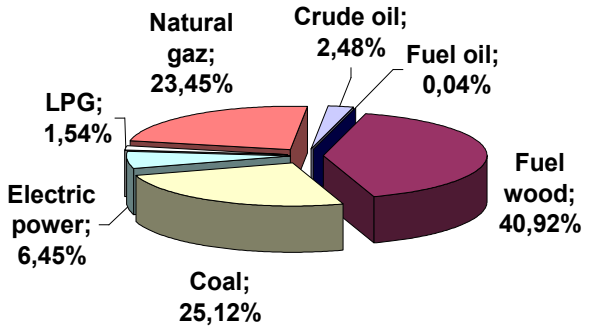


Figure 4-5 Structure of Primary Energy Consumption in the Kolpashevo Urban municipality

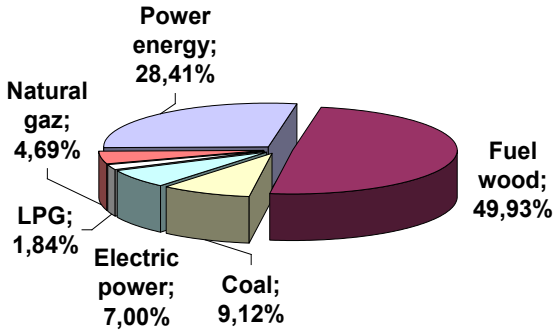


Figure 4-6 Structure of End Use in the Kolpashevo Urban municipality

4.4 Assessment of Inter-Fuel Substitution Efficiency in Heat and Power Sector after the First Stage of Gas supply and distribution

Implementation of the first stage (steps 1,2) of the Kolpashevo Urban municipality Gas supply and distribution Project has resulted in significant modification of fuel balance structure in the heat and power engineering sector (Table 4.7; Table 4.8).

In 2009, the share of natural gas will grow to 49.3% thanks to reduced consumption of coal and oil by 59.1 and 81.3%, respectively. Conversion of boiler houses to gas using modern heat and power engineering equipment will enable total fuel reduction by 29.7% (17764.8 ton of fuel equivalent) and electric power consumption decrease by 36.3% (2686 thousand kW hr).

Introduction of heat generation technology processes' automation and dispatching will lead to reduction of the number of personnel by 54.1% (273 persons). Optimization of heat supply patterns thanks to liquidation of low-efficient units will result in decrease of useful heat supply and corresponding reduction of heat losses in networks.

Modernization of heat sources will allow raising efficiency to 73.9%. Optimization of heat supply patterns will result in reduction of heat losses in the networks. All this will finally improve performance of heat supply systems (useful consumption factor of 59.9%).

The volume of hazardous emissions to air will reduce 2.4-fold.

Cash saving in 2007 prices will amount to 7.7 mln. USD.

In the municipal heat supply sector, coal and oil consumption will decrease by 81.2 and 89.7%, respectively, the overall fuel consumption being reduced by 39.1% (18217.2 tons of fuel equivalent.), that of electric power – by 44.9% (2686.4 thousand kW hr). The share of natural gas will grow to 73%.

Table 4.7 Indices of Inter-Fuel Substitution Efficiency in the Heat and Power Engineering Sector of the Kolpashevo Urban municipality

	Fuel Consumption, tons of fuel equivalent				Electric Power thou. kW-hr	Number of Personnel, persons	Useful Consumption Factor, %	Hazardous Emissions	Cash Saving
	coal	oil	gas	total:					Total:, thou. RUR
2007	45692.4	14126.4	0	59818.8	7398.7	505	45.6	8152.3	
2009	18668.9	2642.3	20742.8	42054	4712.3	232	59.9	3386.7	
Saving, In Kind.:	**27023.5**	**11484.1**	**-20742.8**	**17764.8**	**2686.4**	**273**	**-14.3**	**4765.6**	
%	59.1	81.3	-100	29.7	36.3	54.1	-31.3	58.5	
Saving, mln. USD	3.3	4.1	-1.9	5.5	0.3	1.8			7.7

Table 4.8 Indices of Inter-Fuel Substitution Efficiency in Municipal Heat Supply Systems of the Kolpashevo Urban municipality

	Fuel Consumption, tons of fuel equivalent				Electric Power thou. kW-hr	Number of Personnel, persons	Useful Consumption Factor, %	Hazardous Emissions	Cash Saving
	coal	oil	gas	total:					Total:, thou. RUR
2007	33665.1	12945.8	0	46610.9	5978.7	440.8	44.4	5557.05	
2009	6316.3	1334.6	20742.8	28393.7	3292.3	167.8	64.5	1202.8	
Saving, In Kind.:	**27348.8**	**11611.2**	**-20742.8**	**18217.2**	**2686.4**	**273**	**-20.1**	**4354.3**	
%	81.2	89.7	-100	39.1	44.9	61.9	-45.2	78.4	
Saving, mln. USD	3.4	4.1	-1.9	5.6	1.8				7.7

4.5 Forecasted Inter-Fuel Substitution Efficiency in the Heat and Power Engineering Sector after the Second Stage of Gas supply and distribution

4.5.1 Characteristics of the Second Stage of Gas supply and distribution

As a result of implementation of the second stage of gas supply and distribution, centralized heat supply of the Kolpashevo city and Togur village should be provided from 35 gas boiler houses; additionally 6500 households should become gas users. To this end, it is necessary to build 166.7 km of distributing gas networks, gasify 7 boiler houses and 5095 private houses. Industrial businesses will presumably actively join this process and will timely prepare their own heat sources to receive gas. The list of projects of the second stage of gas supply and distribution is given below.

4.5.2 Forecasted Energy Balance of the Kolpashevo Urban municipality

Complete fulfillment of planned gas supply and distribution measures will drastically change the energy balance structure of the Kolpashevo urban municipality (Table 4.9).

Table 4.9 Forecasted Energy Balance of the Kolpashevo Urban municipality

	Firewood, thou. Log cub. m	Coal, thou. ton	Electric Power, mln. kW-hr	LNG, thou. ton	Natural Gas, mln. m3	Oil, thou. ton	Black Oil, thou. ton	Heat, thou. Gcal	Total, thou. Ton of fuel equivalent
Primary Energy	13.91	0	52.61	0	47.45	0	0.03	0	67.26
Produced Locally	13.91	0	0	0	0	0	0	0	3.62
In-coming	0	0	52.61	0	47.45	0	0.03	0	63.64
Heat & Power Engineering	0	0	-4.09	0	-26.02	0	0	162.6	-8.58
Municipal boiler houses	0	0	-2.97	0	-18.76	0	0	145.2	-2.19
Industrial boiler houses	0	0	-1.13	0	-7.26	0	0	56.27	-0.84
Own needs	0	0	0	0	0	0	0	-4.77	-0.68
Losses	0	0	0	0	0	0	0	-34.11	-4.88
End Use	13.91	0	48.52	0	21.43	0	0.03	162.6	58.67
Population	13.91	0	24.23	0	20.03	0	0	95.56	44.37
Communal Social Sector	0	0	18.05	0	0.12	0	0	24.67	5.89
Industrial and other users	0	0	6.24	0	1.28	0	0.03	42.37	8.41

Primary energy consumption within the Kolpashevo urban municipality will equal to 67.26 thousand ton of fuel equivalent and will decrease 1.9 times by 61.61 thousand tons of fuel equivalent per year. Local production of primary energy thanks to replacement in private sector of firewood with natural gas will amount to 3.62 thousand tons of fuel equivalent and will decrease 14-fold. The received from elsewhere primary energy sources will amount to 63.64 thousand ton of fuel equivalent – 95% of the total consumed primary energy. Coal and oil will be completely replaced with natural gas. Consumption of fossil fuels in the heat and power engineering sector will amount to coal equivalent of 31.4 thousand ton or 46% versus 2007 index. End use will reach the level of 58.67 thousand ton of fuel equivalent decreasing 1.6 times.

The end use structure by types of energy resources and use fields will change as shown in

Figure **4-7** and Figure 4-8

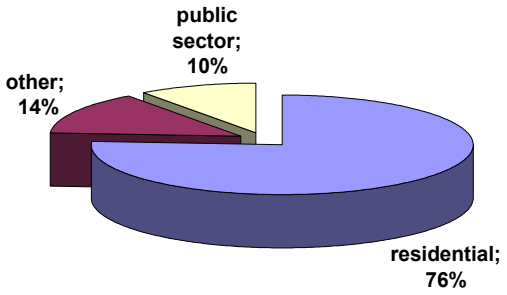


Figure 4-7 End Use Structure by Use Field

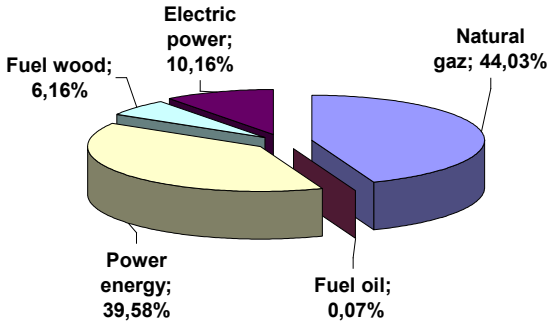


Figure 4-8 End Use Structure by Types of Energy Resources

Among energy resources, natural gas (44.03%) and heat power (39.58%) will prevail while the shares of electric power and firewood consumption will be approximately similar and equal to 10.16 and 6.16%, respectively.

Population will remain the largest energy user (76%), followed by industrial users (14 %) and non-productive sphere (10%).

4.5.3 Assessment of Fuel Substitution Efficiency after the Second Stage of Gas supply and distribution

Complete fulfillment of planned gas supply and distribution measures will result in future in drastic change of fuel balance structure in the heat and power engineering sector of the Kolpashevo urban municipality (Table 4.10).

Natural gas becomes the predominant fuel and will displace earlier used coal and oil. Conversion of boiler houses to gas using modern heat and power engineering equipment will enable total fuel consumption reduction by **47.5%** (28416 tons of fuel equivalent) and electric power consumption decrease by **44.6%** (3300.4 thousand kW hr).

Introduction of heat generation technology processes' automation and dispatching will result in reduction of personnel by 55.8% (282 persons). Optimization of heat supply patterns through

liquidation of low-efficient units will result in decrease of useful heat supply and respective reduction of heat losses in networks.

Modernization of heat sources will allow raising efficiency to 91.7%. Optimization of heat supply patterns will result in reduction of heat losses in networks. All this will finally improve heat supply systems performance (useful consumption factor of 74.1%).

The volume of **hazardous** emissions to air will fall down 63 times. Cash saving in 2007 prices will amount to 246.96 million rubles.

In the municipal heat supply sector, the results will be even more impressive (Table 4.11).

Table 4.10 Indices of Fuel Substitution Efficiency in Heat and Power Sector of the Kolpashevo Urban municipality

	Fuel Consumption, ton of fuel equivalent				Electric Power thou. KW-hr	Number of Personnel persons	Efficiency, %	Useful Consumption Factor, %	Hazardous Emissions	Cash Saving Total:, thou. RUR
	coal	oil	gas	total:						
2007	45692.4	14126.4	0	59818.8	7398.7	505	55.7	45.6	8152.3	
Year of Implementation	0	0	31402.7	31402.7	4098.3	223	91.7	74.1	3386.7	
Saving, In Kind:	**45692.4**	**14126.4**	**-31402.7**	**28416.1**	**3300.4**	**282**	**-35.9**	**-28.5**	**4765.6**	
%	100	100	-100	47.5	44.6	55.8	-64.4	-62.5	58.5	
Saving, mln. USD	5,6	5,0	-2,9	7,8	0,4	1,9				9,9

Table 4.11 Indices of Fuel Substitution Efficiency in Municipal Heat Supply Systems of the Kolpashevo Urban municipality

	Fuel Consumption, ton of fuel equivalent				Electric Power thou. KW-hr	Number of Personnel persons	Efficiency, %	Useful Consumption Factor, %	Hazardous Emissions	Cash Saving Total:, thou. RUR
	coal	oil	gas	total:						
2007	33665.1	12945.8	0	46610.9	5978.7	440.8	54.8	44.4	5557.05	
Year of Implementation	0	0	22568.5	22568.5	2975.3	158.8	91.9	72.7	87.92	
Saving, In Kind:	**33665.1**	**12945.8**	**-22568.5**	**24042.4**	**3003.4**	**282**	**-37.1**	**-28.3**	**5469.1**	
%	100	100	-100	51.6	50.2	64	-67.7	-63.6	98.4	
Saving, mln. USD	5,6	5,0	-2,9	7,8	0,4	1,9				9,9

4.6 Conclusions

1 For the Kolpashevo urban municipality, the task of forming optimal fuel and energy balance in order to ensure maximal independence of the city on fuel and energy resources brought from elsewhere is extremely important. To resolve it, the first stage (steps 1 and 2) of the Kolpashevo urban municipality gas supply and distribution program was implemented through construction of branch gas pipeline “Chazhemto-Kolpashevo”, gas networks within villages, and conversion of some boiler houses to gas.

2 In 2008, centralized heat supply in the Kolpashevo urban municipality was carried out from 28 municipal boiler houses having the aggregate installed capacity of 101.2 Gcal/hr. In accordance with the plan of the first stage of gas supply and distribution, in the beginning of 2008, 14 gas boiler houses having the aggregate heat capacity of 70 Gcal/hr were assembled and commissioned; of them, 10 boiler houses – in the Kolpashevo city and 4 boiler houses – in Togur village. 11 boiler houses of industrial businesses continued functioning.

3 Modular boiler houses are equipped with shell boilers KVSA (made by LLC “Oktan”) with CIBUNIGAS Spa burners, water treatment system, Grundfos pumping equipment. The dispatching system enables centralized monitoring over the operation parameters of equipment, assembly units and aggregates of boiler houses without permanent presence of operators.

4 Gas supply and distribution of boiler houses has significantly improved their energy efficiency. For the settlement in general, the specific fuel consumption decreased from 0.256 to 0.176 ton of fuel equivalent/Gcal. Useful fuel consumption factor, which figure for the Kolpashevo urban municipality in 2007 equaled to 45.6% and for municipal systems to 44.4% on average, will grow to 60.1 and 64.5%, respectively. This will allow reducing fuel consumption by 29.7% (17764.8 tons of fuel equivalent), that of electric power - by 36.3% (2686.4 thousand kW-hr).

5 Organization of heat and power co-generation

5.1 Co-Generation of Heat and Electric Power

At present, co-generation of heat and electric power in Russia is carried out mostly in steam-turbine heat power plants (HPP), which produce only 36% of heat power, the remainder being generated in boiler houses.

The necessity of revising the ratio of centralized and distributed energy sources is becoming obvious. At that, the task of local electric power generation at housing and communal facilities seems becoming more and more topical, which is related to high monopolistic tariffs on electric power and the energy security problem of communal heat and power engineering facilities.

Recently, a new direction is developing in organization of power supply based on mini-HPP that can be equipped with steam turbines (condensing, counter-pressure), gas turbines, or gas-diesel installations.

In settlements gas supply and distribution, it is expedient to use mini-HPP with gas-turbine or gas-diesel power plants.

Gas turbines are widely used in electric power generation. The possibility of producing more power with smaller dimensions and weight, high reliability and cost-efficiency of gas-turbine installations allow their wide use in industrial and communal power engineering. The advantages of this technology including long service life, small investments in a wide range of powers, high percentage of useful energy of effluent gases and insignificant emission of carbon dioxide. Electric efficiency of the installations amounts to 35-38%.

Modernization of boiler houses on the basis of gas-turbine plants (GTP) can be done in two ways:

1 Installation of separate GTP modules with gas heaters for delivery water;

2 Adding on to the existent water-heating or steam boilers with gas-turbine plants.

When the existent boilers are equipped with a gas-turbine plant (GTP), it becomes necessary to arrange backup fuel storage, gas-compression booster stations, replace boilers, reconstruct chimneys.

All this limits GTP application in the existent urban development conditions. For small-capacity boilers, steam-gas superstructures based on gas turbines become rather problematic due to small consumption volumes of working media.

A mini-HPP based on internal combustion engine consists of a monoblock of engine-generator with WHR heat exchangers. Economically feasible heat recovery systems allow using 1 Gcal of heat per 1 MW-hr of generated electric power (75% of emitted heat). Gas-piston engine uses only 6% of diesel (ignition) fuel that is also used as backup.

Within the capacity range between 10 kW and 4 MW, piston drives have substantial advantages compared to gas-turbine installations. Such plants have lower fuel consumption and operation costs, which are explained by 36-45% efficiency of piston machines. Gas turbine installations require high gas pressures (up to 2.0 MPa), while gas-piston installations operate at low- and mid gas pressures.

Basic parameters of gas-piston and gas-turbine engines are given in Table 5.1.

Table 5.1 Parameters of Gas-Piston and gas-Turbine Engines

Parameter	Gas-Piston Drive (GPD)	Gas-Turbine Drive (GTD)
Durability	Unlimited subject to observance of operation and maintenance rules	
Repairability	Repaired on site	Repaired at special factories
	Repair takes less time	Time and money expenses on transportation, centering etc.
Shelf life	Preserves properties subject if stored correctly	
	Can be transported using any type transportation	Transportation by railroad in not desirable
Efficiency	Efficiency almost does not vary under duty between 100% to 50% of capacity	Efficiency drastically drops down in case of partial duties
Specific fuel consumption at 100% / 50% duties	9.3…11.6 MJ/kW·hr /0.264…0.329 m3/kW·hr	13.2…17.7 MJ/kW·hr/ 0.375…0.503 m3/kW·hr
Voltage drop and recovery time after 50% duty addition	22% 8 sec	40% 38 sec
Influence of variable duty	Long-term operation at duties lower than 50% is not desirable (strongly affects intervals between maintenance)	Partial duty operation (less than 50%) does not affect turbine condition
Accommodation in the building	Requires more space since it has greater weight per power unit	With power plant capacity of 5 MW, gain from a room of smaller size is not large
	Does not require gas booster compressor, input gas working pressure is – 0.1…0.35 bar	Minimal input gas working pressure is 12 bar, high-pressure gas is required or a booster compressor
	Overhaul after 72000hr, carried out on site	Overhaul after 60000 hr, carried out at a special factory

Comparison of turbine and piston engines for their application in mini-HPP shows that gas turbine installation is beneficial in large industrial factories having significant electric consumption (over 8-10MW), in-house production facilities, highly qualified personnel to operate the installation, high-pressure gas input.

Mini-HPP based on gas-piston engines are promising as the main source of electric and heat power in communal power engineering facilities.

5.1.1 Gas Power Plant Equipment Market Analysis

Today, the market of equipment for de-centralized power supply installations features a wide choice of offers both from foreign and Russian manufacturers. Russian and foreign manufactures of gas-piston power plants are listed below.

Table 5.2 Model Range of Barnaultransmash Gas-Piston Power Plants

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)
Gas-piston power plant MTP-100/150	100	100
Gas-piston power plant MTP-200/300	200	200
Gas-piston power plant MTP-315/400	250	250

Table 5.3 Model Range of Gas-Piston Power Plants from CJSC "Barachinsky Electromechanical Factory"

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)	Electric Efficiency (%)	Heat Efficiency (%)	Overall Efficiency (%)
Gas-piston power plant MTES-100/150	100	150	50	42	92

Table 5.4 Model Range of Gas-Piston Power Plants from JSC "Volzhsky Diesel named after Maminy" (50 Hz)

Installation Model	Electric Capacity (kW)
Gas-piston electric unit GDG 500/1000	500
Gas-piston electric unit GDG 500/1000-1	500
Gas-piston electric unit GDG 600/1000	600

JSC "Volzhsky Diesel named after Maminy" also manufactures gas-piston power plants based on Waukesha and MTU&Detroit Diesel engines.

Table 5.5 Model Range of Gas-Piston Power Plants from CJSC "Verkhnepyshminsky Factory of Compressor Equipment"

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)
Gas-piston mini heat and power plant with 100 KW capacity	100	150

Table 5.6 Model Range of RUMO Gas-Piston Power Plants with Engine Line 36/45 (50Hz)

Installation Model	Electric Capacity (kW)
Gas-piston electric unit DG68M	800
Gas-piston electric unit DG98M	1000

Table 5.7 Model Range of RUMO Gas-Piston Power Plants with Engine Line 22/28 (50Hz)

Installation Model	Electric Capacity (kW)
Gas-piston electric unit 6DG22G2	500-630
Gas-piston electric unit 6DG22G1	800
Gas-piston electric unit 8DG22G2	800
Gas-piston electric unit 8DG22G1	1000

Table 5.8 Buderus Gas-Piston Power Plants

Module	Unit of Measurement	E 0204 DN-20	E 0824 DN-40	E 0826 DN-60	E 1306 DN-100	E 2212 DN-200
Electric capacity	kW	18	45	65	120	230
Heat used	kW	34 [2)]	78 [2)]	114 [2)]	200 [2)]	358 [3)]
Electric efficiency	%	31.0	33.3	32.8	34.3	35.4
Heat efficiency	%	58.6	58.1	57.6	57.1	55.2
Overall efficiency	%	89.6	91.5	90.4	91.4	90.6

Table 5.9 Model Range of Caterpillar Co-Generation Plants with Separated Recovery Unit

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)
Co-generation plant CAT-500, 770, 1200, 1500, 2000	510 - 2000	597 – 2144

Table 5.10 Model Range of Deutz Heat Power Plants

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)
Deutz TCG 2015	172-230	261-351

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)
Deutz TCG 2016	580-774	674-893
Deutz TCG 2016 K	337-678	463-898
Deutz TCG 2020	1169-2014	1339-2247
Deutz TCG 2020 K	1021-1364	1240-1661

Table 5.11 Model Range of EC Power Gas-Piston Power Plants

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)
EC Power XRGI 13G	4-13	17-29

Table 5.12 Model Range of Elteco Gas-Piston Co-generation Installations

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)
katja 5 C	3.8 – 33.3	8.9 – 64
petra	40.7 – 1944	68.8 – 2224

Table 5.13 Model Range of Jenbacher Heat Power Plants

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)
Model line 2	312-330	351-361
Model line 3	526-1064	640-1200
Model line 4	1416	1455-1498
Model line 6	1820-3041	1808-3047

Table 5.14 Model Range of KORNUM Gas-Piston Co-generation Installations

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)	Electric Efficiency (%)	Heat Efficiency (%)	Overall Efficiency (%)
KORNUM	118 – 3200	169 – 3462	34.3 – 41.2	42.5 – 52.6	83.8 – 87.9

Table 5.15 Model Range of Motorgas Gas-Piston Co-generation Installations, Series KLASIK, STRATOS, MOBIL

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)	Electric Efficiency (%)	Heat Efficiency (%)	Overall Efficiency (%)
Series KLASIK	257 – 3200	365 – 3463	35.6 – 41.3	45 – 50.9	86.1 – 87.9
Series STRATOS	40 – 380	68 – 443	31.5 – 37	43.1 – 53.5	84.7 – 86.2
Series MOBIL	71 – 698	112 – 980	32.9 – 36.5	50 – 51.9	84.7 – 87.9

Table 5.16 Model Range of Tedom Gas-Piston Power Plants, Series Premi, Cento, Quanto

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)	Electric Efficiency (%)	Heat Efficiency (%)	Overall Efficiency (%)
Premi F25 AP	25	47	31.4	59.1	90.5
Premi F25 SPI(E)	24	47	30.2	59.1	89.3
Серия Cento	81 – 302	123 – 422	34 – 36.8	50 – 52.8	85 – 87.7
Серия Quanto	412 – 1050	561 – 1387	37.2 – 38.1	48.9 – 50.8	85.6 – 88

Table 5.17 Model Range of Wartsila Gas-Piston Power Plants

Installation Model	Electric Capacity (kW)	Heat Capacity (kW)
Wartsila 12V34SG	4040	46.1
Wartsila 18V34SG	6060	46.1
Wartsila 16V34SG	6984	46.5
Wartsila 20V34SG	8730	46.5

5.2 The Kolpashevo Urban municipality Integrated Power Supply Scheme

Centralized power supply systems from boiler houses and all associated engineering infrastructure provide a most valuable asset for co-generation development. Mini-HPP plants that can be created on the basis of municipal boiler houses are already provided with access to a wide network of heat users. That's why disclosure of the «heating resource» of the municipal heat supply arrangement looks attractive for investments.

Within the project "Creation of a High Energy Efficiency Demonstration Zone in the Kolpashevo City", JSC "Gazprom promgaz" developed suggestions on modernization and reconstruction of heat supply systems in the Kolpashevo city and Togur village in order to improve

heat supply efficiency and reliability. The developers had the task of organizing efficient use of natural gas, find solutions towards replacement of physically worn-out and morally outdated equipment of boiler houses and heat networks, reduction of the costs of heat power production, and conversion to up-to-date heat and electric power generation and distribution technologies.

In development of the power supply scheme, possible options were considered for reconstruction of existent heat supply systems of the Kolpashevo city and Togur village with regard to enlargement of the number of heat sources using new heat and electric power co-generation technologies (mini CHP). In order to implement a rational strategy of reconstructing heat supply systems, engineering solutions were offered targeted to arranging heat and electric power co-generation on the basis of boiler houses “Geolog”, “CRB”, “Centralnaya”. The parameters of mini HPP construction are summarized below together with preliminary estimates of the payback period for each option (Table 5.18).

Table 5.18 Mini CHP Technical Indices Summary

Index	Boiler House “Geolog”	Boiler House “CRB”	Boiler House “Centralnaya”	Summarized Indices
Energy source type	Jenbacher JMS-316+ ABK boiler house	Jenbacher JMS-320 + ABK boiler house	Jenbacher JMS-320+ ABK boiler house –8.0	
Number of mini HPP units, pcs.	2	2	2	6
Mini HPP capacity:				
• Electric, MW	1.55	1.95	1.95	5.45
• Heat, Gcal/hr	1.88	2.26	2.26	6.4
Coverage of boiler house users’ load, Gcal/hr	7.98	7.1	6.84	
Electric power supply, mln. kW/hr	10.3	14.4	14.5	21.92
Heat power supply, Gcal:	34370	36570	36400	107340
• HPP	13160	16724	16840	46724
• Boiler houses	21210	19846	19560	60626
Fuel consumption, ton of fuel equivalent	6490	7300	7280	21520
including mini HPP, , ton of fuel equivalent	3098	4125	4150	11737

Boiler House “Geolog”. Reconstruction of boiler house “Geolog” including installation on its site of mini CHP (JMS-316) from Jenbacher and self-contained modular boiler house ABK-12.0, with housing and communal users to be switched from boiler house «Bath-house» that is subject to reconstruction and conversion to technological steam load.

Construction of the mini CHP having electric capacity of 1.55 MW on the site of boiler house "Geolog" allows generating 13160 Gcal/year of heat power and 10.85 mln. KW•hr of electric power, which will require about 3.1 thou. ton of fuel equivalent of fuel. Specific fuel expenditure in electric power generation at mini CHP (JMS 316) equals to about 300g of fuel equivalent/kW•hr and for heat generation in modular boiler house - 160kg of fuel equivalent/Gcal.

Boiler House "CRB". Reconstruction of boiler house "CRB" including installation on its site of mini HPP (JMS-320) from Jenbacher and self-contained modular boiler house ABK-14.0, with shutdown of inefficient boiler houses and connection of their users to boiler house "CRB".

A self-contained mini CHP power source for CRB improves power supply reliability.

Construction of the CHP having electric capacity of 1.95MW on the site of boiler house "CRB" allows generating 16725 Gcal/year heat power and 14.4 mln. kW•hr of electric power, which will require about 4.1 thou. ton of fuel equivalent of fuel. Specific fuel expenditures during electric power generation at mini CHP (JMS 320) amount to about 300g of fuel equivalent /kW•hr and for heat generation in modular boiler house - 160kg of fuel equivalent /Gcal. For comparison, in 2005, for boiler houses of LLC "Kolpashevo Utility Systems", specific fuel consumption for heat supply equaled to 240-380kg of fuel equivalent/Gcal (fuel - coal) and 190-230kg of fuel equivalent /Gcal (fuel - oil) on average.

Boiler House "Centralnaya" (Togur village). Reconstruction of boiler house "Centralnaya" including installation of mini HPP (JMS-320) from Jenbacher and modular boiler house ABK-7.0. Shutdown of boiler houses "Sovetskaya", "Zavodskaya" and switching the housing and communal users to the modular boiler house. Additionally, it is envisaged to install a HWS system in Togur village as well as shutdown boiler house "Chapaeva" and switch its subscribers to boiler house "Orphan Asylum".

Construction of a mini HPP having electric capacity of 1.95 MW on the site of boiler house "Centralnaya" allows generating 16840 Gcal/year of heat power and 14.5 mln. kW•hr of electric power, which will require about 4.15 thou. ton of fuel equivalent of fuel. Specific fuel expenditures during electric power generation at mini HPP (JMS 320) amount to about 300g of fuel equivalent /kW•hr and for heat generation in modular boiler house - 160kg of fuel equivalent /Gcal.

In the course of urban municipality's heat supply system reconstruction, it is planned to shutdown a number of boiler houses because of extremely low load percentage ("Laundry", "Annex to Bath-house", "River-Boat Station", "Suvorov", "School No.3"). Besides, private residential houses should be switched to individual heat supply (currently, they receive heat from centralized heat supply systems) with installation of gas heating boilers (unit rating of 10 to 100 kW) there.

Mini HPP will ensure supply of 21.92 mln. kW-hr /year of electric power to enable full satisfaction of communal needs and 37.4% of requirement of the Kolpashevo urban municipality. Income from sale of electric power will approximately amount to 20-25% of current income from heat sale in the settlement.

As a result, local generation and sale of electric power may not only increase energy independence of housing and communal services but also provide financial resources for reconstruction of all units of the heat supply system.

1 LLC PKF "Oktan" is a major manufacture of boiler equipment in Siberia and is interested in sale of its own products.

2 Efficient operation of mini-HPP is possible under the conditions of concurrent operation with network but this requires a number of actions determined by specification requirements, which finally leads to considerable increase of initial capital expenditures.

Boiler houses of the second stage of gas supply and distribution, due to low capacity, absence of HWS, are of no interest for application of the heat and electric power co-generation technology.

5.3 Forecasted Energy Balance of the Kolpashevo Urban Settlement after Implementation of Integrated Energy-Supply Scheme

Full-scale implementation of planned measures within the frame of integrated energy-supply scheme (combined heat and power production) will change the structure of the Kolpashevo Urban Settlement energy balance (Table 5.19).

Table 5.19 Forecasted energy balance of the Kolpasevo Urban Settlement

	Fuel wood, 10^3 solid m^3	Coal, 10^3 t	Power energy, 10^6 kWh	LPG, 10^3 t	Natural gas, 10^6 m^3	Crude oil, 10^3 t	Fuel oil, 10^3 t	Heat, 10^3.Gcal	Total, 10^3 tce
Primary energy	13,91	0,00	14,36	0,00	64,58	0,00	0,03	0,00	83,37
Own production	13,91	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3,62
Import	0,00	0,00	14,36	0,00	64,58	0,00	0,03	0,00	79,75
Heat-and-power engineering	0,00	0,00	34,16	0,00	-43,15	0,00	0,00	162,60	-24,62
Mini CHP Plants	0,00	0,00	38,43	0,00	-14,19	0,00	0,00	46,72	-5,72
public boiler-houses	0,00	0,00	-3,14	0,00	-21,53	0,00	0,00	98,49	-12,29
industrial boiler-houses	0,00	0,00	-1,13	0,00	-7,43	0,00	0,00	56,27	-1,05
own purposes (auxiliaries)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-4,77	-0,68
losses	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-34,11	-4,88
Final consumption	13,91	0,00	48,52	0,00	21,43	0,00	0,03	162,60	58,74
residential consumers	13,91	0,00	24,23	0,00	20,03	0,00	0,00	95,56	44,44
public utility consumers	0,00	0,00	18,05	0,00	0,12	0,00	0,00	24,67	5,89
industrial and other consumers	0,00	0,00	6,24	0,00	1,28	0,00	0,03	42,37	8,41

The structure of final consumption by type of energy resources and consumption areas will change, see below Figure 5-1 and Figure 5-2.

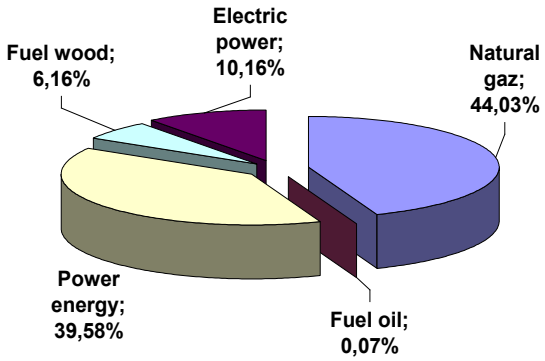


Figure 5-1 Structure of FER final consumption by energy resources type

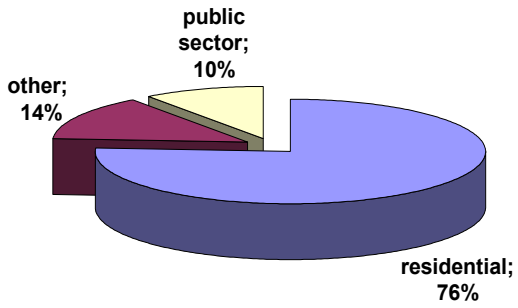


Figure 5-2 Structure of final consumption by consumption areas

Between fuel and energy resources natural gas (44,03%) and heat energy (39,58%) will prevail.

Residential sector (76%) will stay the largest energy consumer, industrial consumers (14%) and non-productive sphere (10%) is following after.

As compared with “traditional alternative” (renovation of heating facilities using gas-fired boiler-houses) application of combined heat-and-power production allows to shorten power energy import by 75,5% (44,43 mln. kWh).

5.4 Assessment of Inter-Fuel Substitution after Implementation of Integrated Energy-Supply Scheme of the Kolpashevo Urban Settlement

Full-scale implementation of planned gas-supply-and-distribution measures will lead to drastic change of FER balance of the Kolpashevo Urban Settlement heat-and-power sector (Table 5.20).

Natural gas driven out coal and oil used before will be the sole fuel type. Conversion of boiler-houses to gas fuel plus introduction of advanced heat-and-energy equipment provides for decreasing of total fuel consumption by 30% (18001,1 tce). Thanks to power energy production by Mini-CHP plants in heat-and-power sector, considering auxiliary consumption, surplus power energy (34,16 mln. kWh) is formed.

Embedding of automatics and dispatching control of heat-production technological processes provides for reduction of personnel by 60% (305 persons). Optimization of heat-supply schemes by means of removal of ineffective sections leads to decreasing of supplied heat and proper reduction of heat losses in networks.

Renovation of heat-supply facilities allows to increase efficiency up to 89,5%. Optimization of heat-supply schemes will lead to reduction of heat losses in networks. Finally it will result in fuel consumption efficiency increase (FCE 73,6%) of heating facilities.

Volume of harmful emissions will decrease 50-fold. Savings of cash resources in 2007 prices will be 12,8 mln. USD.

Results of integrated energy-supply scheme implementation in the public heat-supply sector of the Kolpashevo Urban Settlement are submitted in Table 5.21.

Table 5.20 Indices of Fuel Substitution Efficiency in Heat and Power Sector of the Kolpashevo Urban municipality

	Fuel Consumption, ton of fuel equivalent				Electric Power (auxiliary), thou. KW-hr	Number of Personnel, persons	Efficiency, %	Useful Consumption Factor, %	Hazardous Emissions	Cash saving, mln. USD
	coal	oil	gas	total:						
2007	45692,4	14126,4	0,0	59818,8	7398,7	505,0	55,7	45,6	8152,3	
Year of Implementation	0,0	0,0	41817,7	41817,7	5038,2	200,0	89,5	73,6	162,5	
Saving, In Kind:	**45692,4**	**14126,4**	**-41817,7**	**18001,1**	**2360,5**	**305,0**	**-33,8**	**-28,0**	**7989,8**	
%	100,0	100,0	-100,0	30,1	31,9	60,4	-60,7	-61,4	98,0	
Saving, mln. USD	5,6	5,0	-3,8	6,8	0,3	2,0				12,8

Table 5.21 Indices of Fuel Substitution Efficiency in Municipal Heat Supply Systems of the Kolpashevo Urban municipality

	Fuel Consumption, ton of fuel equivalent				Fuel Consumption, ton of fuel equivalent	Fuel Consumption, ton of fuel equivalent	Fuel Consumption, ton of fuel equivalent	Useful Consumption Factor, %	Hazardous Emissions	Cash saving, mln. USD
	coal	coal	coal	coal						
2007	33665,1	12945,8	0,0	46610,9	5978,7	440,8	54,8	44,4	5557,1	
Year of Implementation	0,0	0,0	27245,5	27245,5	3908,9	135,8	89,4	72,5	127,7	
Saving, In Kind:	**33665,1**	**12945,8**	**-27245,5**	**19365,4**	**2069,8**	**305,0**	**-34,6**	**-28,1**	**5429,4**	
%	100,0	100,0	-100,0	41,5	34,6	69,2	-63,1	-63,4	97,7	
Saving, mln. USD	4,1	4,6	-2,5	6,2	0,2	2,0				12,3

5.5 Conclusions

1 The system of centralized heat supply from boiler houses and all accompanying engineering infrastructure of the Kolpashevo urban municipality is a most valuable asset for co-generation development.

2 With the existent tariff structure, the HWS heat load is most profitable for production of electric power in communal boiler houses as it allows year-round loading of created co-generation capacities and achieving maximal efficiency of capital investments.

3 In the course of development of the power supply arrangement for the Kolpashevo city and Togur village, possible options were considered of reconstructing existent heat supply systems with regard to enlargement of the number of heat sources using new heat and electric power co-generation technologies (mini CHP).

4 For implementation of a rational strategy to reconstruct the heat supply systems, engineering solutions were offered targeted to organization of heat and electric power co-generation on the basis of boiler houses “Geolog”, “CRB”, “Centralnaya”.

5 For a number of reasons, mostly, economic , the investor - LLC PKF “Oktan” - preferred the “traditional option” of heat sector modernization on the basis of gas boiler houses at the first stage of gas supply and distribution.

6 Boiler houses of the second stage of gas supply and distribution, due to low capacity, absence of HWS, are of no interest for application of the heat and electric power co-generation technology.

6 Analysis of factors impeding investments into modernization of heat supply systems

6.1 The Tomsk Region Legislation in the Field of Investment Activity

In the Tomsk Region, a number of regulatory legal acts were adopted that regulate investment activity, the Tomsk Region Law dated 18.03.2003 No. 29-OЗ "On State Support of Investment Activity in the Tomsk Region" being the main of them.

This Law, together with legislative acts of the Russian Federation and the Tomsk Region, sets forth the forms and procedures for support of investors on the part of regional state authorities as well as additional guarantees for investment activity.

The region also has established the Procedure of funding from the regional budget of the interest rate on loans raised for implementation of investment projects and received by investors from Russian Federation credit organizations (approved by Enactment of the Head of the Regional Administration (Governor) dated 24.04.2003 No.86).

The Enactment of the Head of the Tomsk Region Administration (Governor) dated 30.06.2007 No. 106a "On Approval of the Regulations on Selection, Evaluation and Ranking of Investment Projects of Municipal Districts and City Circuits to Municipally-Owned Capital Development Projects" is established in order to support implementation by Tomsk Region municipal districts (city circuits) of investment projects concerning municipally-owned capital developments; assist implementation of the Tomsk Region Program of Social & Economic Development For Years 2006-2010, the Program of Reforming the Tomsk Region Social Finance Management System for Years 2006-2008.

The investment support rendered both at federal and regional level is insufficient and does not cover project risks, especially in problematic and socially important communal sector. Therefore, in order to create mechanisms stimulating investments, it is necessary to develop new and modify the existent regulatory legal acts on support of investors.

The main factor responsible for repayment of investments made to communal sector is the tariff regulation system. According to the effective basic pricing in communal sector[33] and the Federal Law on basic regulation of tariffs of communal companies[34], also basic pricing in respect of electric and heat power in RF[35], the main method of establishing tariffs is the method of economically substantiated expenses (costs).

Along with this method, the method of economically substantiated yield of invested capital and the tariff indexation method can be used. Still, as of today, the last two methods are not yet sufficiently elaborated making their lawful application rather difficult. The draft law "On General Principles of Regulating the Tariffs of Communal Sector Organizations" proposes to complement them with establishing maximal limits for tariffs on the products and establishing factors to the effective tariffs on the products or tariff modification limits.

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[33] Russian Federation Government Enactment "On Approval of Basic Pricing in the Field of Housing and Communal Services" dated 17 February 2004 No. 89.

[34] Federal Law dated 30.12.2004 No. 210-FZ "On Basic Regulation of Tariffs of Communal Sector Organizations".

[35] Russian Federation Government Enactment dated 26 February 2004 No. 109 "On Pricing In respect of Electric and Heat Power in the Russian Federation".

Economic stimulation of energy saving essentially is:

Economically substantiated costs of energy suppliers on implementation of energy saving projects are taken into account through maintaining for them of the estimated level of expenses taken into account in tariff regulation during the period preceding maintenance of expenses.

The effective period of a tariff with fixed level of expenses and basic level of the volumes of financing energy resources consumption is determined by the recoupment period of the expenses on implementation of energy saving projects plus one year – for users that are budget organizations, plus two years – for energy suppliers.

In municipal entity "Kolpashevo District" and in the Kolpashevo urban municipality, a number of regulatory acts were adopted that regulate the process of rendering housing and communal services including heat supply, tariff regulation within the competence of local authorities, formation and execution of the municipal order.

6.2 Analysis of Various Options of Financing Investment Projects in the Field of Energy Saving

The main forms of financing investment projects in communal power engineering are: budget, joint-stock, mixed financing, bank loans, and leasing.

6.2.1 Budget Financing

The dynamics of income and expenses of the consolidated budget of the Kolpashevo District is shown in Figure 6-1. During the period before 2002, the district budget was mostly deficit, but later, it was balanced, mostly, through reduction of expenses on maintenance of the district infrastructure.

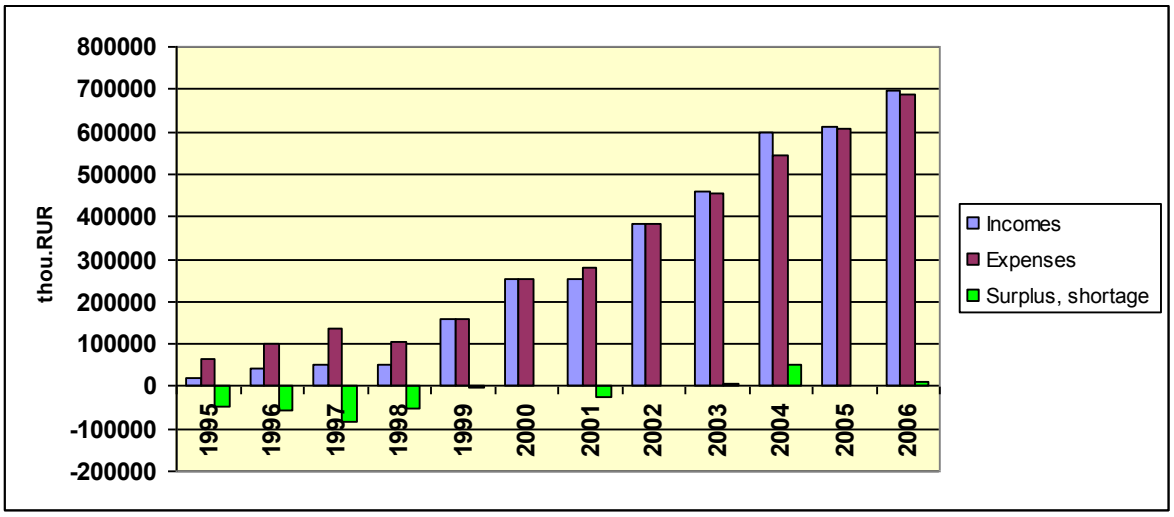


Figure 6-1 Dynamics of income and expenses of the budget of the Kolpashevo District during the period from 1995 through 2006

A considerable part of the district budget income (72%) is gratuitous income from the superior (regional and federal) budgets as well as income from taxation of natural individuals (24.9%). Consolidated budget performance for the years 2004-2007 is given in Table 6.1.

Budget expenses are divided into general state (allowance of authorities), law-enforcement, state support of economic sectors, housing and communal services, social and cultural, and other expenses (Figure 6-2).

Housing and communal services are the third in volume item of budget expenses. Since 2004 financing of the sector has fallen down from 18.1 to 10.3 %. At that, the growth of budget financing on reimbursement of the difference in tariffs equaled to 14%, payments to cover losses made 40%, payments from the budget to social security beneficiaries grew by 5%, subsidy payments grew 1.7-fold.

Table 6.1 Consolidated budget performance for the years 2004-2007

Item	2004		2005		2006		2007	
	Sum (thou. RUR)	Specific Weight (%)	Sum (thou. RUR)	Specific Weight (%)	Sum (thou. RUR)	Specific Weight (%)	Sum (thou. RUR)	Specific Weight (%)
Tax Income – Total,	91 794	13.39	74 453	12.18	173384	24.88	228713	33.48
Non-Taxation Income – Total:	15 744	2.65	16 138	2.64	21 613	3.10	35 261	5.16
Total Income:	107538	18.04	89 127	14.58	194994	27.98	263974	38.65
Gratuitous Income from Other Budgets – Total,	488741	81.96	521977	85.42	501777	72.02	419083	61.35
Total Income:	596 311	100.0	611 104	100.0	696 771	100.0	683 057	100.0
Total Expenses:	546630	100.0	607285	100.0	687733	100.0	701094	100.0
Including Housing & Communal Services	98774	18.07	103773	17.09	110585	16.08	72405	10.33
Surplus (+), Deficit (-)	49681		3819		9039		-18037	

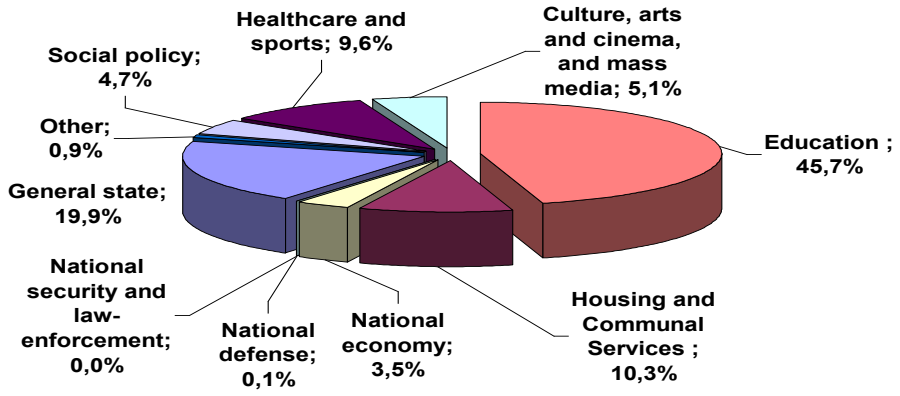


Figure 6-2 The Structure of Expenses of the Kolpashevo District Budget for 2007

The budget of the Kolpashevo urban municipality in 2006 - 2007 had positive balance result (1-3% surplus), still, the volumes of income and expenses are not large (Table 6.2).

Table 6.2 Budget of the Kolpashevo Urban municipality for Years 2006-2007

Urban municipality Budget, Thou. RUR	2006			2007		
	Plan	Actual	%	Plan	Actual	%
Income						
Budget Income, Total:	88907.4	87556.1	100	143980.1	145606.6	100
including Own Income	21554.0	22191.5	25.3	56534.0	58350.8	40.1
Gratuitous Income	67353.4	65364.6	74.7	87446.1	87255.8	59.9
Expenses						
Budget Expenses, Total:	88572.7	86476.0	100	141346.1	140956.3	100
Including Financing of Housing and Communal Services	14008.0	12020.5	13.9	8131.8	8131.8	5.8
Budget Surplus/(-) Deficit	334.7	1080.1	1.2	2634.0	4650.3	3.2

For the urban municipality, 60% of the budget income is received within the frames of inter-budget relations (dotation, subvention, transfer deeds). In spite of the fact that own income is continuously growing, the planned collection of taxation and non-taxation income is fulfilled, the funds are insufficient to cover all necessary expenses.

So, it can be stated that the budgets of the municipal district and settlement, with the current level of own income, cannot be a source of investments into modernization of communal infrastructure facilities.

6.2.2 Funds of Utility Companies

Utility companies, as independent economic agents, according to the ideology of market transformations, should bear responsibility not only for everyday operations but also for development of the infrastructure; and hence, they should have certain financial capabilities to ensure this development, which should be taken into account in tariff formation.

The enlarged structure of expenses on the heat supply services in the Kolpashevo urban municipality for year 2007 is given in .Table 6.3.

Table 6.3 The Structure of Expenses on Heat Supply Services in the Kolpashevo Urban municipality, %

Item	Reference Indicator	Existent Cost Structure for RF	Kolpashevo, 2007
Operational expenses	67.4	83.5	87.93
including:			
Electric power	5.2	6.2	4.66%
Fuel	30.2	37.5	39.54%
Routine repair expenses (repair fund)	6.5	7.5	7.41%
Salaries together with deductions	9.1	16.4	32.49%
Other (emergency repairs, general production, workshop and other expenses)	16.4	15.9	3.83%
Funds on investments, Including from the cost	22.40	9.8	0.01
Depreciation	10.20	4.2	0.01%
Part of the repair fund allocated to replacement of worn out fixed assets	4.80	2.4	0.00
From profit	7.4	3.2	0.00
Profit allocated to payment of taxes and consumption	10.2	6.7	5.06

Comparative analysis of the structure of expenses on heat supply services in the Kolpashevo urban municipality versus average Russian and rational structure of expenses shows the scale of non-productive expenses and directions of cost re-structuring, increase of the share of investment expenses.

The main part in the structure of tariffs on heat supply (95%) is operational (running) expenses, which share exceeds not only the reference indicator but also the current RF cost

structure. Thus, insufficiency of the investment component is evident, which consists of depreciation deductions to restoration of fixed productive assets and at the same time is deprived of part of the repair fund since it is not formed in the enterprises.

Accumulation of depreciation in the accounts of the owner of fixed assets is the source of future capital investments for fixed assets renovation. Underestimation of depreciation expenses decreases the cost and tariff but deprives the owner of the funds to reproduce fixed assets. This results in their aging and, consequently, growing expenses on repair, liquidation of accidents, electric power and, finally, tariff growth.

The specific weight of expenses on fuel in the companies' costs exceeds the rational level, which is explained by low efficiency of boiler equipment and high heat losses in the engineering networks.

Labor remuneration expenses are higher than the general Russian level evidencing high share of direct labor, low level of automation and insufficiently efficient management arrangements.

The said directions of cost re-structuring allow the utility companies to form the investment component of the tariff to ensure rehabilitation and modernization of heat supply facilities at the level of 20-25%.

6.2.3 Leasing

Classical leasing as one of the options of financing provides for participation of three parties: the lessor, the lessee, and the seller (supplier) of property. The essence of a leasing transaction is as follows:

One of the peculiarities of applying leasing relations in investments into power engineering equipment is the fact that the service life of the equipment greatly exceeds the possible term of a leasing contract (about three years in domestic practice). Therefore, for the lessor it is naturally necessary to have the expenses on equipment paid back (including the cost of credit resources) within the leasing term.

Thus, the maximal term of a leasing contract may be equal to the equipment payback period with regard to the time the equipment was used before it was handed over into leasing and the payback period should be calculated taking into account the specificity of leasing relations as regards costing and taxation.

Another leasing peculiarity consists in the specificity of calculating the investment efficiency criteria since the investment project, if leasing is used, is essentially carried out by the joint agent of leasing relations representing both the lessor and the lessee, since the ownership right to the leased property (equipment) during the whole contract term as well as credit repayment obligations rest with the lessor while the effect from equipment operation as revenue from product sales rests with the lessee. So, the efficiency of a project employing the leasing mechanism is determined by its repayment for the lessor and the lessee as the joint agent of leasing relations. The peculiarity of calculating the traditional project efficiency criteria – net discounted value, discounted payback period and internal profit rate, in this instance, is putting together the current costs of the lessor and the lessee arising from project implementation, and, on the contrary, deletion of "internal" payments (depreciation component, the commission component forming the lessor's profit, and VAT included in leasing payments).

The third peculiarity of the leasing contract, which subject matter is power engineering equipment, consists in that power production is the domain of natural monopolies, hence the energy prices (tariffs) are regulated by the state. According to the current provisions, leasing payments are fully included into the product cost, in this case – in the cost of energy, making the calculated tariff rather high, much higher than mean values. This necessitates state support of

leasing relations in the power engineering sector at the regional and local levels. Therefore, after the equipment supplied under leasing is put into operation, it is necessary to establish, at the level of regulatory body, fixed tariffs for heat and electric power enabling settlements under leasing contracts that would take into account the cost of credit resources (refinancing rate). The effective period of the fixed tariff depends on the equipment payback period.

Leasing as an option of financing is used in implementation of the investment project of the Kolpashevo urban municipality heat supply system reconstruction.

Outsourcing of loans

Investment Repayment Guarantees and Risks

Satisfaction of the energy supplier's financial needs for implementation of an investment program (repayment of outsourced funds and expenses related to investment activity) is done by the representative body of the municipal entity by setting an adjustable mark-up to the price (tariff) for the uses, which is established by the Tomsk Region REC.

There is a risk of non-fulfillment by counteragents and users of their financial obligations resulting in shortage of the money received.

Requested State Support

When REC makes a decision on non-affordability for users to buy and pay for ESO heat power taking into consideration the price (tariff) for uses and mark-up to the price (tariff), compensation of the falling out income as the existent difference between the regulated REC tariff and the tariff set forth for the population;

Granting tax privileges provided for by the RF and the Tomsk Region laws.

The source the production program financial needs is the tariff on heat power and its transportation set forth for the subject company by the regulatory body according to the «Basic Pricing in Respect of Electric and Heat Power in the Russian Federation» approved by the RF Government Enactment dated 26 February 2004 under No. 109.

The source of f the investment program financial needs is the adjustable mark-up to the price (tariff) for users set forth according to the provisions of Federal Law No. 210-FZ "On Basic Regulation of Tariffs of Communal Services Organization".

7 Recommendations on the training and skills upgrading of the staff

7.1 Basic directions of the human resources policy Implementation

One of the main problems of communal sector companies remains shortage of qualified personnel.

Over the years of reforms, some part, though small, of available experienced and qualified staff changed their job moving to other sectors of the national economy with higher labor remuneration standards or retired. The youth, who received good-quality technical, engineering and economic education, seeing no prospects of professional and personality growth, goes mostly to private companies or large state-owned companies. Those who received basic or secondary professional technical education do not show interest in obtaining additional professional education to work in the communal sector either preferring non-recurrent earnings or unqualified labor.

Low level of labor remuneration, absence of professional and personality growth prospects, overall negative image of the sector actually brought about low requirements to the personnel's professional qualities. This resulted in overall decrease of labor productivity and quality. At that, in the Tomsk Region, 40% of cases when technology processes are not observed creating high accident rate occur at the fault of the attendant personnel.

7.2 Assessment of the Requirement for Human Resources

For qualitative and quantitative assessment of the sector's requirement for human resources at the municipal level, questioning of community sector companies was carried out, and the results of this questioning are summarized in Table 7.1.

As of the beginning of 2007, in municipal entity "Kolpashevo District", 12 companies were registered, whose main activity consisted in supplying housing and communal services; their staff number of personnel equaled to 919 units.

The share of administrative and managerial personnel and engineers and technicians in the sector companies accounted for 20.02% of the total employment in the sector (Figure 7-1). At the same time, only 184 jobs of managers and engineers were filled (or 93% of the needed number).

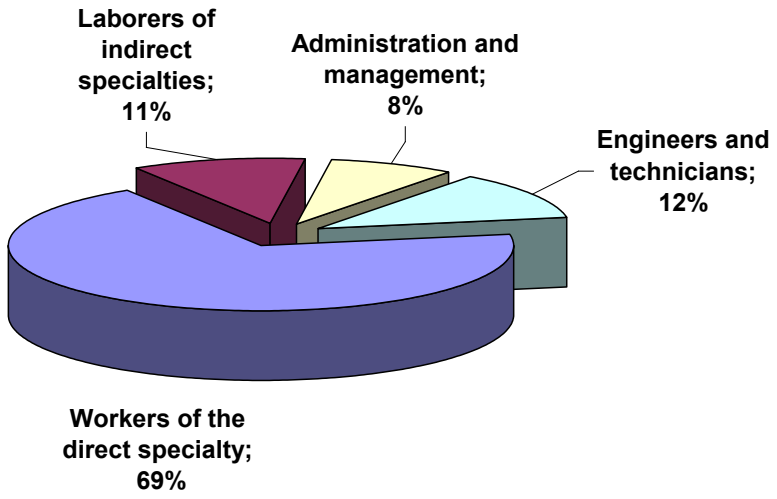


Figure 7-1 The staff structure of housing and communal companies in municipal entity "Kolpashevo District"

The structure of the educational level of the staff of housing and communal companies in municipal entity “Kolpashevo District” looked as follows (Figure 7-2):

- 82 employees (or 8.9 % of the total number of people employed in the sector) had higher education, but only 27 of them (32.9 %) worked in the field of their specialty;

- 329 (35.8%) of employees had secondary special education, 5.5% of them worked in the field of their specialty;

- 267 (29.05%) of employees had basic professional education, 5.6% of them worked in the field of their specialty.

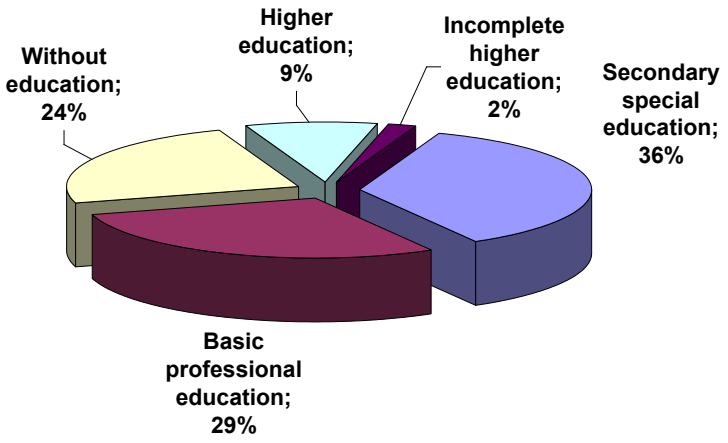


Figure 7-2 The structure of the staff educational level in housing and communal companies of municipal entity “Kolpashevo District”

Hence, there is a shortage of qualified mangers and engineers in the sector.

Table 7.1 Information on the Staff of Housing and Communal Companies in the Tomsk Region as of 01.01.2007. Municipal Entity "Kolpashevo District"

Housing and Communal Companies of All Type of Ownership in This Settlement	Actual Number of Employees					Number of Employees Who Have Education				Number of young specialist up to 25 years of age	Taken on in 2006	Dismissed in 2006	Actual Number of Employees Who underwent in 2006			There is requirement
	Total	Administration and Management	Engineers and Technicians	Workers of Direct Specialty	Workers of Indirect Specialties	Higher including working in the field of their specialty	Incomplete higher including working in the field of their specialty	Secondary special including working in the field of their specialty	Basic professional including working in the field of their specialty				training	re-training	Skills upgrading	
LLC "Vodostok-1"	77	5	11	55	6	11	3	21			11	11				
LLC "Vodostok-2"	43	5	11	23	4	4	3	9			13	13				
LLC "ZhKH"	78	14	5	49	10	11/7		18/5	25/8	4	31	35			3	
LLC "Zarya-service"	49	7	2	39	1	4/4		7/3	15/7	4	17	12				
LLC "Gleb"	45	3	3	37	2	4/3		14/6		3	53	8			3	

LLC “TST”	55	4	6	43	2	6	1	6	17	1	66	10	1			Heating engineer
LLC “TISTO+”	34	3	10	18	3	8		3	12	1	30	22				
LLC “KSK”	351	9	39	256	47	19/10	5/3	218	109	2	161	162	1	6		
LLC “Agrostroi”	95	5	16	67	7	3	2	22	58		68	57	1		5	
LLC “Teploservis”	27	9	1	13	4	5/3	1	5/4	12		32	11				
LLC “SKUPiK“	49	4	6	28	11	3	1	2	12		28	30			8	
MUE “Energosnab“	16	4	2	10		4	1	4	7	1	5	2				
TOTAL:	919	72	112	638	97	82/27	17.Mar	329/18	267/15	16	515	373	3	6	19	

The staff number of jobs of the direct specialty equaled to 638, the number of jobs of indirect specialties was 97 people. The level of job filling for these categories of personnel was recorded at the level of 84% and 81%, correspondingly.

The sector is characterized by an evident tendency towards staff ageing. There were only 1.7% of young specialists under 25 years of age among the total number of people employed in the sector while the share of employees of the age of retirement or close to it was 17%. As a result, the average age of employees in the housing and communal services sector reached 41 years.

The existent staffing situation in the housing and communal sector of municipal entity “Kolpashevo District” was caused by:

1) Low level of labor remuneration that does not help attracting and anchoring specialists in the sector;

2) Inconsistence of the staff number and structure with the volume of housing and communal services rendered to users, tasks and directions of the sector reform;

3) Insufficient social security of employees.

It should be noted that in the district there is no comprehensive targeted system of personnel training and retraining for housing and communal services sector.

7.3 Human Resources Strategy

Absence of a human resources planning system in the sector resulted in shortage or inconsistence of the sector employees’ qualification with modern requirements. This is equally true both for management and engineering personnel and for workers. The shortage of qualified personnel is typical for rural localities where there are no qualified accountants, managers, electrical engineers, heating engineers, and this list of scarce jobs can go on. For urban locality, there is no training of professional housing managers.

At present, juvenation of the housing and communal sector’s human resources and attraction of young specialists into the sector has become an urgent need. Consequently, a targeted training program for young specialists is required including practical training or pre-diploma training in housing and communal services companies with subsequent mandatory employment.

Professional personnel training should be carried out taking into consideration the orders from municipal entities and sector companies. There should be bilateral guarantees when respective education is received, i.e. guarantees of employment on one side, and employee’s obligation to work for a particular period of time, on the other side. For basic and secondary special education, taking into account the unfavorable image of the sector and the income of the rural population, budget-funded places in educational institutions should be planned.

The specificity of the communal sphere is continuously changing regulatory legal documents regulating the technical and economic and technological aspects of the activity, the pricing process, the tariff regulation procedure and mechanism etc. Hence, personnel re-training and skills upgrading based existent educational institutions and successful communal services companies have become particularly topical.

To anchor the young specialists who arrived based on targeted warrants to rural localities, the local authorities should resolve the matters of providing or buying housing for them, allocating financial resources so that they could provide themselves with personal household including at the expense of the budget.

Young specialists in the field of housing and communal services who arrived to a rural locality based on the warrant should be granted with preferences similar to the preferences granted to the employees of agroindustrial sector.

It is necessary to stop the practice of temporary (seasonal) employment of employees by sector companies. In all housing and communal services companies, labor and collective agreements should be concluded abiding by the current labor legislation and the sector tariff agreement.

Achievement of the posted tasks should ensure the optical balance of the processes of renovation and preservation of the required quantitative and qualitative membership of the sector employees, development of human resources to meet the needs of the housing and communal sector, in accordance with the requirements of the current legislation and the labor market situation.

7.4 Staff Training and Re-Training

Organization of training and re-training of the communal sector human resources requires coordinated efforts of three parties: companies, authorities, and educational institutions.

Among the educational institutions capable of coping with the said tasks, the Center of Paid Educational Services and Employment of the Tomsk Polytechnical University (TPU) and the Institute of Continuous Education of the Tomsk State Architectural and Building University (TGASU) in Tomsk should be mentioned in particular.

The Center of Paid Educational Services and Employment provides training in the fields and specialties closely related to the communal sector:

- Electric power engineering systems and networks;
- Electric power supply;
- Factory economics and management;
- Industrial heat power engineering;
- Heat and electric power plants.

Besides, training is carried out following the programs of all types of additional education developed individually to customer's needs and the existent level of students' education. Lessons are delivered by leading TPU professors and assistant professors and also by qualified specialists from firms and companies.

The TGASU Institute of Continuous Education provides skills upgrading and professional re-training of specialists including the sphere of housing and communal services and road facilities ("Engineering Systems and Networks of Buildings and Facilities", "Economics and Management in Housing and Communal Services", "Rating Certification of Housing and Communal Facilities" and so on). Lessons are delivered by TGASU professors and assistant professors, specialists from other Tomsk universities, businesses and organizations are invited. Short-term training of specialists in the field of heat and gas supply and ventilation and economics and management at works (municipal services) is carried out;

Taking into account the vast available experience, up-to-date educational and methodical base, it is necessary to use TPU, TGASU and other Tomsk universities intensively in order to accomplish the tasks of skills upgrading and training and re-training of high-qualification

specialists in all key fields of the Tomsk Region housing and communal services operations (Table 7.2).

Table 7.2 List of Specialties for the Communal Sector

Seq. No.	Specialties	Educational Institutions
1.	Electric power engineering systems and networks. Electric power supply Electromechanics Electric and electronic apparatuses Electric drive and automation of industrial plants and technological installations Relay protection and automation of electric power engineering systems	Electro-Engineering Institute TPU
2.	Instruments and quality control and diagnostic methods Information and metering equipment and technologies Quality management	TPU (Electric Physics Faculty)
3.	Accounting, analysis and audit Economics and management at works (by sectors) Counter-crisis management	TPU (Engineering Economics Faculty)
4.	Welding production equipment and technology	TPU (Machine-building Faculty)
5.	Chemical technology of inorganic substances Chemical technology of natural energy media and carbon materials	TPU (Chemical Technology Faculty)
6.	Thermal Physics Heat electric power plants Industrial heat power engineering Boiler and reactor building Automation of technology processes and production facilities	TPU (Heat Power Engineering Faculty)
7.	Management and information science in technical systems Software of computing equipment and automatic systems	TPU (Automation and Computational Equipment Faculty)
8.	Water supply and drainage Municipal development and services	TGASU

Seq. No.	Specialties	Educational Institutions
	Heat supply and ventilation Economics and management at municipal services companies	
9.	Automated data processing and management systems Counter-crisis management Software of computing equipment and automated systems	TUSUR
10.	Accounting, analysis and audit Law	TGU

Training of workers and technical specialists as well as upgrading and improvement of the communal sector employees skills on the basis of existent vocational schools and colleges should become an important component of human resources policy (Table 7.3).

Table 7.3 Secondary Vocational Education Institutions

Seq. No.	Specialty	Educational Institutions
1.	Water supply and drainage Installation and operation of indoor sanitary engineering appliances and ventilation Installation of gas supply equipment and systems Assessment of the technical condition of industrial and civil buildings and facilities Law studies Heat supply and heat engineering equipment Operation of electric equipment of factories and civil buildings	Tomsk Communal & Construction School
2.	Operator of pump installations Tool-maker of monitoring and metering instruments and automation Mechanization and automation devices and systems Technical operation, maintenance and repair of mechanization and automation equipment Technical operation, maintenance and repair of electrical and electromechanical equipment Electrician	Tomsk State Industrial and Humanitarian College

Seq. No.	Specialty	Educational Institutions
	for repair of overhead power lines Electrician for repair of electric equipment	
3.	Electrical machines and apparatuses Electric isolation, cable and condensing equipment	Tomsk Polytechnical School
4.	Software of computing equipment and automated systems	Tomsk Instrument-Building School Higher College of Information Science, Electronics and Management TUSUR Tomsk state Industrial and Humanitarian College Seversky State Industrial College
6.	Electric power plants, networks and systems	Seversky State Industrial College

Table 7.4 Institutions of Basic Vocational Education

Seq. No.	Specialty	Educational Institutions
1.	Accountant	PU No.9 (Kolpashevo city)
2.	Operator of boiler installations	PU No.31 (Kozhevnikovo village)
3.	Fitter of sanitary engineering, ventilation systems and equipment. Plumber	PU No.27 (Tomsk) PU No.10 (Seversk)
4.	Adjuster of monitoring and metering instruments and apparatuses	PU No.10 (Seversk)
5.	Adjuster for monitoring and metering instruments and automation	Radio-Mechanic Vocational Lyceum No.16
6.	Metalworker	Radio-Mechanic Vocational Lyceum No.16 PU No.27 (Tomsk)
7.	Breakdown mechanic	PU No.9 (Kolpashevo city) PU No.29 (Kolpashevo village)

Seq. No.	Specialty	Educational Institutions
9.	Electric welder	PU No.29 (Kolpashevo village)

Training and re-training in the field of new equipment and technologies as well as practical experience of energy saving and raising energy efficiency of production is particularly topical. It is necessary to complement the educational process with consultations of practical specialists and remote education elements. In future, it is necessary to equip the laboratory and production classes with samples of modern equipment and teaching aids.

The main source of financing the development of the material base of educational institutions should be the funds of companies interested in targeted training of their employees, operation of new types of equipment and machinery.

7.5 Human Resources Policy Implementation Measures

To achieve the objectives, it is necessary to implement the following measures:

- Create a system of planning the sector's requirement in human resources based on staff situation monitoring;
- Introduce a system of state and municipal orders for training of the sector specialists i for rural localities;
- With the help of the Tomsk Region regulatory legal acts, establish preferences for employees of the housing and communal services, similar to those applied in the agroindustrial sector;
- Approve the requirements to the content of the housing and communal services personnel training and re-training programs for educational institutions that receive budget financing with regard to regional specificity.

In conclusion, we would like to note that implementation of the above measures will allow to:

- Consolidate efforts of all interested parties to attract qualified specialists to ensure restoration and development of the communal services infrastructure;
- Provide training and re-training of the required personnel in terms of their number and qualifications, which would be capable of ensuring efficient functioning of the communal sector;
- Make a progress to a new stage of sector specialists training and re-training system development on the basis of modern teaching technologies and educational programs adequate to current and future needs of the Tomsk Region communal sector.

8 PROSPECTS OF APPLYING THE INTER-FUEL SUBSTITUTION PROJECT RECOMMENDATIONS IN RF REGIONS

Russia is one of the world leaders in energy industry. Having significant energy resources at its disposal, Russia is also the largest exporter and one of the major consumers of those. However, in contrast to the leading industrially developed countries, Russia is marked by high level of energy intensity of the economy and extremely low efficiency of energy utilization.

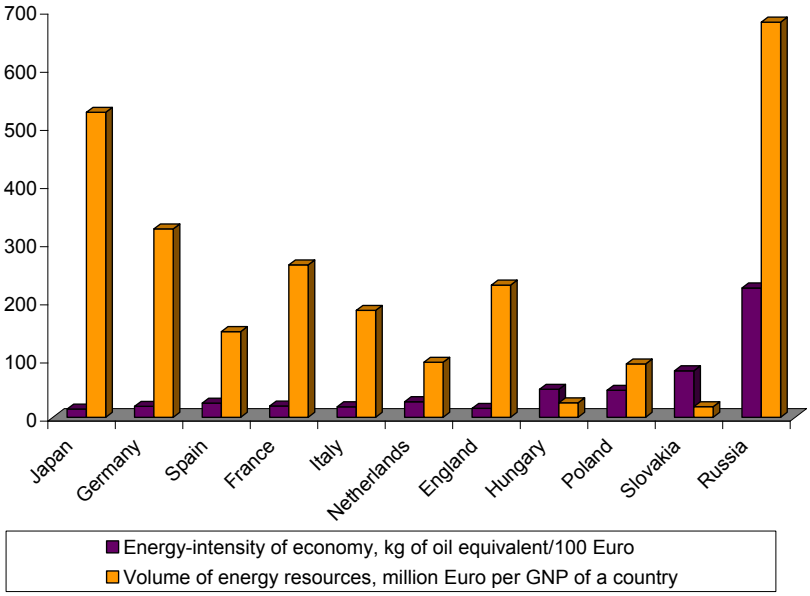


Figure 8-1 Comparison of energy intensity of the economies of different countries of the world, 2005 (ton oil equivalent/million Euro per GNP of a country)

On the one hand, low efficiency of energy utilization puts significant obstacles in the way of sustainable development of Russia, while on the other the volume of inefficiently used energy made available could have been directed towards satisfaction of the demand of European countries in energy resources. This way, one may talk about potential common interest of all European countries in the issues of enhancement of efficiency of energy consumption in Russia and CIS countries.

At the present time, the dominant type of fuel used in Russia to generate electric power and heat is gas. Its share in the overall balance of the country makes upwards of 50 per cent while coal and oil cover only an order of 35-36 per cent in the total volume of consumed energy resources.

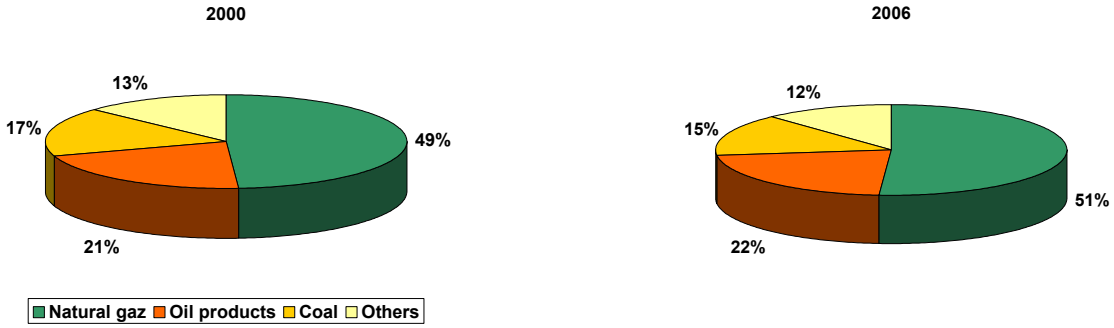


Figure 8-2 The Structure of Fuel and Energy Resources of Russia, years 2000-2006

The largest volume of gas is consumed in large urban settlements. Meanwhile, coal and liquid fuel remain predominant sources of energy in the rural areas, in small towns, as well as in the northern regions of the country with low level of gasification. Common knowledge is that those kinds of fuel are the most hazardous from the environmental point of view.

On evidence of the Statistics Service of Russia, the Rosstat, an order of 180 000 of sources of thermal energy was found in Russia in the year 2005. Of those, share of gas-firing boilers in urban settlements made an order of 57 per cent, coal-firing 35 per cent, and liquid fuel - 8 per cent. Whereas the share of gas-firing boilers in rural settlements made about 48 per cent, coal-firing - already 43 per cent and liquid fuel - an approximate 9 per cent.

At the present time, a Program of Gasification of the Regions of Russia is being implemented which, on account of expansion of gas supply in the regions, shall afford to implement conversion of coal and liquid fuel firing boilers to more environmentally-friendly gas.

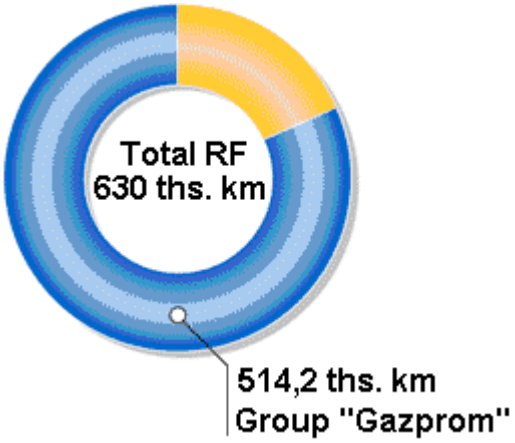
The formulation and implementation of Gas Supply and Distribution Programs of RF regions are aimed at:

- Creation of and entry into solvent markets of end users of gas;
- Ensuring rational loading of functioning gas pipelines and pipelines under construction;
- Mutually beneficial cooperation with regional and local authorities, creation of favorable economic conditions;
- Improved efficiency of natural gas use.

This Program is one of the fundamental components of the energy strategy of Russia. Due to the joint effort of Gazprom, JSC and public authorities at the Federal and regional levels, mean penetration of gasification went upwards of 20 percentage points within the latest few years - from 41 to 62 per cent as of 2007 data.

The Program is underway in 58 RF regions (Table 8.1). Its implementation will result in natural gas supply and distribution reaching the level of 60%. In addition, about 4 million flats and households with the population of about 13 million people, i.e. an average European state, will be provided with gas.

Concurrently, the loading of functioning gas tap lines will be significantly increased and efficiency of their use will be improved.



The Program of Gasification of Russian Regions had already enveloped more then 64 RF subjects and emerged at the level of priority National Projects for its significance.

Investment of Gazprom, JSC into gasification of the regions of Russia in the years 2005-2006 made about RUR 22.8 billion (RUR 5.2 billion in 2005, RUR 17.6 billion in 2006). Gazprom, JSC allocated RUR 20.2 billion for the implementation of the gasification Program in 2007.

The main consumers of natural gas in the regions are housing and communal services facilities and the population, which should be timely prepared to receive gas; this requires considerable capital investments into modernization and new development.

One of the key problems of the communal services sector related to tariff design is the absence of a mechanism to account the paying capacity of users, first of all, of the population.

With continuous growth of tariffs on the housing and communal services, private businesses pondering at the possibilities of investing into housing and communal services have a reasonable question: what is the level up to which the tariffs can be raised without rendering a detrimental effect on the population's ability to pay for the services. The federal standard of the maximally permissible share of payments in the aggregate income of the population is set at the level of 22%. Analysis of the structure of consumer expenses of the population has shown that the possibility of additional increase of population's payments for the housing and communal services is extremely limited. Mean share of payments for the housing and communal services equals to 7% and the maximal ultimate preparedness of the population to pay for the housing and communal services can be estimated as equal to 10%, otherwise, the families with low income will have to abandon vital goods and services.

There is a considerable variance in the level of economic development and corresponding mean income per capita of the population of RF regions. There is similar differentiation in RF constituents as well. Income of the urban population, and, hence, the ability to pay for the services, is much than that of rural. Low paying capacity of the population increases the investment risks and does not warrant timely payment for the services at the acceptable level of tariffs.

In Table 8.1, in the overall list of regions provided with gas distribution and supply, RF constituents are singled out where the level of income of the population and the ultimate preparedness of the population to pay for the housing and communal services exceeds 10%, which is an obstacle to inflow of private investments into modernization of communal infrastructure facilities in order to get them ready to receive gas.

Table 8.1 Indices of Paying Capacity of the Population in the RF Regions Provided with Gas Supply & Ditribution [11, 12]

	Average cash Income per Capita, rubles	Collection of Payments, %	Expenses on Housing and Communal Services as Share of Family Income, %
The Central Federal Area	**11084.4**		
The Vladimir Region	4141.1	91.4	6.9
The Voronezh Region	5488.6	94.4	6.5
The Ivanovo Region	3486.3	98.3	4.4
The Kostroma Region	4934.2	92.4	6.7
The Kursk Region	5196.8	97.3	6.1
The Lipetsk Region	5642.3	97.3	6.1
The Moscow Region	7592.4	91.9	6.8
The Oryol Region	4801.6	95	6.4

	Average cash Income per Capita, rubles	Collection of Payments, %	Expenses on Housing and Communal Services as Share of Family Income, %
The Ryazan Region	4798	92.6	6.7
The Smolensk Region	5571.4	90.8	7.0
The Tambov Region	5325.4	91.7	6.8
The Tver Region	5637.1	90.6	7.0
The Tula Region	5027.7	87.4	10.0
The Yaroslavl Region	6263.8	90.9	7.0
The Moscow city	24957.5	95.9	6.3
The North-West Federal Area	**9045.4**		
The Republic of Karelia	7096.1	86.9	10.1
The Komi Republic	11246.7	85.5	10.2
The Arkhangelsk Region	7857	89.2	7.2
The Nenets Autonomous Area	21455.7	84.9	10.3
The Vologda Region	6344.7	89.5	7.2
The Kalinigrad Region	6460	87.7	7.4
The Leningrad Region	5807.3	90.5	7.0
The Novgorod Region	5478.6	91.9	6.8
The Pskov Region	4906.2	88.6	7.3
Saint Petersburg	12555.9	84	10.3
The South Federal Area	**5332.9**		
The Adygei Republic	3880.1	88.4	7.3
The Republic of Dagestan	4457.3	77.5	10.9
The Republic of Kalmykia	2425.4	77.9	10.8
The Karachayevo-Cherkessian Republic	4266.3	81.6	10.5
The Krasnodar Territory	5572	93.6	6.6
The Stavropol Territory	5172.9	83.8	10.3
The Asrakhan	5683.3	83.4	10.4
The Volga Federal Area	**6220.3**		
The Republic of Bashkorstan	6891.1	96.8	6.1
The Republic of Mary El	3383.8	92.1	6.8

	Average cash Income per Capita, rubles	Collection of Payments, %	Expenses on Housing and Communal Services as Share of Family Income, %
The Republic of Mordovia	4133.8	88.8	7.3
The Udmurt Republic	4661.3	94.8	6.4
The Chuvash Republic	3925.4	95.2	6.4
The Perm Territory	8201.7	100.1	4.0
The Komi-Permyak Autonomous Area		86.9	10.1
The Kirov Region	4580	89.4	7.2
The Nizhny Novgorod Region	6062	91.6	6.9
The Penza Region	4385.9	100.1	4.0
The Ulyanovsk Region	4590.1	89.5	7.2
The Urals Federal Territory	**9507.1**		
The Kurgan Region	4728.9	87	10.1
The Sverdlovsk Region	8932.4	92.2	6.8
The Siberian Federal Territory	**6680.5**		
The Republic of Altai	4333.8	92.2	6.8
The Republic of Buryatia	6044.1	66.1	11.8
The Republic of Khakassia	5141	84.3	10.3
The Altai Area	4579.8	85.2	10.2
The Zabaikalye Territory	5887	90	7.1
The Agin-Buryat Autonomous Area	5043.3	85	10.2
The Taimyr (Dolgano-Nents) Autonomous Area	12168.1	70.9	11.4
The Evenki Autonomous Area	10361.3	50.2	13.2
The Irkutsk Region	7040.9	91.3	6.9
The Ust-Ordyn Buryat Autonomous Area	2220.3	79.2	10.7
The Kemerovo Region	7812.8	92.8	6.7
The Novosibirsk Region	6649.6	94.4	6.5
The Omsk Region	6916.5	85.2	10.2
The Tomsk Region	8076.5	82.8	10.4
The Far-East Federal Territory	**8892.1**		
The Primorsky Territory	7126.8	40.9	14.0

	Average cash Income per Capita, rubles	Collection of Payments, %	Expenses on Housing and Communal Services as Share of Family Income, %
The Khabarovsk Territory	9450.8	91.6	6.9
The Amur Region	5874.2	81.9	10.5
The Magadan Region	11106.5	81.6	10.5
The Sakhalin Region	12548	86	10.2

However, one should admit, in this regard, that the highest percentage of gasification persists in the central regions of the Russian Federation. Penetration of gasification of the Urals, Siberian and the Russian Far East Federal Districts is significantly inferior to that of the central regions of the country.

Predominant types of furnace fuel in those regions remain fuel oil and coal.

Table 8.2 Penetration of natural gas in Russia by Federal District

Item No.	Name of the Federal District	Penetration of gasification, per cent		
		Total	In cities and urban-type settlements	In rural areas
1	Central Federal District	68,70	77,30	42,67
2	North-West Federal District	46,76	56,79	10,47
3	South Federal District	74,05	83,73	52,70
4	Volga Riverside Federal District	73,52	82,96	52,58
5	Urals Federal District	46,68	54,67	12,78
6	Siberian Federal District	3,96	4,79	1,68
7	Russian Far East Federal District	5,56	6,59	1,83

This way, the Program of Gasification of the Regions of Russia is an important and positive condition for multiplication of the Project of "Kolpashevo Urban Settlement" municipality in both other district of Tomsk Province and in various regions of the entire Russian Federation.

The experience from the project in "Kolpashevo Urban Settlement" of Tomsk Province demonstrated that, in consequence of conversion of 14 urban boilers of the 28 operational from liquid and solid fuel to gas with the use of present-day heat and power equipment, saving of 29.7 per cent (17764,8 ton of equivalent fuel) of energy resource, 36,3 per cent (2686,4 thousand kW/h) of electric power shall be achieved. Volume of emission of hazardous substances into the atmosphere shall be reduced by 2.4 times.

Complete gasification of every boiler in that municipality shall afford to achieve, as estimated, even more significant results: the total volume of fuel consumption shall reduce by 47.5 per cent

(28416,1 ton of equivalent fuel), volume of hazardous emissions into the atmosphere from the heating supply systems of Kolpashevo shall decrease by 63 times.

Continued gasification of the regions of the Russian Federation, relative simplicity of the Project and significant results achieved in the course of its implementation are important attributes testifying of capability and need for its multiplication.

The following data may testify of the scale of multiplication of that project. As mentioned above, there are about 180 000 boilers in the Russian Federation per Rosstat information. Of those, 84 thousand fire coal and fuel oil for their fuel. Even partial conversion of those boilers to the use of gas may cause significant indicators in saving energy resources. Particularly high indicators could have been achieved in the domain of prevention of greenhouse gases emissions.

Besides, one should take a note of the majority of existing boilers being commissioned into operation back in the Soviet times, and exemplified by significant deterioration at present. Mean depreciation of boilers, especially those located in rural areas and small municipalities similar to Kolpashevo exceeds 60 per cent. Wasteful mode of fuel consumption is peculiar to those. By indicator of energy resources consumption for heat generation, boilers installed in the Russian regions are substantially inferior to their contemporary international counterparts. For utility boilers, fuel utilization factor (FUF) does not, on average, exceed 30 per cent.

Under those conditions, even unsophisticated upgrade of sources of heating peculiar of their high degree of depreciation, including those firing gas, may bring about substantial saving of energy resources. When addressing Kolpashevo project experience, one may see that upgrade of boilers shall also afford:

- increase efficiency of heating sources to 91.7 per cent,
- substantially reduce losses in the heating supply systems,
- reduce electric power consumption by 44.6 per cent (3300,4 thousand kW/h) and
- reduce costs for personnel payroll associated with its reduction by 55.8 per cent (282 people) on account of implementation of automation and scheduling of production processes.

Thus it is evident that the gross volume of feasible saving of energy in case of multiplication of a similar project for other facilities is immense.

By various estimates, potential of energy saving in Russia makes an order of 40-45 per cent of its existing annual consumption. Energy saving potential for gas only is estimated at upwards of 100 billion cubic meters a year. The bulk of that potential is concentrated in housing and public utilities complex, a testimonial of which is evaluation of the project in "Kolpashevo Urban Settlement". Should one estimate feasible potential of energy saving in the housing and public utilities complex of Russia in specific values, then its volume is estimated at 95-110 million ton of equivalent fuel.

In other words, assessment of energy-saving potential in the regions of the Russian Federation on the basis of the use of the experience of the project in the municipality "Kolpashevo Urban Settlement" of Tomsk Province testifies of significant results that may be achieved in case of its multiplication. An especially significant effect is achieved in the domain of reduction of greenhouse gases emissions.

Yet to implement this task, one should accomplish measures of encouragement of economic motivation of fuel and energy consumers to energy saving, and actualize measures of appropriate incentives of investment in that domain.

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List of Abbreviations

GEF	Global Environmental Fund
HCS	Housing and Communal Services
EBS	European Business Congress
UGSS	Unified Gas-Supply System
UNECE	United Nations Economic Commission for Europe
IP	Investment Premium
L	Leasing
JSC	Joint Stock Company
LLC	Limited Liability Company
REC	Regional Energy Commission
EC	Equity capital
T	Tariff
FEC	Fuel and energy complex
FER	Fuel and energy resources
CHPP	Combined heat and power plant
FGEF	French Fund for Global Environment
FL	Federal Law
UNF	United Nations Fund
ESCO	Energy Service Company
FTS	Federal Tariff Service

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