

REGIONAL ASPECTS OF HEAT SUPPLY IN THE SYSTEM OF FUEL AND ENERGY COMPLEX OF UKRAINE

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This paper attempts to characterize the fuel and energy complex of Ukraine and analyzes the heat supply complex on the example of Lviv region. The main problems in the field are highlighted. The ways of diversifying fuel and energy resources of Ukraine are determined. The basic directions of implementing the alternative energy sources are analyzed. A comprehensive description of the alternative and renewable energy sources potential, on the examples of different regions of Ukraine, is provided.

Key words: housing and utilities services, problems of the branch, energy resources of Ukraine, fuel and energy complex, Lviv region, heat supply.

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РЕГІОНАЛЬНІ АСПЕКТИ ТЕПЛОПОСТАЧАННЯ В СИСТЕМІ ПАЛИВНО-ЕНЕРГЕТИЧНОГО КОМПЛЕКСУ УКРАЇНИ

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Зроблено спробу охарактеризувати паливно-енергетичний комплекс України та проведено аналіз теплопостачального комплексу на прикладі Львівської області, висвітлено основні проблеми у вищеназваній сфері. Визначено шляхи диверсифікації паливно-енергетичних ресурсів України. Проаналізовано основні напрями впровадження альтернативних джерел енергії. Надано вичерпну характеристику енергетичного потенціалу нетрадиційних та відновлюваних джерел енергії на прикладі різних областей України.

Ключові слова: житлово-комунальне господарство, проблеми галузі, енергоресурси України, паливно-енергетичний комплекс, Львівська область, теплопостачання.

Problem statement

A significant amount of the energy balance of Ukraine is heat supply, which is a matter of national importance. Efficient, high-quality and reliable heat supply is a part of the energy security of Ukraine. In this area there is a need to diversify energy suppliers and to implement alternative energy sources.

According to recent estimates of experts, in the near future the further strengthening of dependence of industrialized countries on energy imports is expected. EU member states are set to deepen cooperation with suppliers and transits of energy resources. Important is also the policy of diversification of sources and routes of energy supplies.

The economy of most countries in Europe depends on outside supplies of energy. The EU is now the world's largest consumer of natural gas. The leading suppliers are Algeria and the North Sea basin countries (Norway, the United Kingdom, the Netherlands) [1].

Analysis of recent research and publications

Politicians and scientists pay much attention to the issue of energy independence of Ukraine. Namely Volovych O.O. in his works suggests methods of diversifying sources of energy. Among them are “Energy Security of Ukraine in context of European oil and gas prospects”, “The conflict between Moscow and Minsk and Russian oil pipeline control”. In the work of M. Vyhoda “Issues of energy security of Ukraine” the problem of

energy security is also highlighted. Studies of heat supply and thermal modernization of housing stock in Ukraine is carried out by many authors, including: Brygilevych B., Holler K., Shrekkenbah L. Janickyj T., A. Shchodra O., Shvets N., Bernatskyj V., Svystyuk S., Maximov A.

Objectives

- establishing liability of subjects of heat supply for violation of legislation on heat supply;
- increasing environmental safety of heat supply systems;
- creating conditions for the implementation of energy-saving technologies.

Materials

“Ukraine has a very advanced and fulfilling fuel and energy complex (FEC). From its own sources the country meets its needs in primary fuel and energy resources (FER) by almost 45 %”, – says Mykola Vygoda [4].

Table 1

Statistical information for the FEC in 2013 [6]

Indicators	December 2013	as of December 2012		2013	as of 2012	
		+ / -	%		+ / -	%
ELECTRICITY (mln.kWh)						
Production	18 549,8	- 607,7	96,8	193 564,4	- 4 555,0	97,7
Export	745,5	- 53,2	93,3	9 861,5	116,2	101,2
Consumption (net)	13 636,5	- 142,4	99,0	147 264,4	- 3 456,6	97,7
COAL (thsnd. tons)						
Production	7 538,6	332,1	104,6	83 697,5	- 2 218,5	97,4
including coking coal	2 072,4	- 12,9	99,4	23 724,5	- 1 099,0	95,6
power-generating coal	5 466,2	345,0	106,7	59 973,0	- 1 119,6	98,2
Consumption of coal	3 566,8	93,2	102,7	37 641,9	- 609,4	98,4
OIL (thsnd. tons)						
Production of oil with gas condensate	250,2	0,0	100,0	3 050,9	- 124,0	96,1
including Naftogaz of Ukraine National Joint Stock Company	223,3	- 2,9	98,7	2 746,8	- 147,5	94,9
Oil supply to refineries of Ukraine	217,9	- 86,6	71,6	3 270,6	- 743,4	81,5
including oil import	3,0	- 45,3	6,2	659,1	- 852,3	43,6
Refining crude oil at refineries of Ukraine and Shebelinsk gas refinery	240,3	- 67,2	78,1	3 377,0	- 1 193,3	73,9
Production of oil products:						
petrol	71,7	- 46,4	60,7	963,6	- 673,4	58,9
diesel	57,8	- 27,3	67,9	950,6	- 413,8	69,7
fuel oil	44,9	- 0,1	99,8	600,1	- 115,2	83,9
Consumption of oil 8:						
petrol	321,9	0,1	100,0	3 984,9	- 212,4	94,9
diesel	471,0	24,7	105,5	5 947,3	- 67,5	98,9
fuel oil	21,5	0,6	102,9	191,5	- 122,5	61,0
Oil transit	1 335,6	25,1	101,9	15 577,2	1 020,5	107,0

Table 1 continued

Indicators	December 2013	as of December 2012		2013	as of 2012	
		+ / -	%		+ / -	%
GAS (mln. m ³)						
Production	1 824,9	79,3	104,5	20 998,2	806,7	104,0
including Naftogaz of Ukraine National Joint Stock Company	1 600,6	36,1	102,3	18 663,2	455,1	102,5
Consumption	6 679,6	- 1 281,7	83,9	50 357,6	- 4 417,0	91,9
Import	2 305,4	- 265,4	89,7	27 974,4	- 4 964,9	84,9
Transit	8 930,9	- 26,1	99,7	86 125,7	1 864,7	102,2

Having analyzed the key indicators presented in table 1, it can be concluded that by all accounts, there is a decrease in production of energy resources, including:

- production and consumption of electricity decreased by 2.3 % compared to 2012, but despite this electricity exports increased by 1.2 %;
- production and processing of oil in 2013 significantly reduced, it can be argued that the production of oil fell by an average of 28.8 %, while 15.2 % only due to reduction in the consumption of fuel oil;
- In the field of gas producing there are positive trends, including the increase of gas production (4%) and reduction of its consumption by 5.1 % as well as reduction of imports by 15.1 %. In addition, transit increased by 2.2 %.

As follows from the analysis, the main strategic directions of growth of energy independence of Ukraine are:

- optimally justified raising the level of the country providing domestic fuel and energy resources;
- increasing the efficiency of energy production and energy use as the direction of internal reserves of energy;
- diversification of sources and routes of supply of energy resources into Ukraine;
- use of profitable transit facilities of oil and gas to Western Europe;
- improving state governance and regulation of activities in the energy sector;
- introduction of energy efficient technologies of heat energy production;
- reduction of heat losses in buildings and while transportation [5].

Let us name the main ways to diversify oil and gas supply sources of energy:

1. The pipeline “Odessa – Brody – Plock – Gdansk”. This is one of the most important ways to build a transit system of the Eurasian oil transportation corridor that will provide Europe with Caspian oil.

2. EU gas project Nabucco (“Nabucco”). It applies to transport gas from Iran, Turkmenistan and Azerbaijan via Turkey and the Balkans, bypassing Russia. It is expected that the pipeline will pass through Romania and Hungary, near the south-western border of Ukraine.

3. Pipeline project GUEU (Georgia – Ukraine – EU) – “White Stream”. Potential opportunities of attracting Georgian gas to Ukraine.

4. Transarabian Pipeline (TAP). This system supplies Egyptian gas. In the future there is perspective of joining TAP to “Nabucco”.

5. Liquefied natural gas. Liquefied natural gas is obtained when it is cooled or pressure is increased. Liquefaction of natural gas is made for easy and compact storage or transportation to the consumer. Cabinet of Ministers regards construction of LNG-Terminal as one of the measures aimed at reducing the consumption of Russian gas [11, p. 68–75]

6. Development of the Black Sea shelf.

So, as we see in terms of the energy crisis, the issue of transition from traditional energy sources to new, alternative, environmentally safe ones is topical [7].

The International Renewable Energy Agency (IRENA) determines that renewable energy is all forms of energy derived from renewable sources in a sustainable manner, including:

- 1) bioenergetics;
- 2) geothermal energy;
- 3) hydropower;
- 4) ocean energy (tidal power, wave and ocean thermal energy);
- 5) solar power;
- 6) wind power [12].

Ukraine has a rather high potential for renewable energy development. The same is true of other alternative traditional sources of energy – such as mine methane, peat, lignite, waste heat potential of domestic and industrial wastewater treatment and more. There are possibilities of the use of alternative renewable energy sources (ARES) in all areas of the country. However, despite the large number of adopted laws, programs and other documents, implementation of ARES is moving too slow, their contribution to the country's energy balance is negligible.

The reasons for this are many. The main ones are - absence of economic incentives for switching to ARES, declarative legal acts without specific implementation mechanisms, and low executive discipline. We can not say that there is nothing being done in this direction, but not enough measures are taken to avoid negative tendencies - the world's rising energy prices, increasing energy dependency of the country and pollution.

Not introducing new types of ARES, not investing in technology without developing production based on new technologies, the country preserves technological backwardness and could lose their chance to enter the European Union. [9] Indicators for ARES in the main areas of development are presented in table 2.

Table 2

**Indicators for ARES in key areas of development (baseline), million tons
of conventional fuel / year [8]**

ARES development areas	The level of ARES development by years			
	2005	2010	2020	2030
Alternative sources of energy, total	13,85	15,96	18,5	22,2
including mine methane	0,05	0,96	2,8	5,8
Renewable energy sources, total, including:	1,661	3,842	12,054	35,53
bioenergetics	1,3	2,7	6,3	9,2
solar power	0,003	0,032	0,284	1,1
small hydro power	0,12	0,52	0,85	1,13
geothermal energy	0,02	0,08	0,19	0,7
Wind power	0,018	0,21	0,53	0,7
ambient energy	0,2	0,3	3,9	22,7
Total	15,51	19,83	30,55	57,73

Table 3

**Technically feasible energy potential of alternative and renewable sources of energy in terms of
standard fuel (million tons of conventional fuel) and volume of FER replacement [9]**

#	Regions	Solar power	Geothermal energy	Small hydro power	Bio-mass energy	Waste water thermal energy	Thermal energy of the soil and groundwater	Total throughout regions	Consumption of organic fuel		% of replacement of organic fuel by RES
									Residential sector	Total	
1	2	3	4	5	6	7	8	9	10	11	12
1.	Crimea	0,39	0,68	0,05	0,59	0,16	0,35	2,22	0,133	2,193	101,2
2.	Vinnitsia Region	0,25	0	0,09	1,08	0,08	0,42	1,91	0,097	7,777	24,8
3.	Volyn Region	0,18	0	0,03	0,29	0,05	0,29	0,84	0,054	3,064	27,4
4.	Dnipropetrovsk Region	0,32	0	0,03	1,90	0,59	1,36	4,20	0,203	27,023	15,54
5.	Donetsk Region	0,27	0	0,05	1,16	0,50	1,36	3,34	0,285	33,795	9,88
6.	Zhytomyr Region	0,26	0	0,09	0,38	0,06	0,30	1,09	0,079	2,399	45,4

Table 3 continued

1	2	3	4	5	6	7	8	9	10	11	12
7.	Zakarpattia Region	0,13	7,40	1,05	0,21	0,05	0,45	9,29	0,065	1,175	79,6
8.	Zaporizhia Region	0,28	0	0,03	1,13	0,19	0,34	1,97	0,108	14,568	13,5
9.	Ivano-Frankivsk Region	0,13	0,51	0,09	0,17	0,11	0,49	1,50	0,076	6,916	21,7
10.	Kyiv Region	0,26	0	0,06	1,02	0,63	1,14	3,11	0,258	16,458	18,9
11.	Kirovohrad Region	0,23	0	0,04	1,26	0,06	0,33	1,91	0,065	2,855	66,9
12.	Luhansk Region	0,27	0	0,10	1,11	0,16	0,93	2,57	0,150	10,630	24,2
13.	Lviv Region	0,22	0,45	0,42	0,41	0,32	1,05	2,87	0,144	8,604	33,4
14.	Mykolaiv Region	0,26	0	0,04	0,97	0,08	0,30	1,65	0,070	5,22	31,6
15.	Odessa Region	0,37	0	0,01	0,42	0,21	0,35	1,37	0,136	7,046	19,4
16.	Poltava Region	0,26	0,39	0,09	1,43	0,11	0,81	3,08	0,092	10,492	29,4
17.	Rivne Region	0,17	0	0,08	0,36	0,06	0,27	0,95	0,062	2,282	41,6
18.	Sumy Region	0,22	0,96	0,08	0,79	0,06	0,40	2,50	0,072	5,122	48,8
19.	Ternopil Region	0,15	0	0,09	0,44	0,05	0,34	1,06	0,060	2,560	41,4
20.	Kharkiv Region	0,29	0,37	0,06	1,69	0,35	1,07	3,82	0,168	15,298	25,0
21.	Kherson Region	0,31	0	0,01	1,09	0,06	0,23	1,69	0,065	3,455	48,9
22.	Khmelnitskyi Region	0,20	0	0,07	0,79	0,07	0,39	1,52	0,079	2,579	58,9
23.	Cherkasy Region	0,21	0	0,09	0,36	0,10	0,38	1,13	0,079	4,819	23,5
24.	Chernivtsi Region	0,09	0	0,21	0,29	0,03	0,19	0,81	0,048	1,348	60,1
25.	Chernihiv Region	0,28	1,24	0,04	0,66	0,06	0,35	2,62	0,072	3,672	71,4
Total		6,00	12,0 0	3,00	20,0 0	4,2	13,89	59,09	59,02	202,07	29,2
The volume of replacement of organic fuel by "big" hydropower in Ukraine								7,0			3,6
The volume of replacement of organic fuel by wind power in Ukraine								15,0			7,4
Technically feasible power potential of alternative energy sources								12			4,9
TOTAL								93		202,07	46

The problems of energy supply in Ukraine today become crucial for the development of heat supply system of residential areas.

Heat supply system of Ukraine is based on the principles of Article 6 of the Law of Ukraine "On Heat Supply" [2]:

- ensuring energy security of the country;
- state control and regulation in the sphere of heat supply;
- the optimal combination of centralized and autonomous heat supply systems in accordance with approved by local executive power bodies heat supply schemes with a five years period of revision;
- state support and encouragement in the heat supply sphere;
- pricing and tariff policy;
- the priority development of applying technology of combined production of heat and power (cogeneration) and utilization of secondary energy resources, alternative and renewable energy sources;
- protecting the rights and interests of consumers;
- mutual liability of subjects of relations in the field of heating for high-quality supply of thermal energy and its timely payment;
- periodic review, improvement and technical-economic optimization of heat supply schemes approved by local authorities;
- keeping the standards, rules and regulations by all subjects of relations in the field of heat supply;
- a ban on limiting power supply of facilities in the heat supply sphere during the heating period below the technological minimum of natural gas. In case of failure or making no full payment for the consumed natural gas services and transportation gas supplier has the right to limit the consumption of natural gas by economic entities in the field of heat supply, for which rates are set at reasonable levels, to the technological level of consumption;
- creation of conditions for the functioning of the heating industry on the principles of self-sufficiency;

- promotion of a competitive market for heat supply;
- establishing liability of subjects of heat supply for violation of legislation on heat supply;
- increasing environmental safety of heat supply systems;
- creating conditions for the implementation of energy-saving technologies;
- Ensuring the implementation of metering devices and regulation equipment of heat consumption

[1].

However, in heat supply system remain many problems typical of most residential areas of Ukraine, namely:

- power of boiler houses far exceed the thermal load;
- boiler houses equipment is outdated and inefficient;
- reliability of heat supply network is rather low, networks are outdated, insulation is very poor, resulting in heavy losses. Heat supply system suffers large losses as a result of frequent accidents and significant amounts of repair work [3].

According to the Lviv Regional State Administration (LRSA) district heating of residential areas in Lviv region is carried out by district heating companies, owned by local communities of regional significance.

Out of 20 districts of Lviv region centralized heat supply is provided in 14 of them. In other districts heat supply companies have been eliminated (data for the region are presented in Table 4) [10].

Table 4 [10]

Heat supply companies in Lviv Region as of 01.01.2012

#	Names of regional centers, districts	# of company	Heat supply company	Heat supply company address
C1	Lviv (city council)			
	C1.1.	1	Lvivteploenerho Lviv city household utility (HU)	Danylo Aposto l str.,Lviv, 79040
	C1.2.	2	Zaliznychneteploenerho CHU	S.Petlyury str., 4a, Lviv, 79054
C2	Boryslav (c/c)			
	C2.1.	3	Boryslavteploenerho HU	Kovaliva str., 52a, Boryslav, 82300
C3	Drohobych (c/c)			
	C3.1.	4	Drohobychteploenerho HU	Industrialna str., 1a, Drohobych, 82100
	C3.2.	5	Stebnykteplokomunenerho SHU	Melnychuka str., 17, Stebnyk, 82172
C4	Morshyn (c/c)			
	C4.1.	6	Morshynteploenerho HU	Pryvokzalna str., 45, Morshyn, 82482
C5	Novyj Rozdil (c/c)			
	C5.1. <i>Private</i>	7	Energy- Novyj Rozdil JSC	Hrushevskoho str., 37, Novyj Rozdil, 81652
C6	Sambir (c/c)			
	C6.1.	8	Sambirteplokomunenerho enterprise for heating networks	Krushelnyskoyi str., 9, Sambir, 81400
C7	Stryj (c/c)			
	C7.1.	9	Stryjteploenerho HU	O.Basarab str., 13a, Stryj, 82400
C8	Truskavets (c/c)			
	C8.1.	10	Truskavetsteplo HU	Stebnytska str., 100, Truskavets, 82200
C9	Chervonohrad (c/c)			
	C9.1.	11	Chervonohradteplokomunenerho HU	Promyslova str., 1, Chervonohrad, 80100
D1	Brody			
	D1.1.	12	Brodyteploenerho HU	Honcharska str., 3a, Brody, 80600
D5	Zhydachiv			
	D5.1.	13	Zhydachivteplokomunenerho CHU	Hrushevskoho str., 28a, Zhydachiv, 81700
D6	Zhovkva			
	D6.1.	14	Zhovkvateploenerho HU	L.Ukrainky str., 5, Zhovkva, 80300

Table 4 continued

#	Names of regional centers, districts	# of company	Heat supply company	Heat supply company address
D7	Zolochiv			
	D7.1.	15	Zolochivteploenerho CHU	Shashkevycha str. 28, Zolochiv, 80700
D9	Mykolaiv			
	D9.1.	16	Mykolayivteplokomunenerho CHU	Hrushevskoho av., 1, Mykolaiv, 81600
D11	Peremyshlyany			
	D11.1.	17	Peremyshlyanyteplokomunenerho SHU	Lypova Aleya str., 7a, Peremyshlyany, 81200
D13	Radehiv			
	D13.1.	18	Radehivteploenerho CHU	Sonyachna str. 3a, Radehiv, 80200
D15	Skole			
	D15.1.	19	Skoletteploenerho HU	Stryjska str., 29a, Skole, 82600
D16	Sokal			
	D16.1.	20	Sokalteplokomunenerho HU	Heroiv UPA str., 21, Sokal, 80000
D17	Staryj Sambir			
	D17.1.	21	St.Sambirteplokomunenerho HU	D. Halytskoho str., 98, Staryj Sambir, 82000
D20	Yavoriv			
	D20.2. <i>Private</i>	22	Energy-Novoyavorivsk Ltd.	Pasichnyka str. 1, Novoyavorivsk, 81054

From the analysis of above listed heat supply companies it can be concluded that, as of 01.01.2012, 20 companies were of communal property and only 2 were private.

According to the information given in the program of modernization of heat supply systems in Lviv region in 2012-2016, the power of centralized heat supply sources is 3720.69 Gcal/h., attached – 1504.63 Gcal/h.

Heating companies consumed 398,375.7 thousand m³ of natural gas in 2011. Gas consumption in recent years has shown a downward trend, mainly due to the transition of apartment buildings from centralized heating to individual heating.

The number of people receiving centralized heating is 696 thousand people or 61.8 % of the total urban area residents.

The technical state of heat supply companies (objects) is characterized by a significant moral and physical deterioration of fixed assets (50 %), so the efficiency of the heat sources is very low, there are large network heat losses due to the poor condition of heating networks and ineffective insulation. Namely, out of 1117 km of pipelines only 294 km (26.3 %) are laid with pre-insulated pipes, the determined capacity of heat sources with efficiency over 90 % is only 9.0 % [10].

Tariff policy, which over the years does not provide the cost of production of thermal energy, causes negative impact on the activities of district heating companies. Thus, in 2011, compared to 2010 the financial performance of district heating companies worsened and losses increased from UAH 112.7 million (–17.7 %) to UAH 185.6 million (–28.6 %) [10].

Table 5

The main problems of heat supply systems in Lviv region [10]

#	Problem	Potential of natural gas consumption reduction (as of end of 2011)	
		thousand m ³	%
1	2	3	4
1	Excessive consumption of natural gas due to imperfect heat supply circuits, low efficiency of depreciated and obsolete heat generating equipment and heating systems	70 000	18,00%

Table 5 continued

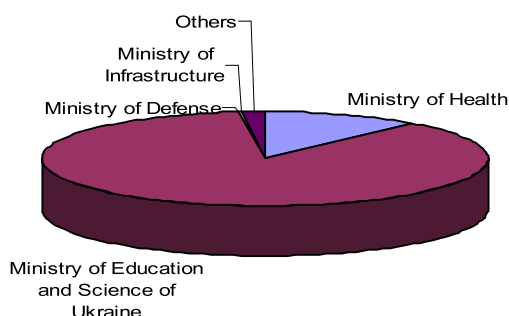
1	2	3	4
2	Excessive consumption of natural gas due to imperfect means of control and accounting in the supply of thermal energy to the consumers	20 000	4,50%
3	The low level of substitution of natural gas by local alternative fuels and the use of cogeneration to produce electricity and heat	10 000	2,50%
4	Lack of organizational methods of heat supply systems and heating companies' activity	-	-
	Total	100 000	25,00%

In general heat supply industry in Lviv region includes 1373 boiler houses, of which 1092 are departmental and only 281 boiler houses are owned by local governments.

According to the given results of the distribution of departmental boiler houses (fig. 1) it can be concluded that most boiler houses are owned by the Ministry of Defense of Ukraine (due to the legacy of the former Soviet Union), a large number of them are concentrated in the institutions of the Ministry of Health of Ukraine.

Structure of departmental boiler houses of Lviv region

Fig. 1. Structure of departmental boiler houses of Lviv region



According to the Department of Housing and Communal Services of LRSA and plan objectives approved by the Head of the Regional Administration of 14 May 2013 № 239/0/5-13 "On preparation for the heating season 2013/14" it has been decided to carry out the preparation of objects of housing and communal services and social services for winter use, which has been executed in full on October 1, 2013, including preparation conducted in 1373 boiler houses among them:

- 281 boiler houses of communal property;
- 124 boiler houses under control of health care institutions;
- 947 boiler houses of institutions of Department of Education and Science;
- 18 boiler houses of other departments;
- 1069.7 km of heat networks, including 971.6 km of communal property.

There have been 57 replacements of boilers with new energy-saving ones, of which 38 boilers in the boiler houses of the Department of Education and 19 boilers in boiler houses of communal property. In addition, boilers with usage of alternative fuels (firewood) have been installed in Zolochiv.

Preparation has been carried out in residential fund:

- 18216 apartment buildings, of which 15821 houses of communal ownership;
- premises of social and cultural purposes, including 1366 schools, 505 kindergartens, 191 hospitals [13].

Conclusions

Analysis of statistical data allows to reach specific conclusions. And, in particular, that it is possible to solve the problems of heat supply by:

- 1) reduction of natural gas consumption, optimization of heat supply, increase of efficiency and modernization of outdated heat generating equipment and distribution networks, which requires:
 - optimization of heat supply circuits: the development and approval of heat supply schemes for residential areas, the elimination of boiler houses with low capacity factor and the conversion of apartment buildings to individual heating;
 - reconstruction of central heat supply stations, installation of individual heat supply stations;
 - introduction of technological devices of thermal energy and dispatching of heat supply;
 - replacement of gas boilers for solid fuel heaters or transfer to alternative fuels;
 - implementation of cogeneration to produce electricity and heat;
- 2) modernization of inefficient heat supply sources: reconstruction of boiler houses with the installation of energy efficient boilers and pumps, replacement of low-to high-efficiency burners;
- 3) replacement of emergency and worn heating systems by insulated pipes;
- 4) restoring insulation systems;
- 5) introduction of cost-based policy on tariffs for heat supply.

Perspectives for further research

In addition, it was possible to notice that the given area needs further fundamental research, exploring the possibility of attracting innovative approaches as well as finding ways to diversify sources of hydrocarbons. Equally important is the question of the introduction of technologies that will help reduce the consumption of natural gas.

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