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CURRENT STATUS OF SUBREGIONAL AND COUNTRY-ORIENTED PROJECTS UNDER THE UMBRELLA OF THE ENERGY EFFICIENCY 21 PROJECT

Financing Energy Efficiency Investments for Climate Change Mitigation

Analytical Study on Inter-Fuel Substitution Implemented in Kolpashevo Municipality

Note by the secretariat

INTRODUCTION

1. The analytical strategy paper Analytical Study on Inter-Fuel Substitution Implemented in Kolpashevo Municipality - Recommendations for Future Inter-Fuel Substitution Implementations in Municipalities of the Russian Federation has been financed by the European Business Congress (EBC) through the United Nations Economic Commission for Europe (UNECE) in the framework of the project financing Energy Efficiency Investments for Climate Change Mitigation.

2. The present note provides a detailed evaluation of the energy efficiency, environmental, social and financial outcomes related to gas supply and accompanied reconstruction of heat-supply system. The analysis also aims to reveal factors restraining investments in energy-saving and energy-efficiency activities and to help develop directions of a better investment climate.

I. ASSESSMENT OF INTER-FUEL SUBSTITUTION OF COAL AND LIQUID FUEL BY NATURAL GAS

3. 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:

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

4. 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.

5. By December 2008 the following activities had been implemented:

(a) Construction of a gas pipeline to Kolpashevo;
(b) Implementation of the first and second stages of gas supply;
(c) 14 municipal boiler houses have started operating, which covers 70 % of the heat needs of the district;
(d) Installation of modern gas boilers with chemical water treating, processing automation, gas flow meters;
(e) Reconstruction of 7.5 km heat network.

6. Plans for the future include substitution of the boiler houses fuelled by coal and oil with gas-fired ones. For the purpose of implementing a comparative study of the inter-fuel substitution and the effectiveness of the accepted decisions, four alternatives were defined:

Alternative 1 - Before gasification reflects the heat and power supply situation in the district prior to the unified gas supply system connection.

As of 1 January 2007, heat to Kolpashevo city was supplied by 50 boiler-houses with 147.4 Gcal/h of total installed capacity, including 39 public (municipal) and 11 owned by different enterprises.

Alternative 2 - First stage describes the district heat and power supply after implementing the first stage of gas supply and distribution and re-equipping 14 boiler houses.

The heat supply system of Kolpasevo city and Togur village is very centralized. In 2008, according to the lease agreement with the Kolpashevo city administration, operation of the basic municipal boiler-houses in Kolpashevo city was done by:

- Kolpashevo Heating Company ltd
- Heating Systems and Technologies ltd
- Housing and Municipal Services ltd

On the basis of an investment agreement with the Kolpashevo administration, Kolpashevo Heating Company put in place 14 gas-fired boiler-houses that started operating from spring 2008. These boiler-houses replaced 25 old ones. Financing for this activity was provided by a leasing company.

Alternative 3 - Gas-fired boiler-houses - all boiler-houses fed by coal and oil have been shut down and replaced by gas-fired boiler-houses.

It is planned to replace the remaining 14 municipal boiler-houses with six gas-fired ones. After implementation of the planned measures, the total number of municipal boiler-houses will be 20.

Alternative 4 - Mini combined heat ant power (CHP) plants - virtual model of implementation of the high energy efficiency zone project.

7. These four alternatives are compared in table 1 through selected parameters. Table 2 compares the energy balances of the four considered alternatives.

8. Before gasification, annual primary energy consumption in Kolpashevo was 128,870 t.o.e. After implementation of the first stage of gasification, primary energy consumption will decrease by 22,000 t.o.e (by 20 per cent). Later, primary energy consumption will decrease to 63,700 t.o.e (by 1.9 times compared with 2007). If mini CHP plants are constructed, then consumption will decrease to 83,400 t.o.e (by 35 per cent).

9. After implementation the first stage, final consumption will decrease by 20 per cent, while for Alternatives 3 and 4 it will decrease by 40 per cent (in comparison with Alternative 1).

Table 1 Comparison of some parameters of boiler-houses for assessed alternatives

Item	Unit	Alternative 1 Before gasification (2007)	Alternative 2 First stage (2009)	Alternative 3 Gas-fired boiler-houses	Alternative 4 Mini CHP plants
Main heat-supply facilities (boiler-houses), incl.:	pieces	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, including:	Gcal/h	146.69 (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 power capacity	MW	-	-	-	5.45
Efficiency rate of installed capacity in use		0.5	0.58	0.64	0.64
Nominal thermal 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, including:	Gcal/yr	233 067,6	217 441.1	201 480.0	201 480.0
- gas-fired boiler-houses	Gcal/yr	-	97 100.0	201 480.0	154 760.0
Annual power generation	10^6kWh	-	-	-	39.2

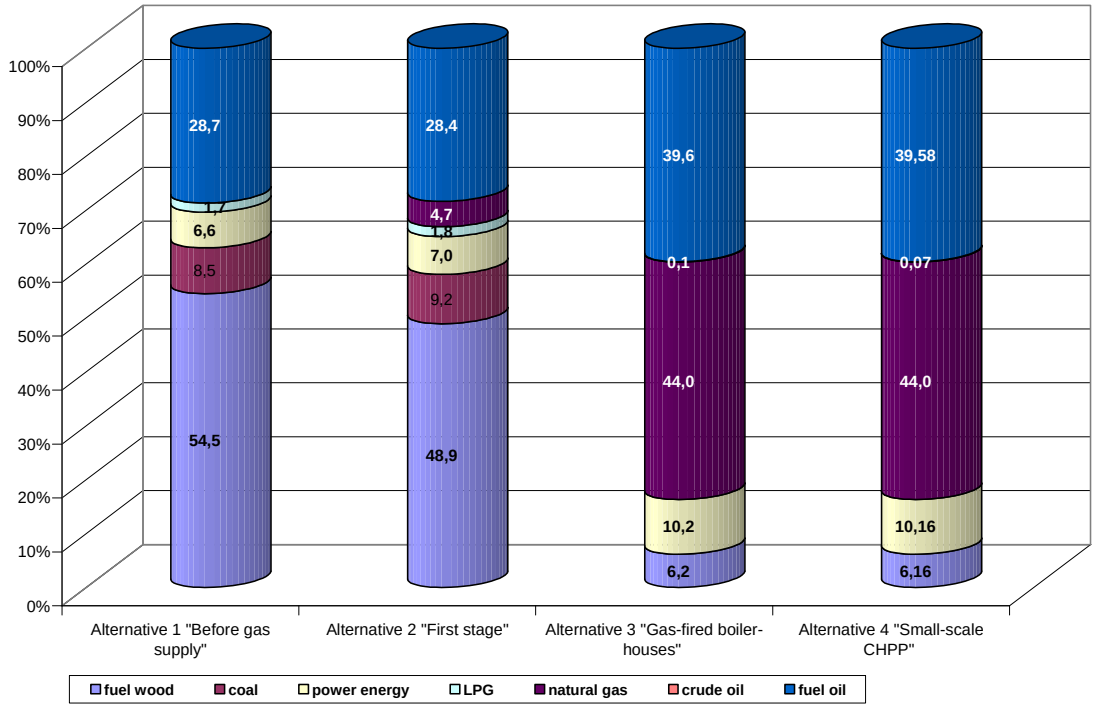
Table 2 Fuel and energy resources consumption

Item	Unit.	Alternative 1 Before gasification (2007)	Alternative 2 First Stage»(2009)	Alternative 3 Gas-fired boiler-houses [a]	Alternative 4 Mini CHP plants [a]
Primary energy	10^3 tce.	128.8	106	67.3	83.4
Final consumption	10^3 tce.	95.3	88.9	58.7	58.7

[a] After complete implementation of the project

10. As indicated in figure 1, final fuel and energy resources consumption in the district changes considerably: predominant share of wood fuel decreases from 54.5 per cent (Alternative 1) to 49 per cent (Alternative 2) and in the future will drop to 6.2 per cent (Alternatives 3 and 4). The share of natural gas in the structure of final consumption increases: up to 4.7 per cent in Alternative 2 and up to 44 per cent (Alternatives 3 and 4). Development of the gasification programme gradually makes oil and coal disappear from the fuel balance of house boilers to the benefit of natural gas.

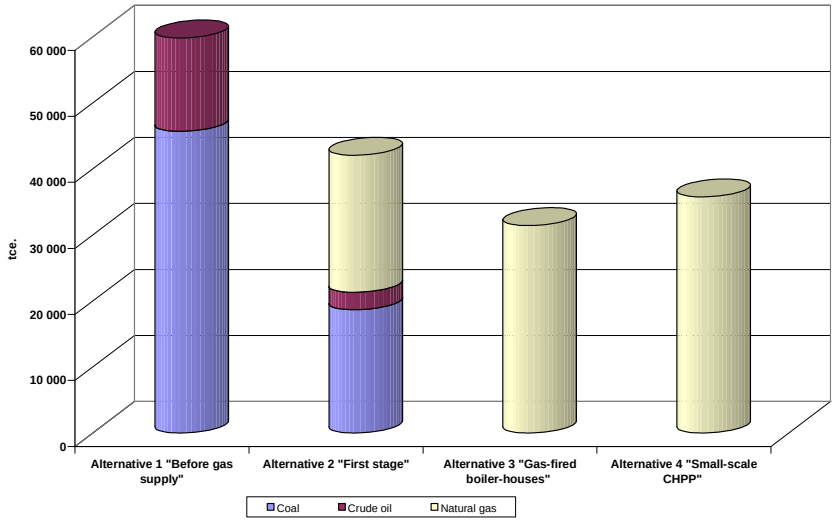
Figure 1 Structure of fuel and energy resources consumption by energy resources type



II. DESCRIPTION OF HEAT SUPPLY SYSTEMS

11. A comparison of boiler-houses fuel balance for the examined alternatives is shown in figure 2.

Figure 2 Comparison of volumes and structure of fuel consumption for examined alternatives

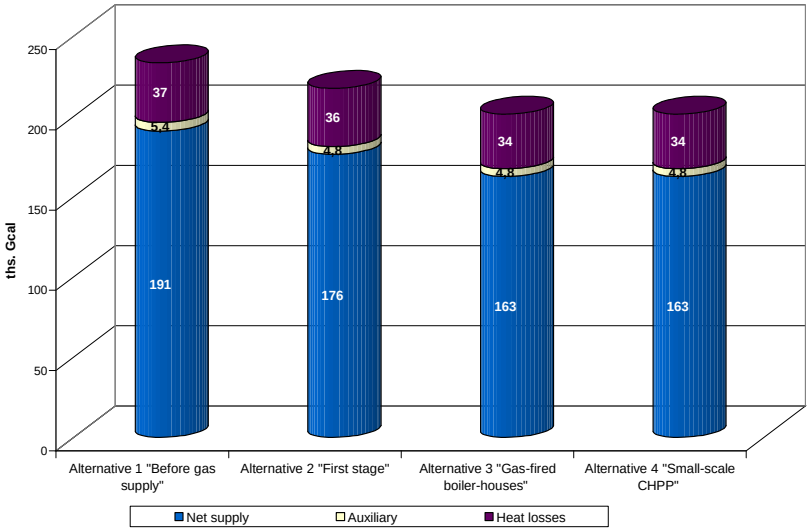


12. Fuel consumption decreases through optimization of the heat supply structure and installation of newer and more effective equipment:

- after implementation of the first stage (Alternative 2) – decrease of 30 per cent (42,000 t.o.e versus 59,800 t.o.e consumed in 2007);
- for Alternative 3 – Gas fired boiler-houses – almost 50 per cent (31,000 t.o.e versus 59,800 t.o.e in 2007)
- for Alternative 4 – mMini CHP plants – 40 per cent. However, in addition to heat generation and supply of heat to the district, it is planned to produce electricity also from the same fuel volume.

13. The Main producers of heat energy in the city of Kolpashevo were and still are municipal (public) boiler-houses. In 2007, their share in total heat generation was 76.6 per cent.

Figure 3 Use of the generated heat for examined alternatives (in ths. Gcal)



14. Optimization of the localization of boiler houses led to a decrease in heat generation in Alternatives 2, 3 and 4 as compared with Alternative 1. However, the share of heat losses in the heating systems did not vary from an average of 17 per cent of the annual heat generation.

III. ENERGY AND ENVIRONMENTAL EFFICIENCY

15. Table 3 shows average parameters of energy and environmental efficiency for the heat facilities of Kolpashevo city. The following conclusions can be drawn from this information:

(a) After implementation of the first stage, net efficiency of fuel consumption in all boiler houses of the district grew by almost 15 per cent, reaching then 60 per cent. This improvement resulted from the use of advanced equipment for several municipal boiler-houses. For alternatives 3 and 4, efficiency of fuel consumption exceeded 70per cent.

(b) Specific fuel consumption (SFC) in boiler houses is also expected to be positive: before gasification, average SFC in the district was 0.256 tce/Gcal while after implementation of the first stage SFC should be 0.193 tce/Gcal (for gas-fired boiler-houses – 0.155 tce/Gcal), which demonstrates a significant increase in the equipment's efficiency. For Alternative 4 – mini CHP plants – SFC increased due to combined heat and power generation.

(c) Alternatives 3 and 4 show substantial efficiency increase by 1.6 times.

Table 3 Comparison of energy and environmental efficiency parameters for assessed alternatives

№	Item	Unit	Alternative 1 Before gasification	Alternative 2 First stage	Alternative 3 Gas-fired boiler-houses	Alternative 4 Mini CHP plants
1.	**Fuel consumption efficiency (FCE)**	**%**	**45.6**[a]	**59.9**	**74.1**	**78.2**
	- municipal boiler-houses	%	44.4	64.5	72.7	72.7
2.	**Specific fuel consumption (SFC)**	**toe/Gcal**	**0.256**	**0.193**	**0.157**	**0.160**
	- municipal boiler-houses	toe/Gcal	0.261	0.176[b]	0.155	0.160
	- Mini CHPP	toe/kWh	-	-	-	0.300
3.	**Average weighted efficiency of 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**	**t/year**	**8 152**	**3 387**	**122.3**	**202.2**
	- municipal boiler-houses	t/year	5 557	1 203	87.9	167.4

[a] Recommended value 68-70%
[b] For gas-fired boiler-houses specific fuel consumption will be 0.155 tce/Gca

The low efficiency rates that existed before gasification were leading to high fuel consumption high production costs of heat.

(d) The positive trend of specific power energy consumption (SPEC) due to the installation of advanced equipment is obvious. For Alternatives 3 and 4, initial SPEC was 25.19 kWh/Gcal and decreased to 20.49 kWh/Gcal.

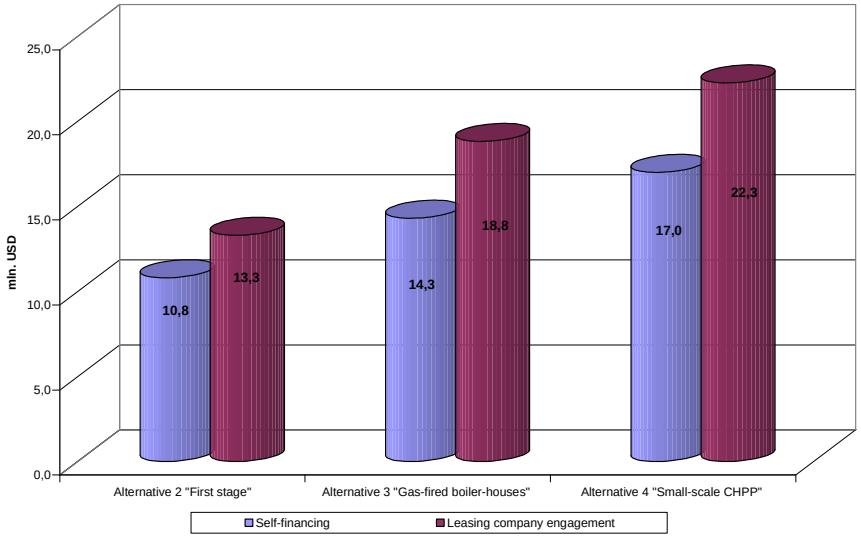
(e) The installation of advanced equipment led to a 2.5 times reduction in staff, which will undoubtedly decrease production costs and could be a source of material reward for the remaining personnel.

(f) The reduction of harmful emissions vividly demonstrates the advantages of natural gas over the other fuels (coal and oil). Harmful emissions from public boiler houses decreased by more than 4 times after implementation of the first stage (Alternative 2), while for Alternatives 3 and 4 emissions reduction decreased by 60 times and 40 times respectively.

IV. ECONOMIC EVALUATION OF THE INTER-FUEL SUBSTITUTION

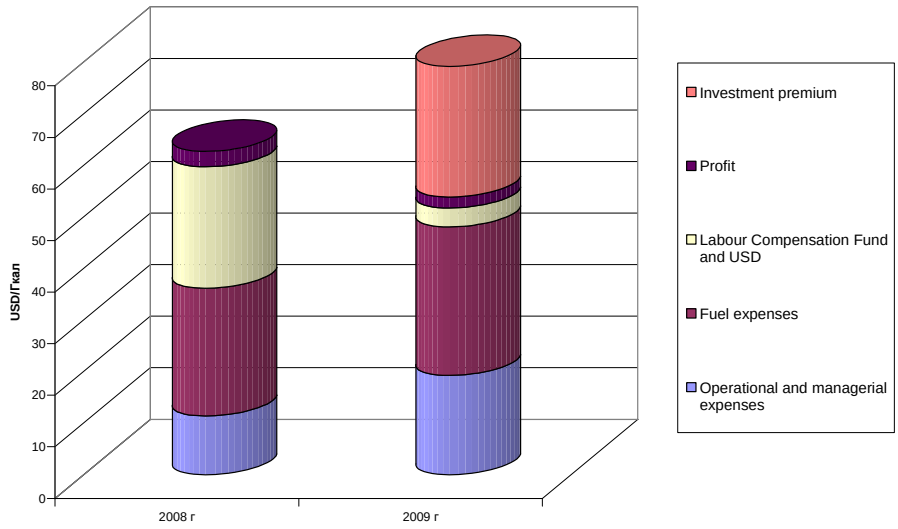
16. The estimated investment needs under the different alternatives are presented in the figure 4, where comparative data are supplied for the cases of self-financing investment and of a leasing company involvement. The figure shows that the capital costs of Alternative 3 – gas-fired boiler houses – are 30 per cent higher that those of Alternative 2 – first stage – and the capital costs of Alternative 4 – mini CHP plants – are 20 per cent higher that those of Alternative 3. The involvement of leasing leads to an increase of required costs almost by 30 per cent.

Figure 4 Investment needs under different Alternatives



17. A comparison of tariffs, calculated in compliance with current legislation for Alternatives 1 and 2, is presented in figure 5.

Figure 5 Formation of tariffs in Kolpashevo Heating Company



18. Analysis of the above information leads to the following conclusions:

(a) Replacement of equipment led to a reduction of heat production costs by 40 per cent:

- Expenses cut by 7 times under item labour compensation fund and uniform social tax
- Expenses cut by 30 per cent under item fuel for production needs.

(b) Tariff reduction by 24 per cent – from $62.7/Gcal to $47.4/Gcal.

(c) Investment Premium addition – $25/Gcal.

19. In Alternative 2 – First Stage - it is planned to freeze the tariff for five years as an investment premium addition, and to remove the investment premium on expiration of the leasing agreement. As a result, the tariff will decrease and its value will be lower than in Alternative 1 – before gasification.

20. In Alternative 3 – gas fired boiler houses – the same structure of heat generation costs and of tariffs will be kept.

21. Tariff formation under Alternative 4 – small-scale CHP plant – differs from the one in Alternatives 2 and 3 due to generation of electricity in addition. However, the tendency towards tariffs reduction is maintained.

22. Fuel substitution from oil to natural gas leads to a reduction of heat tariffs. Besides, introduction of mini CHP plants provides not only higher energy efficiency, but also a nearly 30% reduction of the weighted average tariff.

V. ASSESSMENT OF PROFITABILITY OF THE INVESTMENTS

23. Results of the investment profitability analysis for each Alternative are shown in table 4.

Table 4 Analysis of commercial viability of considered alternatives

Index	**Equity capital – tariff**	**Equity capital – investment premium**	**Leasing – tariff**	**Leasing – investment premium**
Alternative 2 – first stage – (estimated period 10 years)				
Investment needs, million 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				
Investment needs, million USD	17.0	17.0	22.3	22.3
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%

24. These data lead to the following conclusions:

Alternative 2:

(a) Alternative 2 Equity capital – tariff: use of the investor's own funds as the only investment source with the basic tariff set at 60 USD/Gcal[*] leads to a quite low profitability, with an IRR of only 7 per cent. Such a low profitability index would be a major barrier to investments in the heat supply sector.

(b) Alternative 2 Equity capital – Investment premium: use of the investor's own funds as the only investment source with the basic tariff set at 72.7 USD/Gcal secures positive economic efficiency indices, which shows an improvement in the investment potential on condition that investment premium is put in place. However, the requirement of such high investment amounts (USD 10 million) is a major barrier for the housing and utility sectors.

(c) Alternative 2 Leasing – tariff: financing including a leasing scheme with the tariff of 47.4 USD/Gcal as set by the Federal Tariff Service (FTS) for Kolpashevo Heating Company

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

will not pay back within the considered life cycle of the project of 10 years. As standard service life of boiler houses is 7-10 years, this Alternative does not seem realistic.

(d) Alternative 2 Leasing – investment premium: financing including a leasing scheme can be economically viable with a tariff of 72.7 USD/Gcal, which is currently implemented by the Kolpashevo Heating Company.

Alternative 4 can be characterized as follows:

(a) Under the current legislation on tariffs formation, the investment project will have a low profit margin. Raising tariffs by only 20 per cent will ensure higher profit and a shorter pay-back period.

(b) Investment needs are higher than under other Alternatives envisaging the construction of boiler-houses, which is a significant factor for this economic sector.

(c) This Alternative's implementation makes it necessary to solve the issue of excess electricity generation, which is a common issue for districts with low industrial activity. Excess electricity can be sold on the wholesale electric power market, which however may face an overwhelming number of technological difficulties and bureaucratic barriers.

Table 5 Analysis of barriers to successful investments in energy savings and energy efficiency and suggestions on how to overcome them

	Barrier	Possible solution
1.	Weak legal and regulatory framework for energy savings	Reforms of legal and regulatory framework for energy savings
2.	Insufficient support from the State to energy saving activities	Provision of State support for technical re-equipment and renovation of power equipment, development and introduction of energy efficient technologies
3.	Low prices and assignation of natural gas entitlements	Differentiation of natural gas prices according to the gas use efficiency and development of secondary regional gas market model
4.	High capital intensity and low profitability of energy-saving projects	Formation of schemes that will guarantee investment paybacks and profitability Formation of a structure able to attract investments to the public (municipal) sector; Implementation of investment schemes attracting borrowed capital (credit, leasing)
5.	Low credit capacity of public (municipal) sector enterprises	
6.	Low paying capacity of residential consumers	Provision of subsidies to low income consumers
7.	Insufficient social awareness about energy efficiency in the Russian Federation economy and lack of understanding of the necessity to save energy	Formation of public opinion about energy savings necessity

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