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Municipal Network for Energy Efficiency

Urban Heating in Russia:

Experience from the Transition and Future Directions

ALLIANCE TO SAVE ENERGY
Creating an Energy-Efficient World

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Abbreviations

CENEf	Center for Energy Efficiency (Russia)
CHP	combined heat and power
DH	district heating
DHS	district heating system
ESCO	energy service company
GHG	greenhouse gas
HOA	home-owner associaitons
REC	regional energy commission

List of Figures

List of Tables

List of Boxes

Table of Contents

Introduction

This paper summarizes Russia's experience in the urban heating sector gained during the transition period and provides some vision of how it should evolve in the future. The findings presented below are well illustrated by numerical case studies, which are mainly not taken from the literature, but rather from CENEf's projects to upgrade distinct heating systems in several regions in recent years. Lots of data used in the case studies were collected during energy audits of district heating systems, in the process of metering or, if provided by third parties, carefully verified by CENEf.

Conclusions and suggestions are based on 14 years of CENEf's experience in promoting energy efficiency in Russia's district heating sector, which includes development of several regional and more than 60 municipal district heating investment programs. Some of them were developed in the framework of the programs of the International Bank for Reconstruction and Development, European Bank for Reconstruction and Development, U.S. Agency for International Development, United Nations Development Programme, and Technical Assistance to the Commonwealth of Independent States. Others were accomplished under contracts with Russian regional or municipal authorities, or with private investors, who have recently moved to the district heating sector. Most illustrations presented in this paper are for municipalities in Khanty-Mansiysky Autonomous Okrug - Ugra, Sakhalin oblast, and for the cities of Berezniky, Cherepovetz, Vorkuta, and Norilsk.

The paper includes three sections. All major findings are listed in the first section, so those who do not need sophisticated explanations, may stop right after that. Section 2 describes the experience and recent status in Russia's urban heating sector; while Section 3 explains ten steps are to be taken to reform Russia's DHS markets. These ten steps are not pure theory; they are already adopted and serve a basis for heat supply upgrade programs in all 113 municipalities of Khanty-Mansiyskiy Autonomous Okrug - Ugra, the city of Berezniky, and some other Russian municipalities.

1 Summary for Policy Makers

The Russian heating sector is regularly ignored when national energy policies are discussed, even though it accounts for about 45% of all domestic energy consumption, and for about 50% of fossil fuel use. It represents one the largest single product market in Russia split into more than 50,000 local markets with US$ 36 billion annual sales, US$ 10 billion potential annual savings costs, which are available with US$ 50 billion efficiency improvement investments. Presently, only US$ 500 million are invested annually for this purpose. At such rate, it will take Russia 100 years to implement the costs reduction potential.

Neglecting reforms of the hat sector cause problems fro the entire country: every year, federal, regional, and municipal authorities face problems related to ensuring reliable heat supply during the heat supply season (about US$ 3 billion are spent for this purpose annually) and to addressing numerous emergencies (another US$ 3 billion annually). In 2005, heat tariff growth was accused of being a driving force for country-wide inflation.

Any country-wide averages or statistical aggregates should be considered against the background of amazing diversity of heat supply system in Russia: the heat supply season in Russian cities lasts from between 3,000 and 12,000 degree-days; with overall DHS efficiency varying from a Helsinki-like level to as low as 25%. Heat tariffs range from 4 to 250 US$/Gcal. Systems are dominated by industrial or residential consumers, and range from completely centralized to completely decentralized systems and from completely municipal to wholly private-owned.

The Russian district heating system is the largest in the world: it includes 485 CHP, over 190 thousand large boilers, 22 thousand central heating points, 183 thousand km of heat pipes. Its heat sources annually generate about 2,300 million Gcal, with boilers dominating in heat generation, while the share of CHP accounts for 30%.

The average fuel efficiency of district heat generation is 71%, and heat transportation and distribution losses are over 20%. Heat supply to residential and public buildings is responsible for about 75% of all heat losses. The share of buildings in the overall heat end-use approaches 50% and is higher than that of the industrial sector, which is only second largest heat consumer.

In spite of their diversity, many DHS in Russia face a common set of problems:

- substantial excessive supply capacity;
- excessive estimates of consumer heat loads;
- excessive centralization of DHSs;
- low density of heat loads and a corresponding high level of distribution losses;
- a lack of heat supply parameters regulation;
- an absence of effective cost allocation procedures and misleading indicators for investment decisions to rehabilitate different parts of DHSs;
- a lack of clear dominance of reliability criteria in assessing DHS managers' performance; and

- a lack of incentives to improve efficiency and shortage of qualified personnel, especially in small-size heat supply systems located in small towns.

The controversy of centralization versus decentralization is a major factor driving the future for CHP in Russia. Unlike in many other countries, which support CHP, the present and the future of CHP in Russia are gloomy. There is no specific policy to support CHP throughout the power sector reform. Demand for heat generated by power utilities' CHP is gripped in a competition vice between declining demand (competition from energy efficiency and other energy carriers) and growing alternative heat supply by autonomous boilers and small modern industrial and municipal CHP. This released a sear spring and triggered the cost escalation mechanism. Both heat and power generation costs started their mounting curves.

There is a mosaic of different institutional models and settings in Russian district heating markets across the country. The share of the private sector in DHS ranges from 100% to none, and declines as one goes along the heat supply chain from generation to distribution. Municipalities predominantly own DHS facilities, and are increasingly leasing them to private operators. In some cases they transferred ownership of some parts of DHSS to private companies. Sometimes municipal DHS facilities are sold to cover debts for heat provided by public power utilities. The part of the Russian business community that has moved to DHS employs two different strategies to penetrate the heat market. The first one may be described as "wide regional coverage first – learning-by-doing next". The alternative strategy, employed by "Novogor" company and some others, is different: "learning-by-doing first – scale up activities next". The second strategy appeared to be more effective. However, so far there is not enough evidence that private companies are more efficient operators of DHSs than municipal ones.

The whole DHS system is not well institutionalized to motivate heat costs reduction and end-use efficiency improvement. There are no bad habits, but there are bad incentives and bad market structures! In Russia, those who are capable of improving energy efficiency often have no wish to do so, and those wishing have no capabilities. Motivation is a key to "swallowing up" best practices by the district heating and building sectors.

The institutional organization of end-users in the housing sector is one of the most serious problems. It is not quite clear, what exact market product is on sale (comfort or resource), and how the customer is defined. A relatively simple market transformation is needed to replace the existing situation with the one in which heat comfort is on sale. It requires introducing certain agents to the market to perform the ECSO's function, i.e. to buy resource and turn it into comfort to then sell to residents. This scheme requires a specific system of metering and billing, current systems are to be supplemented with building level heat meters, or better, individual heating points, which would allow not only for metering, but also for regulation. An alternative system, individual households-consumers, creates a lot of problems related to heat billing in multi-family buildings, which are designed for a collective consumer. While many experts aggressively support transition to flat-level heat meters (allocators), this is not a cost-effective solution.

Heat metering programs are to be well tuned to the desired institutional market scheme allowing for transition, where necessary, to billing for really consumed and metered heat or comfort service, to more accurate consumption norms for consumers who are not equipped with meters. For buildings with heat load below 0.2 Gcal/hour, potential savings will never cover meters service and maintenance costs. There is a potential trap: high tariffs urge installation of meters and heat consumption controls, which, in its turn (if heat supply company's costs are not reduced), becomes a driver for tariff growth in the city. Importantly, heat consumer's behavior is not well known.

Heat costs and tariffs in Russia vary widely across the country: from 4 to 250 US$/Gcal. The prices for heat provided by regional power utility companies is set by Federal Tariff Service, a government agency. Heat prices are set for two coming years in the form of minimal and maximum caps. That provides some predictability of heat price evolution. The final price level is established by Regional Energy Commissions (RECs). These commissions also set prices for heat generated by industrial CHP and boilers. As a rule, municipalities are not responsible for setting heat prices any more. The heat tariff setting system was supplemented in the very end of 2005 with the heat tariffs growth caps established for each region by the Federal Tariff Service to control country level inflation.

According to the new regulation enacted in 2004, heat generation and transportation costs are unbundled, and heat suppliers are eligible for investment price component to partly finance investment programs coordinated with municipality. However, heat pricing is still a hostage of the ineffective heat costs allocation rules and poor knowledge of price sensitivity of both producers and consumers. Heat prices are set with no account of the remoteness and size of customer, or any seasonal flexibility. The heat tariff menu is poorly populated, so both suppliers and consumers are facing lack of tariff flexibility.

After heat subsidies were basically eliminated in 2004-2006 (with some exceptions still left over), urban residential consumers pay 20-50 US$/Gcal. Prices for residential heating and hot water vary widely throughout the country mirroring not only supply heat price differentiation, but also different specific heat consumption for space heating and DHW supply. Space heating and DHW are presently responsible for about 40-75% of overall housing and municipal utility costs. So heat price escalation is an important driving force pushing housing and municipal utility costs beyond the affordability thresholds and pushing down collection rates.

Heat pricing policy is locked into the narrow range of affordability thresholds and high production costs supplemented with a need to finance modernization programs. The key for this lock is heat costs reduction through optimization of the DHSs structure and improvement of their energy efficiency.

Poor municipalities are able to supply only 50% or less of required heat to consumers, keeping their indoor comfort much below the required level. They reduce the duration of the heating season, and/or heat supply temperature. Low quality services are often billed for, as if normative heat supply services are being provided. Obviously, this leads to a low payment discipline.

Low payment discipline makes municipal heat sector less attractive for investors, and reduces the role of economic methods in managing this sector.

Lack of attention to this sector on behalf of the federal government is a barrier to further reform. The responsibility for providing reliable heat services to consumers was delegated to municipalities, and there is no federal agency responsible for promoting heating sector reform proposals through the government and the legislature. If this reform goes too slow, the private sector may lose interest in entering the heating sector, and this sector may then further degrade.

The need for changes in the district heating sector remains strong. There is a definite progress in reforming heat supply sector in Russia, but often progress is too slow and sometimes reforms push the sector in the wrong direction. CENEf proposes the following ten steps to continue reforming Russia's DHS sector:

1. ***Mandatory development of sustainable municipal energy plans*** with specific sections on heat supply. It requires the preparation of guidelines on how to develop and monitor such plans, and on how to do the city centralized and decentralized heat supply zoning, as well as establishment of investments rules in accordance with such zoning and municipal energy plans.
2. ***"Menu" of well-designed heat market models*** for municipalities to select from, with all needed regulations and tools available to launch these models. Russian heat supply systems in all aspects are too diverse to use the "one-size-fits-all" approach. Selected heat market model should fit specific conditions of a particular municipality.
3. ***Establish a system of indicative planning*** of DHS companies' activities using the municipal heat supply optimization, reliability, efficiency, economic, and quality of service indicators (standards). DHS companies are to sell positive dynamics of these indicators to the municipality.
4. ***Transition, where necessary, to billing for really consumed and metered heat***, and to more accurate consumption norms for consumers not equipped with meters. Avoiding a blind "metering everything and everywhere" policy, tuning metering programs to the selected heat market models and institutional form of market agents.
5. ***Turning heat consumers into heat comfort buyers.*** This is can be achieved by clearly separating two products (heat resource of given quality and heat comfort), selecting a correct institutional form and size of the collective customer (city-wide, building-level, or single household), setting up Associations of communal services payers (ACSePs), and Home Owner Associations (HOAs), and attracting ESCOs on a competitive basis to provide the least-cost heat comfort.
6. ***Launching "profits-from-savings" mechanisms*** to generate a revenue source to repay DHS rehabilitation investments after affordability limits are approached or exceeded, and further heat tariffs growth lead only to the decline of collection rates or quality of service.
7. ***Providing more operational flexibility and stable market rules to DHS companies*** irrespective of their form of ownership. Making the district heating sector attractive for both private sector and municipal companies by improving the

market environment, making the market rules transparent and stable and changes predictable.

8. ***Careful evaluation of affordability limits*** while developing pricing policies and eliminating cross-subsidies. Shifting from control of heat tariffs alone to account of customers' purchasing power and meeting affordability thresholds. Better energy efficiency allows it easier to meet affordability thresholds under given heat prices.

9. ***Make heat pricing more flexible*** with transition from the "cost plus" principle to sustainable "upper limits" tariffs, given transparent correction rules set by the "pricing formula". Allow for seasonal adjustment and competitive formulas of CHP cost allocation. Better learn how price signals impact supply and demand sides of the market.

10. ***Develop powerful information instruments***: "IKEA-like" prefabricated technical and managerial guidelines. Remove poor communication barriers and educate market agents and DHSs.

2 Present Status of Russia's Urban Heating Sector

2.1 The Role of the Heating Sector in Russia's Energy Strategy

Russia is a cold country: in some municipalities heat supply season lasts "only" 3,000 degree-days, while in others it is 12,000 degree-days. The situation in the heating sector differs so much across the municipalities, that often it is hard to describe the general, country-wide situation in the heating sector. In many localities, there is no "winter" or "summer", but rather a "white winter" and a "green winter", and heat supply season lasts for 9-10 months. Therefore, bread and heat are two life-sustaining products, and it is quite strange that the heating sector is regularly ignored, when energy and GHG mitigation policies are discussed in Russia, while it accounts for about 45% of all domestic energy consumption, and is close to 50% of fossil fuel use. It represents the largest single product market in Russia, which is split into more than 50,000 local markets with US$ 36 billion annual sales, and US$ 50 billion efficiency improvement investments potential, but with only US$ 500 million annual investments in the beginning of the 21st century. At such pace, it will take Russia 100 years to release the potential.

While this sector is ignored strategically, it takes revenge tactically. Every heat supply season, the former Gosstroy, and currently the Federal Agency for Construction and Housing and Communal Sector, which is under the RF Ministry of Regional Development, has to permanently control, first, preparation for the heat supply season, and then the functioning of municipal life support systems through the season itself. For the heat supply season preparation alone, in 2005, all-level budgets allocated over US$ 3 billion (of which US$ 1 billion was provided by the Federal government). However, such allocations do not help avoid about 100 large-scale municipal-level accidents every heat supply season (only a quarter of these originate from natural calamities) all over the country, not to mention smaller ones[1]. No data is available on the costs of fixing these accidents and emergencies in district heating systems, but they may be estimated at US$ 3 billion. Although the heating sector is determined as municipal government responsibility, given the centralization of local financing and the administrative power process underway in Russia, all-level agencies face, and are preoccupied with, daily DHS reliability problems, missing strategic decisions which would help reduce, or completely remove, the pressure of preparation for and surviving in heat supply season.

2.2 RUSSIAN DISTRICT HEATING INDICATORS

Russia's Heat Balance

While considerable progress has been made to improve metering in DHSs, heat pricing in Russia is a mystery of heat quantities and costs. There still is not enough knowledge in many DHSs on numerous key factors:

- how much fuel was delivered to the boiler house;
- what the real efficiency of heat generating equipment is;
- how large real heat losses and heat loads are;
- how they would evolve in the foreseeable future;
- how much heat was really consumed; how much electricity and gas is used to make up for low quality heat supply;
- and how much debt was accumulated for heat which was billed for, but never generated?

There is no reliable statistics on district heating in Russia. Different sources report differently on the size and structure of Russian heat market. Some sources include only large CHP and boilers[2] (over 20 Gcal/h), while smaller boilers are regarded as final fuel consumers. Other sources report heat generation from small boilers. Inclusion of small heat sources is important, as competition to large-scale heat supply systems from smaller ones is growing. It should be admitted, that efforts to develop Russia's heat balance still present a fuzzy picture (see Table1).

Boilers dominate heat generation with CHP accounting for 30%. Average heat losses are 20%, with those attributed to smaller DHSs equal to 27%. About 75% of all losses originate from serving residential and public buildings. The share of buildings in the overall final heat consumption has surpassed the industry and went up to 50%. Industry has become only the second largest heat consumer. In 1995-2001, industrial heat consumption fell by 36%. But even in 2000-2001, industries consumed about 50% of heat generated by CHP. On the contrary, residential and commercial heat demand was almost stable. About one third of the heat in the residential sector is generated by individual boilers or heaters. Data on this sector of heat market are least reliable.

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[1] During 9 days in September 2005, in Krasnoyarsk alone there were 36 emergencies in the heat supply system. See "Novosti Teplosnabzheniya". □ 10, 2005.

[2] See for example Coming In From The Cold. Improving District Heating Policy in Transition Economies. OECD/IEA. 2004.

Heat Supply: Key Performance Indicators

Major general, country-wide indicators of heat supply system are presented in Table 2.2 to illustrate the scale and general efficiency of the system, which includes 485 CHP and over 190 thousand large boilers, 183 thousand km of heat pipes, and is a US$ 36 billion annual sales market.

Table 1. Russian Heat Balance. 2000-2002 (million Gcal)

	Public utility companies	Industrial and municipal boilers	Individual boilers	Total
Generation	1,515.7	613.2	170.7	2,299.6
CHP	680.0			
RAO EES Rossii	494.0			
Industrial CHP	176.0			
Own use	52.7	21.2		73.9
Sold to network	1,463.0	592.0	170.7	2,225.7
Heat losses	284.7	157.0	0.0	441.7
Share of heat losses (%)	19%	27%		20%
Heat losses attributed to				
Industry	74.0	17.0		91.0
Agriculture	8.8	3.6		12.3
Residential buildings	61.4	86.0		147.4
Public buildings	105.3	48.4		153.7
Other	35.1	2.1		37.2
Final heat consumption	1,178.3	435.0	170.7	1,783.9
Industry	599.0	96.4		695.4
Agriculture	49.7	20.2		70.0
Residential buildings	143.4	200.6	170.7	514.6
Public buildings	245.8	112.8		358.6
Others	140.5	4.9		145.4

Sources: Calculated by author based on sources available in different publications including L.Chernyshov[3], A. Nekrasov, and S. Voronina[4] and other sources.

There is a noticeable relatively low fuel efficiency of district heat generation (71%) and high heat transportation and distribution losses (20%, but according to some other estimates

[3] L. Chernyshov. The country is preparing for winter. “Energosberezhenie”, □5, 2001.

[4] A. Nekrasov and S. Voronina. Status and perspectives of district heating in Russia. “Energy, Economics, Techniques, Ecology”. No. 10, 2004.

even 31%[5]). So, at least, 50% of fuel used in the district heating sector is lost in heat generation and transportation. The large variety of heat tariffs throughout the Russian Federation is determined, on the one hand, by cheap industrial waste heat sold to neighboring cities, on the other, by very expensive heat generated using liquid fuels in very remote locations in the Far East and Far North.

There is noticeable relatively low fuel efficiency of district heat generation (71%) and high heat transportation and distribution losses (over 20% and according to some other estimates even 31%[6]). So, at least 50% of fuel used in district heating sector is lost in both heat generation and transportation. The average picture hides the contrast in overall DHSs efficiency is different Russian municipalities (Figure 1). It stays close to that in Helsinki in Pokachi or Nizhnevartovsk and in many other cites, but in Cholmsk over 75% of fuel energy is lost both in combustion and heat transportation processes.

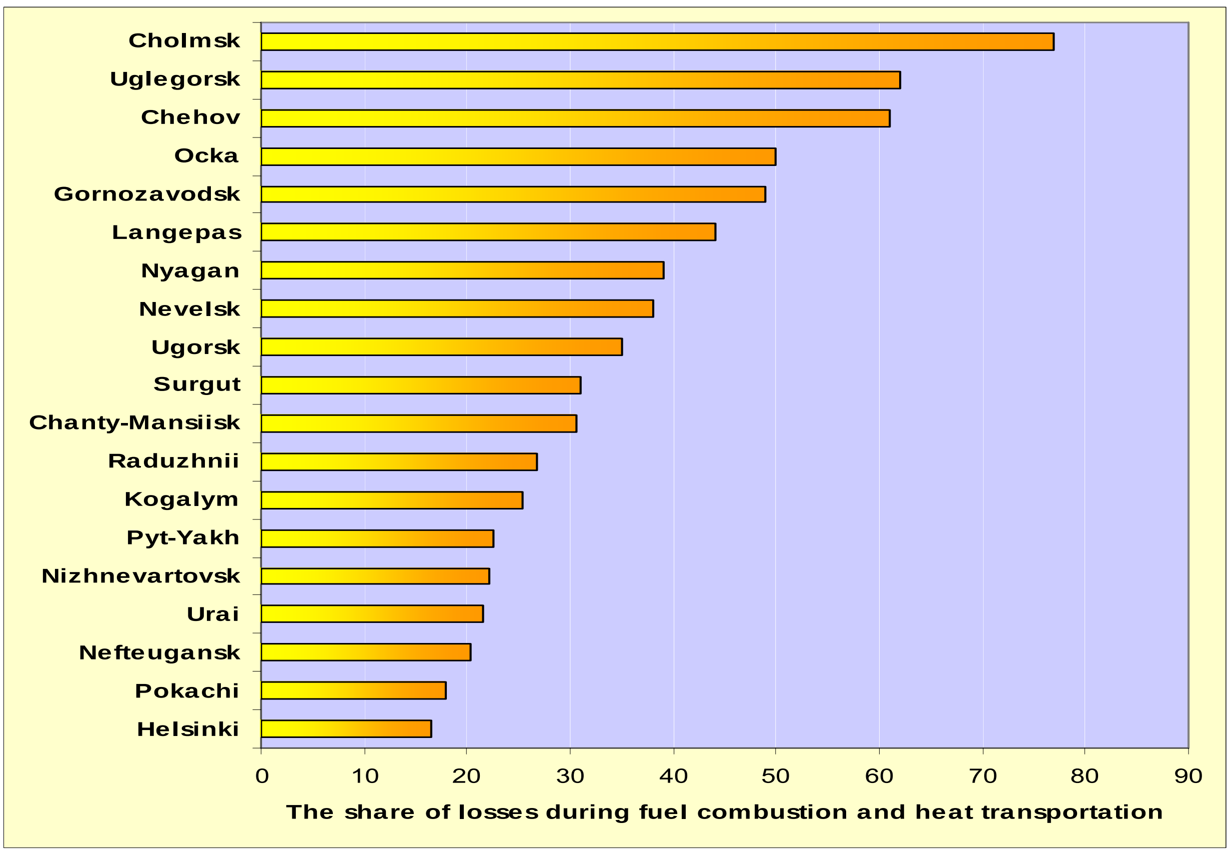

Figure 1. Efficiency of different district heating systems in Russia, as measured by energy lost during fuel combustion and heat transport

Table 2 represents key heat supply performance indicators for several DHSs taken as case studies and displayed against the background of similar indicators for urban DHS in

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[5] A. Nekrasov and S. Voronina. Status and perspectives of district heating in Russia. “Energy, Economics, Techniques, Ecology”. No. 10, 2004.

[6] Nekrasov A. and S. Voronina. Status and perspectives of district heating in Russia. “Energy, Economics, Techniques, Ecology. No. 10, 2004.

several West European countries. It illustrates that there is a lot of room for performance improvements in Russian DHSs. Many of them are still facing pretty universal set of problems all over the country:

- ⇒ Substantial supply overcapacity;
- ⇒ Excessive estimates of consumers' heat loads;
- ⇒ Excessive centralization of DHSs;
- ⇒ Low density of heat loads and corresponding high level of distribution losses;
- ⇒ Lack of heat supply parameters regulation;
- ⇒ Lack of effective cost allocation procedures and misleading indicators for investment decisions to rehabilitate different parts of DHSs;
- ⇒ Clear dominance of reliability criteria in assessing DHS managers' performance;
- ⇒ Lack of incentives to improve efficiency and shortage of qualified personnel, especially in small-scale heat supply systems located in small towns and villages.

Table 2. Russian heat market major indicators in the 2005/2006 heat supply season

Indicator	Units	Volume
Combined heat and power plants	Units	485
Including CHP of RAO EES Rossii	Units	242
Large boilers	Units	>190,000
Individual heat generators and boilers	Units	>600,000
Central heating points	Units	>22,000
Heat generation	Million Gcal	2,300
Own use	Million Gcal	74
Distribution losses	Million Gcal	442
through insulation	Million Gcal	400
through leakage	Million Gcal	42
Distribution losses	%	20%
Heat networks	1,000 km	183
Final heat consumption	Million Gcal	1,784
Fuel efficiency	%	71.5
Total energy inputs to heat generation	Million toe	323
Heat tariffs, average	$/Gcal	20
Heat tariffs, range	$/Gcal	5-100
Heat sales	$ billion/year	36.0
Potential savings from efficiency improvements	$ billion/year	10.0

Source: I. Bashmakov. Key Challenges in Developing Small-Scale Heat Generation Installations / Market and Technology Developments in Small-Scale Heat Generation/ International Workshop, Baku, Azerbaijan, October 20, 2005.

Centralization Versus Decentralization

Excessive centralization is observed by CENEf in 75% of DHSs, which supply about 20% of heat to the market. Decentralization often becomes attractive against the background of the following facts revealed by CENEf during audits of more than 230 DHSs in Siberia and in the Far East:

1) actual losses of 70% of heat supply systems are in the range of 20-70% (see Figure 2);
2) expensive maintenance of heat supply networks is responsible for about 50% of overall DHS costs;
3) low replacement rates: annually only 2% of pipes are replaced, while the demand is 4-8%;
4) critically low physical reliability level of heat networks and high frequency of failures (0.6-4 accidents/km/year);
5) high leakage ratio, lack or poor quality of insulation;
6) failure to ensure required hydraulic modes and to observe the temperature schedule.

Therefore, more often than not buildings are either over- or under-heated.

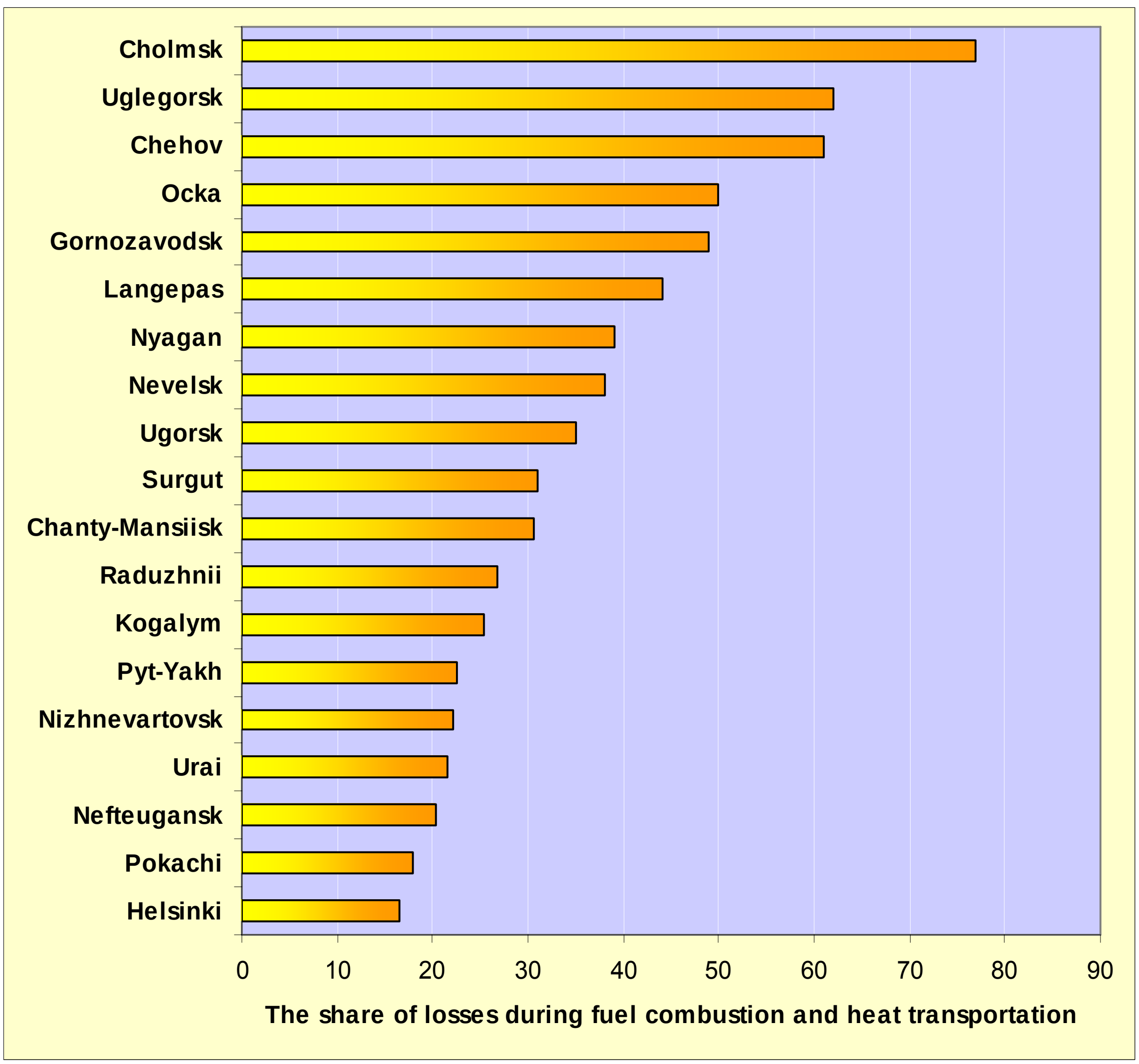

Figure 2. CENEf's evaluation of overall heat supply systems efficiency in several Russian municipalities

Table 3. Major performance indicators of several Russian and foreign municipalities

Performance indicators	Units	Khanty-Mansiysk	Urai	Raduzhny	Nizhnevartovsk	Nefteyugansk	Nevelsk	Okha	Uglegorsk	Kholmsk	The EU countries	Denmark – Greater Copenhagen	Helsinki
DHS performance indicators													
Available capacity reserve	%	58	50	20	34	39	No	3	65	42	10	26	
Relative material characteristics	m²/ Gcal/ hour	226	157	80-90	50-70	70-100	185	396	138	126	<100	<100	
Connected heat load per km of heating network	Gcal/hr /km	0.4	0.4	0.78	1.51	1.77	0.87	0.40	1.07	1.56		2.39	2.24
Heat consumption per 1 m of heating network	Gcal/ year-m	1.43	1.44	1.83	4.42	5.12	1.42	0.98	2.64	1.92		3.17	5.00
Specific heat consumption for space heating	kcal/ (m² * degree-days)	29.56	31.13	34.77	37.75	39.4	13.60	27.91	32.62	24.18	28.7	23.9	
Number of consumers per cut-off	Build-ings												13-14
Energy efficiency indicators													
Heat generation	%	85-87	85-93	88-90	93	91	85	77	62	50	92-94		90
Specific fuel consumption	kgce/ Gcal	182.1	159-162	157.5-164.5	150.4-161.2	158-160	168	197-210	216-231	286			
The share of CHP	%	0	0	0	0	0	0	100	13				93%

Heat transportation efficiency	%	83.4	89.5	84.2	84.8	88.7	80-75	76-69	79-74	75-68	95-90		93.5
Distribution heat losses, including:	%	16.6	10.5	15.8	15.2	11.3	20-25	24-31	21-26	25-32	5-10		6.5
Heat mains	%	6.0	4.0	5.8	5.2	4.8	8	10	8	9	1	1	
Heat distribution network	%	10.6	8.5	10.0	10.0	5.5	12	14	11	16	5	1	
Specific power consumption for heat transportation	kWh/ Gcal	37.9	24.6	22.8	25.8	21.7	42.3	22.0	18.0	55.4		7-9	
Water consumption for DHS	System volume /year	45.7	46.9	44.7	47.9	49.0	47.7	54.9	45.8	49.3	1	0.4-0.7	0.8
Heat metering													
At the source	Yes/no	14% yes	Yes	Yes	Yes	80% yes	Yes	No	No	No	Yes	Yes	Yes
At the central heating point	Yes/no	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes
At the end-user	Yes/no										Yes	Yes	Yes
Housing stock	Yes/no	7% yes	No	9% yes	3 % yes	9% yes	No	No	No	No	Yes	Yes	Yes
Public buildings and other consumers	Yes/no	75% yes	68% yes	97% yes	53% yes	77% yes	No	No	No	No	Yes	Yes	Yes
Reliability indicators													
Frequency of accidents	1/km-year	0.32	0.64	0.24	0.5	0.27	N/A	N/A	N/A	N/A			0.13
Frequency of cut-offs		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			0.28
Automation of heat regulation													

At the source (central)	Yes/no	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
At the central / local heating point (group)	Yes/no	No	No	Yes	85% no	No	Yes	No	No	No	Yes	Yes	
At the end-user (individual)	Yes/no	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes
DHW cut-off for repair	Days	21	21	21	21	21	No DHW	90	90	90	0	0	0
Heat losses determined by non-balanced demand and supply	%	7	3	5.7	4.3	5.2	1.9	4%	7%	7%	0	0	0.00
Heat supply modes dispatch													
At the source	Yes/no	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes
In the heating network		No	No	No	No	No	No	No	No	No	Yes	Yes	Yes
At the central / local heating point	Yes/no	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes
At the end-user	Yes/no	No	No	No	No	No	No	No	No	No	No	No	No

Sources: Reports on energy audits of several Russian district heating systems located in Khanty-Mansiysky Autonomous District - Ugra (Khanty-Mansiysk. Urai, Raduzhny, Nizhnevartovsk, Nefteyugansk) and Sakhalin Oblast (Nevelsk, Okha, Uglegorsk, Holmsk); A. Nuorkivi. Institutional Handbook for Combined Heat And Power Production With District Heating. December 2002. Prepared for BASREC; Helsinki Energy. Annual Report 2004; CTR Annual Report 2003; Copenhagen Energy. Annual Report 2002.

The investments needed to bring heat networks to the required performance levels are estimated at US$ 25-30 billion[7]; however, real investments are much lower, leaving performance of DHS poor. The result of this is that centralized heat supply systems are continuously loosing their market niches. There are cities with completely decentralized heat supply (see Box 2.1). But even where centralized systems dominate, they are loosing part of the market to small local or individual building- or flat-level boilers. The "Energy Strategy of the Russian Federation" was very skeptical about the pace of the decentralization process: this document assumes that decentralized heat generation will grow by 1 percent in 2005-2010 and by 2 more percent in 2010-2020. In 1998, in Moscow 73% of heat was generated by CHP, but in 2005 the CHP market niche shrank by 4% with additional 6% loss expected before 2011. There are whole districts in Moscow (Kurkino is an example) designed for decentralized heating.

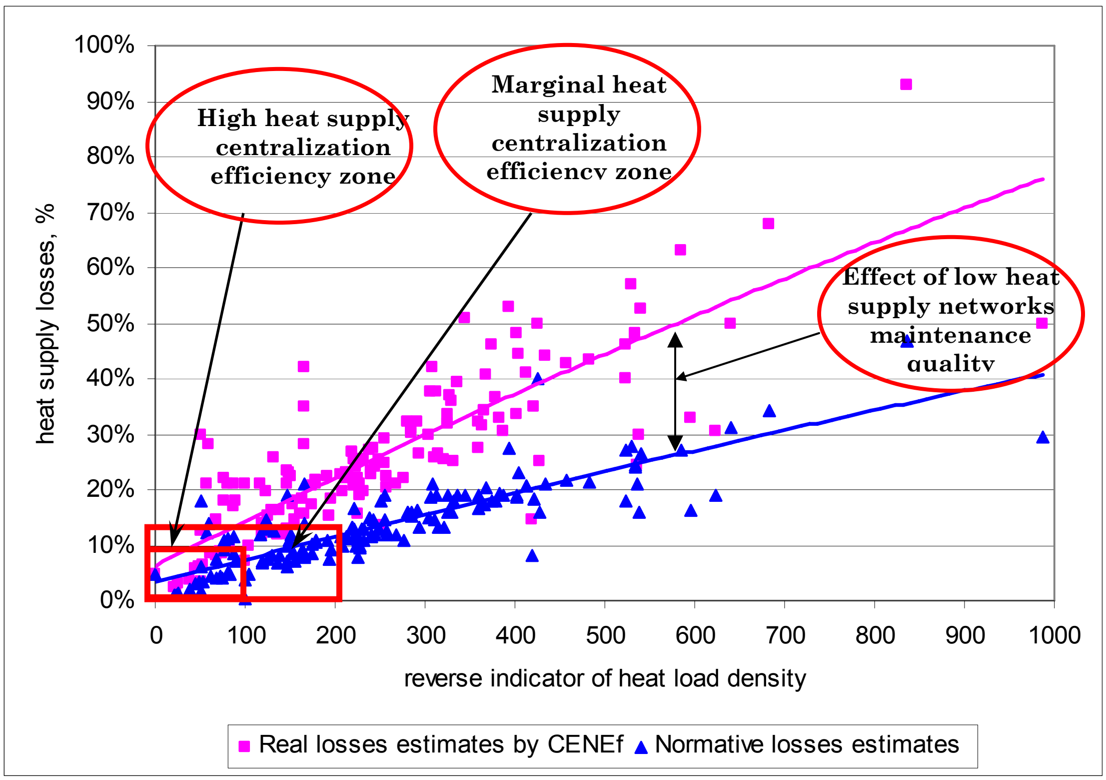

Figure 3. CENEf's evaluation of heat losses in DHSS as a function of heat load density (sample of 190 Russian DHSs)

The key to a long lasting discussion on the economic attractiveness of DHS centralization level is in measuring heat load densities. There are different approaches to do this. CENEf has developed an indicator, which is the ratio of material characteristics of the heat supply system (average pipe diameter multiplied by the length of DHS pipes to attached heat

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[7] I. Bashmakov. District Heating Capacity And Demand In Russia. Policy Approaches for Improvement. District Heating Policy in Transition Economies. IEA/OECD Seminar. Prague, February 22-24, 2004. Published in Euro Heat@Power. V.III/2004.

loads[8]). For better visibility, Figure 3 shows the relationship between heat losses and reverse indicator for 190 Russian DHSS audited in 2003 by CENEf in Khanty-Mansiysky Autonomous Okrug - Ugra.

Obviously, for many centralized DHSs heat load density is beyond the boundaries of high DHS efficiency (normative losses below 5-7%, and actual losses below 10-15%), and is even beyond the marginal boundaries of DHS efficiency (normative losses below 15-20%, and actual losses below 20-30%). In addition to poor design, the poor quality of district heating networks maintenance leads to extra losses in the range of 5-35%. And one more factor, the number of heating degree days, is to be added to this picture to make it consistent country-wide. Small-scale DHSs require additional capacity reserve to meet peak demand. So, large DHSs have lower specific investment costs per unit of produced heat. But when heat losses are over 10%, this benefit disappears and decentralization decisions are becoming economically viable. Therefore, zoning of the city by density of heat loads to avoid conflicts of centralized and decentralized heat supply systems interests is the key for municipal energy planning.[9] As CENEf's experience shows, large DHSs stay attractive, if appropriately managed and given high heat loads densities.

Box 2.1. Examples of efficient and inefficient decentralization

In Khanty-Mansiysky Autonomous Okrug – Ugra, there are examples of efficient and inefficient decentralization. The first example is Khanty-Mansiysk city with considerable (3-fold) excess installed capacity compared to connected heat loads. The municipal heat supply system is a lot less efficient than it could be. With new construction in the city, it is important to increase connected heat loads of boiler-houses, and to decommission and closure of some extra boiler-houses. The second example is Yugorsk city with efficient decentralized heat supply. By degree of centralization, the situation there is very much like in Khanty-Mansiysk, only in Yugorsk the capacity of local systems corresponds to consumer loads, and the tariff (463 rubles/Gcal) is a lot lower, than in Khanty-Mansiysk (693 rubles/Gcal), being just a little bit higher, than in cities with well developed centralized district heating (Nizhnevartovsk or Langepas). *The Yugorsk experience practically proves the good future for decentralized heat supply* in separate locations with local "spots" of relatively dense heat loads.

The Past, Present and Future of Large CHP in Russia

The controversy of centralization versus decentralization is a major factor driving the future for CHP in Russia. Unlike many other countries supporting CHP, the present and future of CHP in Russia is gloomy. There is no specific policy to support CHP through the power sector reform. CHP were designed for large industrial heat loads, with electricity generation as a side product. Due to economic recession, industrial load was partially lost. This led to the escalation of heat generation costs and growth of heat losses' share. This went alongside with insufficient funds invested in the upgrade of heat transportation

[8] I. Bashmakov. District Heating Capacity and Demand in Russia EuroHeat and Power. English Edition. III, 2004. p. 22-29.

[9] Such zoning is applied in many German cities, including Dresden and Leipzig.

systems and with substantial expenditures required to maintain obsolete pipelines. So heat transportation costs escalated as well.

Against this background, the unbalanced and inflexible CHP heat pricing policy led to further scratching of CHP off the picture. Heat price cross-subsidies made it more advantageous for closely located large industrial customers to generate their own heat, while decentralized heat supply to remote housing stock was not cost-effective. High heat prices made both efficiency improvements to reduce heat consumption and heat substitution activities economically viable alongside with independent heat generation. Demand for CHP heat was caught in competition between declining demand (competition from energy efficiency and other energy carriers) and growing alternative heat supply by autonomous boilers and small modern CHP (competition from the supply side). Industrial and municipal boilers were installed often across the road from CHP. Heat load declined even further with additional pressure on heat costs. This released a sear spring and launched the cost escalation mechanism. Both heat and power generation costs started their ascending trajectories.

Power and heat producers, as well as regulators, failed to balance short-term versus long-term visions of markets evolution. Short-term considerations prevailed over unrecognized long-term treat to lose the CHP market niche. Under such conditions, the more CHP costs were allocated to heat, the sooner and higher CHP heat prices escalated and (not surprisingly) the sooner CHP electricity became more expensive and uncompetitive. So short-term power ulitily income maximization considerations worked as a hidden engine shrinking CHP' niche both in the heat and power markets and pressing CHP out of business. As a result, large utility owned CHP today are loaded only at 50% of nameplate capacity, lost 40% of the heat market and 15% of the power market.

Power and housing reforms deteriorate CHP' future even further and squeeze the market faster.[10] Both markets reject expensive power and heat from large CHP. In 1990-2001, overall heat demand fell down by 370 million Gcal, with the CHP' loss of 470 million Gcal and industrial and municipal boilers market gain of 100 million Gcal.

Institutional Structure of Russian District Heating Market

The institutional structure of Russian district heating market is quite a mixture of different schemes with some very general trends. This can be illustrated by data for Khanty-Mansiysky Autonomous Okrug - Ugra (see Box 2.2). The share of the private sector in DHS operation declines, as one goes along the heat supply chain from heat generation to transmission and distribution. Municipalities predominantly own DHS facilities and sometimes rent them out to private operators. There are also examples of shifting the ownership of some parts of DHSS to private companies (in the city of Perm and some others).

[10] See I. Bashmakov. The Future of CHP in Russia. CTI Capacity Building Seminar for CCE/FSU Countries/ Climate Technology and Energy Efficiency – Challenges and Chances for Climate Technology. September 20-24, 2003. Tutzing, Germany.

Box 2.2. The structure of heat supply operators by the form of ownership

Today, half of heat generated in Khanty-Mansiysky Autonomous Okrug is generated by private companies. By the form of ownership, the structure of heat generation is as follows:

- Private (power plants and boiler-houses) 47.0%
- Municipal facilities rented out to private companies (Nyagan') 2.9%
- Private facilities rented out to the municipality (Megion) 3.6%
- Municipal 43.6%
- Individual (separate buildings and flats including single family houses and multi-family buildings with flat level gas boilers 2.9%

In Surgut, 73% of the overall heat load is covered by heat sources of OAO "Tyumenenergo", and 100% in Izluchinsk. In Nefteyugansky and Oktyabrsky districts, boiler-houses owned by industrial companies are responsible for 45% of heat sales. In Nyagan', the whole municipal heat supply system is rented by private "Nyagan generation company". On the contrary, Megion is an example of a municipality which rents private (oil company) boiler-houses.

Comparison of DHSs operation in Khanty-Mansiysky Autonomous Okrug - Ugra and other locations in Russia shows, that there are not enough arguments to support the idea that private companies are more efficient operators of DHSs than municipalities. At the "District Heating Policy in Transition Economies" seminar of the IEA in Prague (February 22-24, 2004) Igor Bashmakov raised this issue for discussion by the seminar participants. While the participants clearly agreed that private operators were more client-oriented compared to the municipal ones, they did not demonstrate a positive conviction that private sector was more efficient in this area. So it looks like "the market rules", not the form of ownership per se, are the key to better efficiency. That is why many large Russian businesses, who have recently moved to the heat market, are putting a lot of effort together to make these rules more effective. These businesses include, among others, daughter companies of "Gasprom" (active in Sankt-Petersburg), RAO "EES Rossii" power holding, a metallurgy holding "INTERROS", "Mezhregiongaz", several large Russian banks, and small private companies serving small DHSs.

To penetrate the heating market, the Russian business community employed two different strategies. The first strategy may be called "wide regional coverage first – learning-by-doing next". It was taken by two daughter companies of RAO "EES Rossii": "Russian Communal Systems" (see Box 2.3) and "Complex Energy Systems" and some others. The alternative strategy taken by "Novogor" (private company part of the "INTERROS" holding) and some others may be formulated as "learning-by-doing first – expanding activities next". This second strategy appeared to be more effective.

Box 2.3. Russian Communal Systems

The activities of “Russian Communal Systems” (daughter company of RAO “EES Rossii”) in the district heating sector were widely covered by mass media in 2003-2005. This company took a “wide regional coverage first – learning-by-doing next” strategy to enter the municipal heat market. The market penetration was strongly supported by the mother company – powerful Russia-wide holding RAO “EES Rossii”. At the beginning, the RCS promised large investments in the heating sector and managed to sign agreements (memorandums of understanding) with 21 regions. During 2003-2005, it lost 12 regions and in 2005 gained 4 new ones. So, as of late 2005 it was only working in 13 regions. The RCS turnover was expected around US$ 800 million, which is about 2% of Russia’s whole heat market.

The RCS top management changed several times. In October 2005, the RCS was expecting to get the first US$ 10 million in profit after two years of continuous financial loss (which in 2004 alone reached US$ 25 million). These profit expectations went down from initial US$ 18 million in April 2005 – not much by the Russian business community standards. According to the Board Chairman, the RCS faced three major problems in 2005:

1. Failure to bring the investments it had promised. It was probably the main reason for regions to terminate contracts with the RCS. Its daughter company in Volgograd invested only US$ 1.8 million in 2005, while it was supposed to invest ten times that amount according to the agreement with the municipality. After this lesson was learnt both by the regional and municipal governments and the RCS, the latter is going to develop and present realistic investment agreements to other regions;
2. Lack of social responsibility and decision-making transparency by the RCS in the eyes of regional governments. Regional and municipal governments had little or no impact on the decision-making process;
3. The remaining poor quality of service. It took the RCS three years to understand that they need to be customer-oriented. For the above-mentioned RCS Volgograd daughter company, the technical inspection concluded that it did not do any diagnostics of the heating network, and revealed about 600 violations of technical requirements.

“Novosti Teplosnabzheniya”. 5 and 10. 2005.

Another angle of the institutional structure analysis determines separation of the business at different stages of the heat supply chain: generation, transmission, distribution, serving building-level heat supply facilities. There are numerous examples of combinations, from establishing a separate business for each element to the whole system run by one company, which may also serve water, gas, and electricity supply facilities (see Tables 4 and 5 for Norilsko and Nizhnevartovsk). In Norilsko, nunicipal heat transmission and distribution is irrationally shared by Norilsko-Taimyrskaya Energeticheskaya Kompaniya and housing companies. While the latter cannot control heat parameters, they are responsible for them in the eyes of the final consumers. They have to get the Tariff Committee of Krasnoyarsky Krai set tariffs for 50-100 meters heat delivery from mains, which is quite confusing for the Tariff Committee, as it has to set the same tariffs for companies with different production costs to avoid a situation when consumers located at the opposite sides of the street would have different heat tariffs. The presented system should be advanced. The whole municipal network is to be served by one operator to the entrance of the building. It would buy heat from Norilsko-Taimyrskaya Energeticheskaya Kompaniya and sell it to ESCOs serving building-level heat supply facilities. This ECSO function may be performed by housing companies. In Nizhnevartovsk, the effective heat company maintains heat sources, heat distribution networks and group heat substations. All heat sources supply heat to the network. If heat generation and transmission are institutionally unbundled, new independent heat producers would be able to sell heat to the grid. The tariff policy in 2002 was characterized by high cross-subsidizing of tariffs for the residential sector. By 2005, cross subsidizing is lowered (the residential sector pays 80% of the average heat tariff). Cross-subsidizing will be eliminated by 2007.

Table 4. The structure of heat supply system in the city of Norilsk

Functions	Facility ownership	Company-operator	Form of operator owner-ship	Tariff setting institution
Heat generation. Single heat producer	Private	Norilsko-Taimyrskaya Ener-geticheskaya Kompaniya	Private	Tariff committee of Krasnoyarsky Krai
Transmission and setting heat supply parameters	Municipal			
Distribution (50-100 meters pipes to the building entrance)	Municipal	Housing companies	Private	Separate tariff set by Tariff committee of Krasnoyarsky Krai
Serving building-level heat supply facilities	Municipal-private	Housing companies	Private	Separate tariff set by Tariff committee of Krasnoyarsky Krai
Final consumers in the residential sector	Single households	Not associated		Tariffs for households are set by the municipality based on heat tariffs established by Krasnoyarsky Krai and municipal heat consumption norms

Institutional organization of end-users in the housing sector is one of the most complex problems[11]. For this heat market segment, it is not quite clear, what the market product is, and how a customer is defined. For a collective consumer, the boundaries of this collective consumption market are often too large: the population of a whole city. So heat consumption quantities are determined based on the municipal consumption norms, which in many cities have been stable for decades, but differ widely for cities in the same climate zones and similar building types and age structure. According to the "Rules of communal

[11] According to "Russian Statistical Annual 2005" in 2004 70% of housing stock in Russian was private.

services supply", municipality sets minimal comfort requirements, and if the quality of service falls below these, customers may refuse paying for this service. So in such a market indoor heat comfort and availability of hot water is the product, but not the quantity of heat. Many experts regard this as a weakness of the market. In reality it is a plus. The only reason why a household should buy heat is to transfer it into indoor comfort. But a household in a multi-family building has a limited expertise to make this resource-to-comfort transition effective. So it pays for the final product, which is comfort, leaving it to a specialized company to purchase heat resources from a heat supplier, to transform them into comfort, and sell it to households. Special metering equipment is needed to monitor comfort. It is easily available in the market, starting from simple sensors to monitor temperature and humidity and finishing with expensive devices able to meter six gases concentration in the indoor air. A relatively simple market transformation is needed to go from the current situation to the one with comfort on sale: have contracts between the households and the housing company for such arrangements[12]. This scheme may be modified to better address the housing company's expenses to turn resources into comfort in various types of buildings.

Table 5. The structure of heat supply system in the city of Nizhnevartovsk

Functions	Facility ownership	Company-operator	Form of operator ownership	Tariff setting institution
Heat generation.	Municipal	Municipal Company "Teplosnabzhenie"	Municipal company	Tariff committee of Tyumenskaya Oblast
Transmission and setting heat supply parameters	Municipal			
Distribution (heat substations and 100-200 meters pipes to the building entrance)	Municipal			
Serving building-level heat supply facilities	Municipal-private	Housing companies	Municipal company	Separate tariff set by Tariff committee of Tyumenskaya Oblast
Final consumers in the residential sector	Single households	16.5% of households are associated in Home Owner Associations (HOAs) and have private buildings		Tariffs for households are set by the municipality based on heat tariffs established by Tyumenskaya Oblast and municipal heat consumption norms

[12] V. Papushkin, T. Tasenko, I. Bashmakov, V. Apekhtin, and S. Gavrilov. Reliable, energy efficient municipal utility services. Moscow. UNDP. 2004.

In Russia today, only in a few cities are consumption norms set by the types of buildings (Megion is an example), so the collective consumer becomes smaller. Although such an approach seems simple, the logic of housing reform in Russia forces the collective to shrink to several, or even single, multi-family buildings. The decision on hiring a housing company is to be made by the owner of the housing real estate: municipality and the owners of private flats, according to the recently adopted RF Housing Code[13]. Consumers of communal services, including heat, are all households of the building, irrespective of the ownership. They are paying for the service to housing or heat supply companies, not to the owner. The owner is only to get his rent payments. So, all consumers should have a right to select comfort- of heat resource supplier.

For the Home Owner Associations (HOAs), the collective group of consumers is reduced to the level of a multi-family building, and they pay based on the readings of the building-level heat meters. Similar procedures are used in a number of cities for multi-family buildings, where households are not associated. In Khanty-Mansiysky Autonomous Okrug – Ugra, 10% of residential buildings are equipped with building-level meters. This is about the highest ratio in the country.

In Moscow, there is an intensive program to equip the whole housing stock (where it is technically possible) with heat meters and launch commercial billing based on such readings from 2007. The experience of the Central Administrative District of Moscow shows, that real heat consumption is 22% below the city consumption norm. It is a quite common result all across the country. It originates from the fact that heat loads evaluation used for setting municipal consumption norms did not account for about 20% of indoor heat balance provided by heat released by residents and appliances they use. And instead of approving a new method for setting consumption norms, large investments are made into proving that the old ones are no good.

Finally, the segment shrinks to a household, when flat-level heat, or hot water, metering is in the focus. The irony of this shrinking segmentation process is that after all consumers are equipped with meters, the quantity of heat they buy is lower. But if production costs of the heat supplier stay stable or grow (to compensate for the depreciation of the newly installed meters), tariffs will grow too, and consumer payments for the same level of comfort grow instead of getting lower. So there is a trap: high tariffs inspire meters installation and heat consumption control, which, if heat supplier's production costs do not reduce triggers city-wide tariff growth.

Not much research so far has been carried out to estimate market reactions of heat consumers. Two types of such reactions – installation of flat-level hot water meters and the reaction of hot water consumption to the price signals – are presented in Boxes 2.4 and 2.5.

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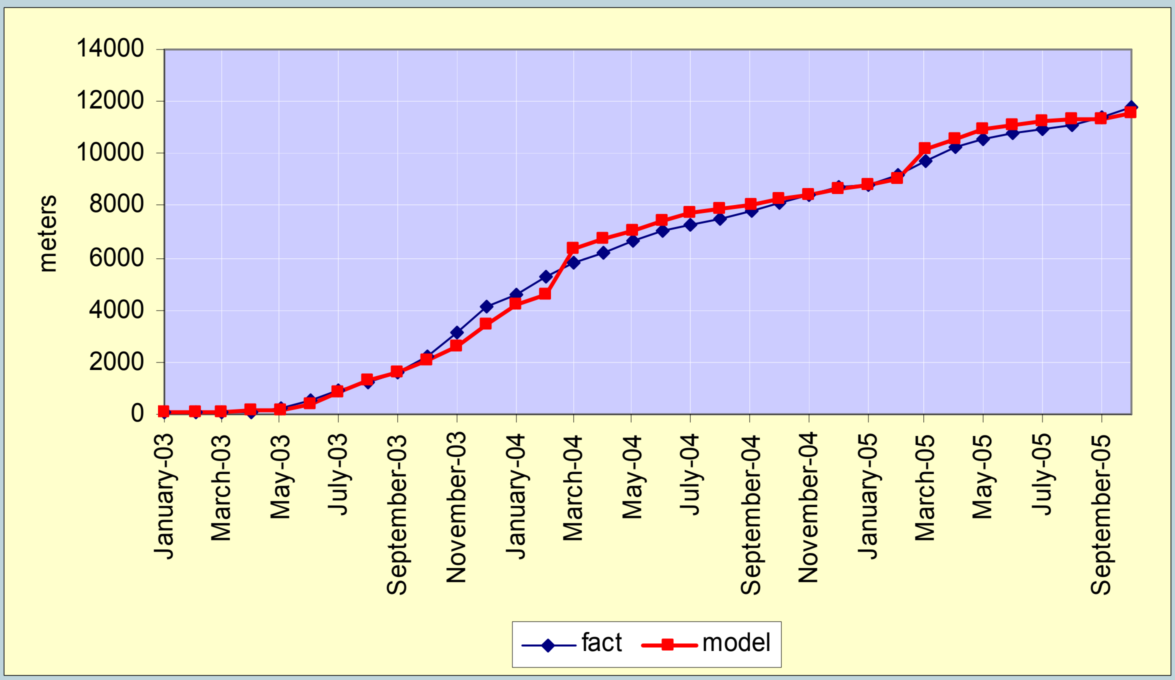
[13] For more details see V. Iliin, Yu. Matrosov, and G. Osipov. Energoeffectivnoye buduszhee stroitelnogo komplekca Rossii. Buylleten Stroitelnoy Techniki. No. 8, 2005.

Box 2.4. The dynamics of the number of households equipped with flat-level water meters in the city of Vorkuta

In Vorkuta city, about a quarter of all households have flat-level meters (FLM) installed. There is no new construction in this city. Meters installation is absolutely voluntary, and is driven by purely market factors. The number of meters installed in Vorkuta may be described by the following equations (see Figure below):

In(FLM) =	-3.170	+ 0.785*In(FLM_{-1})	+ 0.858*In(TWR)	R^2	F	**(1)**
t-statistics	*-3.919*	*27.094*	*4.984*	*0.997*	*2762*	
In(FLM) =	-3.436	+ 0.803*In(FLM_{-1})	+ 0.875*In(TWR_{+1})	R^2	F	**(2)**
t- statistics	*-5.251*	*39.761*	*6.578*	*0.998*	*3680*	

- With FLM and FLM_{-1}– the number of installed meters in the current and previous months;
- TWR • TWR_{+1}– average hot water, tap water, and sewage tariff verified for the inflation rate in the current month and set for the next month.



Both equations show, that the price impulse is considerable: with 1% growth of real (i.e. corrected for the inflation rate) water tariff the number of households equipped with flat-level water meters grows by 0.9% at once and by 4% (0.858/(1-0.785) after a while. Therefore, the installation of water meters in response to tariff growth is characterized by high inertia, caused both by lack of meter installation capacity and by consumers who install meters not only because of a high tariff but because of water bill reductions achieved by neighbors and friends. (In Vorkuta, the maximum number of flats equipped with meters during one month was 976.) Equation 2 shows that the function even better works with price expectations (if a price set for the next month is used).

Box 2.5. Hot water consumption as a function of tariff dynamics

Analysis of the hot water consumption as a function of tariff for 75 households equipped with flat-level meters in Bereznyaki city showed, that the price elasticity has a correct sign (negative), is not large by value (1% price growth brings along only 0.02% consumption reduction), but is not statistically significant (see Equation 4).

In(HWC) =	4.686	-0.064*In(HWC-1)	-0.065*In(□HW)	-0.235*In(Seaz)	R2	F
t-statistics	*9.960*	*-0.681*	*-0.723*	*-1.939*	*0.300*	*1.4*

With HWC □ HWC_{-1}– hot water consumption in the current and the previous months; THW – average hot water tariff; Seaz – season proxy variable.

Annual water consumption reduction rate is only 3.6%. Given 30% water losses (and this is exactly the volume of losses in many Russian cities), such reduction may result from the annual repair of 10% of water taps. In other words, the savings result from continuous replacement of bad taps, rather than from improved consumers' behavior. Water tariff growth has little impact on the water consumers' behavior; water consumption habits are pretty stable.

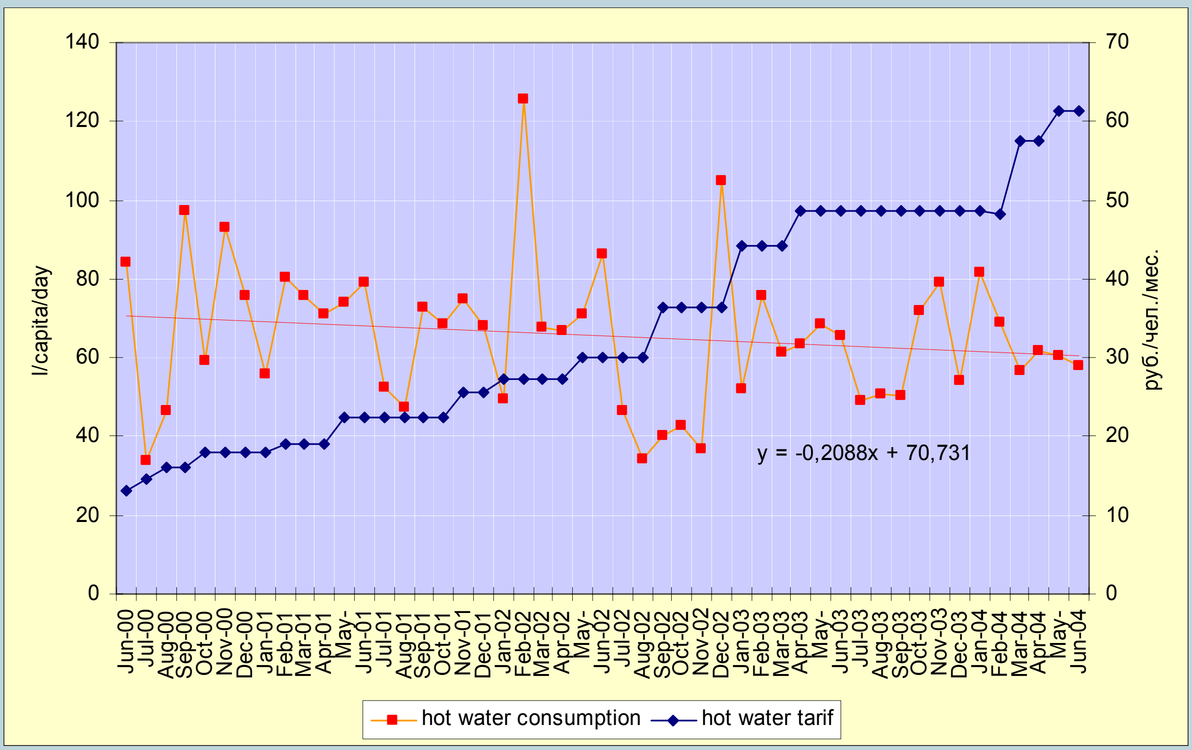


Figure 4. Hot water consumption and water tariff growth (based on the experience of 75 households equipped with water meters in Bereznyaki city)

Finalizing demand-side institutional market description, it is important to note that heat consumer behavior is still poorly known. The product on sale is uncertin and households are deprived of their "market rights" to determine the quality and quantity of product they buy and the ability to negotiate the price. They also face daily substantial over-billing for heat, which was not delivered to poorly insulated buildings and insufficiently weatherized flats; the heat meters and regulation devices saturation rate stays below 10% with only a few exceptions. Facing limited ability and willingness to cover escalating heat costs and a strong opposition to any price increase, the system is institutionalized to repudiate the incentives to use heat more efficiently.

Heat Costs and Tariffs

The prices for heat provided by regional power utility companies are set by a federal agency, Federal Tariffs Service. Heat prices are set for two following years in the form of minimal and maximum thresholds. This provides some predictability of heat price evolution. The final price level is established by regional energy commissions (RECs). These commissions also set prices for heat generated by industrial CHP and boilers. They set maximum heat prices (upper cap) for generation based on the size of the boiler-house and the type of fuel used. So anyone generating heat at a cost lower than this upper cap can adopt this tariff without involving a REC. If production costs are higher, the case is considered by REC, and only then the final decision on heat prices is made. Municipalities have recently been assigned with responsibility for setting prices for heat generated by municipally owned heat supply companies. After the private investors moved to this sector, they faced a reluctance on behalf of municipalities to raise heat tariffs. Many newcomers, like the RCS, are associated with public utility companies, so they were much more comfortable to deal with RECs, rather than with numerous municipalities. They were able to shift municipal heat pricing center from the municipal to the regional level. So in most Russian regions' municipalities have no impact on setting heat tariffs, but they are, according to the legislation in force, responsible for providing reliable heat supply services to their residents. Some effort has been made to bring the heat pricing function back to municipalities. For example, Irkutsk Oblast regional legislation adopted in 2005 required that the heat pricing responsibility (for municipally owned heat supply systems) be given back to municipalities. This heat tariffs setting system was supplemented in the very end of 2005 by the heat tariffs growth cap established for each region by the Federal Tariffs Service to control country-level inflation rate, after housing and communal services costs growth was recognized as the major driving force for the country's inflation.

Russian DHS companies' performance has always been evaluated mainly based on the reliability of heat supply, regardless of the costs. Due to excessive centralization, heat transportation costs in many DHSs significantly exceed generation costs, hence fuel efficiency improvement is not a crucial factor for such DHSs efficiency improvements due to the low (10-25%) share of fuel costs in the end-use heat price.

Heat costs and tariffs in Russia vary widely across the country. For public utilities, in 2006 (heat generated at CHP and by public utility boiler-houses) the lowest price is for Pskovenergo – 9 US$/Gcal, and the highest is for Magadanenergo – 57 US$/Gcal. Industrial boilers sell heat to the neighboring customers with a price range from as low as 4-8 US$/Gcal (Karabash and Kyshtym copper melting plants in the Urals) to over 100 US$/Gcal elsewhere. Municipal heat generation costs and tariffs, even within the boundaries of one Russian region, are very different (see Box 2.6). There are places where heat costs are as high as 250-300 US$/Gcal in 2006 (for example, small wood-fired obsolete boilers in Kondinsky district). If the costs are determined as the cost of delivering heat to the end-user with an account of real distribution losses, in some towns they may be as high as 300-400 US$/Gcal.

Table 6. End-use heat tariffs in 2004

Municipalities	**Tariff** (ave)	**Tariff** (Resi-dential)	**Tariff (other consu-mers)**	**Heat production costs at the boiler-houses***	**Heating Tariff** (residen-tial space, incl. VAT)	**DHW Tariff** (residen-tial, incl. VAT)
	Rubles/ Gcal	Rubles/ Gcal	Rubles/ Gcal	Rubles/ Gcal	Rubles/ m^2/ month	rubles/ person/ month
Khanty-Mansiysk	693	693	693	570-693	17,23	97,13
Raduzhny		373	482	730	9,20	96,13
Kogalym	441	441	441	441	13,11	112,40
Langepas	305	305	305	305	6,30	59,47
Megion		360	620-680	210-424	13,30	98,40
Nizhnevartovsk	575	297	739	575	7,26	99,14
Nefteyugansk	329	329	329	329-593	8,74	67,56
Nyagan'	575	523	575	575	16,23	95,03
Pokachi	442	442	442	510	11,74	102,80
Pyt'yakh		412	677	486	16,20	134,88
Surgut	442	442	442	435-749	9,39	111,25
Urai	442	442	442	442	14,08	96,70
Yugorsk	442	463	442	442	15,74	98,37
Beloyarsky District	413	413	413		13,16	73,69
Berezovsky District		518	541	418-1408	19,19	70,80
Kondinsky District		1087	1087	797-5820	33,77	
Nizhnevartovsky District		507	523	590	13,89	79,46
Nefteyugansky District		578	635	605-1037	15,97	106,88
Oktyabrsky District		1116	1116	762-3726	18,10	66,69
Sovetsky District		359		296-1587	12,22	128,24
Surgutsky District	532	532	532	482-591	17,52	247,11
Khanty-Mansiysky District		536	887	332-1442	26,73	67,42

Excluding VAT, in rubles/Gcal, as of December 1, 2004
**Sept.-Oct. 2004*
Source: Department for Housing&Communal Sector Development, Khanty-Mansiysky Autonomous District; Heat Supply Services Monitoring

Heat pricing is a hostage of ineffective heat costs allocation rules and poor knowledge of price sensitivity of both producers and consumers. Prices for heat are set with no account of the remoteness and the size of the customer, and with no seasonal flexibility. The heat tariff menu is poorly populated, so both suppliers and consumers are facing lack of tariff flexibility. If CHP were eligible (as they are in Finland) to have winter and summer tariffs, they would keep a much larger niche in the market. If, in addition, costs allocation between electricity and heat were based on regional heat price (as in many Danish cities, where fuel use to CHP costs allocated equal only half of fuel used by efficient boilers), they might stay competitive and escape the challenge of competition. The perception was that the consumers of district heat systems had no demand price elasticity and no alternative supply choices, and that this "natural monopoly" was granted as an everlasting gift. The common understanding was that CHP can be easily substituted in the power market (by remote providers through transmission lines or by independent producers), but not in the heat market.

According to the new regulation put in force in 2004, heat generation and transportation costs are unbundled, and heat suppliers are eligible for investment price component to partly finance implementation of investment programs coordinated with the municipality and regional Tariff Committees. Such decisions were made to keep private sector interested in staying in the municipal utility services business. The prices for housing and municipal utility services went up by about 30% in 2005, and are expected to rise by additional 20% in 2006. In 2005, the Russian Government blamed housing and communal sector for being the major driver of inflation in the country. And, in the contrast to its policy to motivate the private sector, the Federal government set up price growth caps for 2006 to slow down the inflation.

District Heat Affordability

After heat subsidies were mainly eliminated in 2004-2006 (with some exceptions still left over), urban residential consumers pay on average 23-25 US$/Gcal. Prices for residential space heating and DHW supply vary widely mirroring not only the supply heat price variations, but also different specific heat consumption norms for space heating and for DHW supply across the municipalities. Heating and hot water presently are responsible for about 40-75% of total housing and communal (H&C) costs. So heat price escalation is an important driving force pushing the housing and communal services costs beyond the affordability thresholds (see Figure 5).

To bring heat price closer to the purchasing power, regional agencies are to use average heat prices for several settlements and use cross-subsidies. Even in some large cities with relatively high incomes cross subsidies are still used (Table 5). They send wrong signals to customers and investors. They make decentralization attractive in the industrial sector and not attractive in the residential sector. Since mid 90-es, as the financial shape of industrial enterprises started to improve, more heat meters were installed, both demand and alternative supply challenged the market for large DHSs. Consumers with sufficient financial resources disconnected from district heating.

Limits to the ability and willingness to pay are the crucial factors of heat pricing and investment policies to keep up the financial health of district heating companies, and of their ability to finance investments in systems development and modernization out of collected heat payments. Careful balancing of the tariff policy with the purchasing power to keep an acceptable payment discipline is a key for a prosperous business in the heat supply sector.

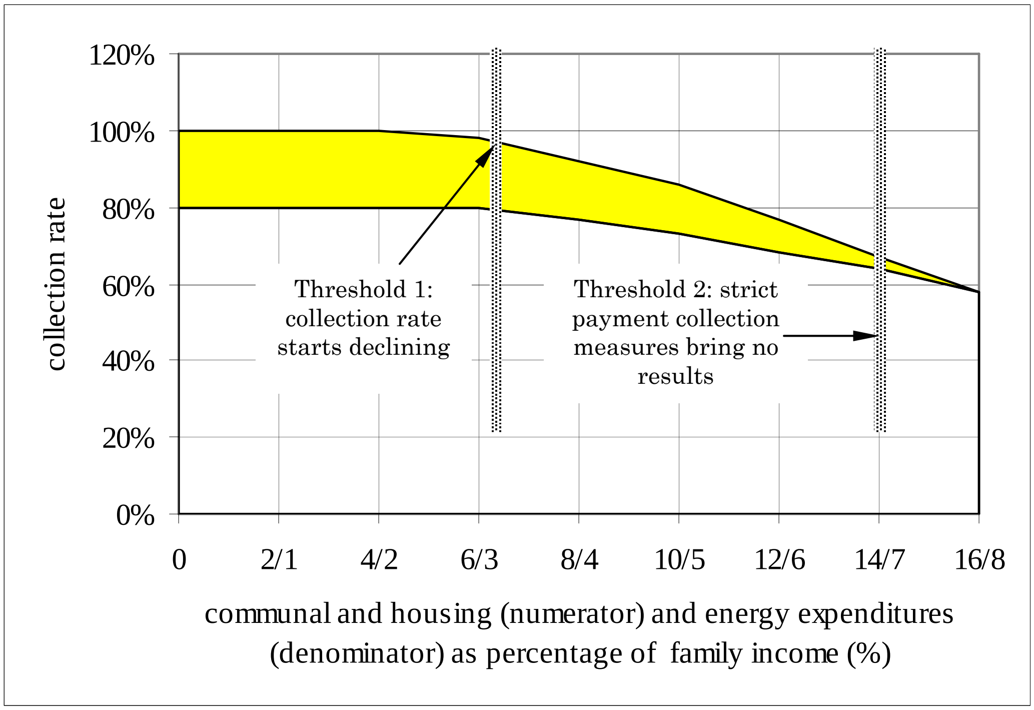


Figure 5. Bashmakov wing showing payment discipline as a function of the share of income taken by housing and energy costs (excluding rent and imputed rental value)

As the Bashmakov wing function shows, the payment discipline as a function of the share of housing and energy costs (excluding rent and rental value input) in personal incomes[14]. The Bashmakov wing can be recognized as the housing and communal (H&C) services affordability distribution function among income groups. It shows that for low-income families with a higher share of H&C costs in their incomes, demand or willingness to pay declines. As the income declines, the share of households able to afford comfortable space heating drops. If consumers cannot be switched off for non-payment, they do not sacrifice their comfort, but rather respond by reducing payment collection rate.

[14] For more discussion on the affordability issue see Bashmakov I. Affordability of Utility Services in Urban Housing: Energy and Water Efficiency Solutions, the Alliance To Save Energy and CENEf, 2006.

As to the lack of comfort, this "wing" function is applicable to the Russian Federation to display the share of municipalities able to afford fuel and maintenance for district heating systems to provide comfortable space heating to residents compared to the purchasing

Box. 2.6. Quality of heat supply at seven audited heat supply companies in Sakhalin Oblast

At seven audited heat supply companies in Sakhalin Oblast, there is no metering of heat supplied by boiler-houses to the heating network; these amounts are estimated. The average specific fuel consumption for heat generation in the boilers exceeds nameplate values by 20-40%. Overall distribution heat losses, given the actual working modes of heating networks (in many instances, they deal with lower amounts of heat determined by lack of fuel), account for 13-30%. Specific technological water consumption by boiler-houses and heating network is 1.5–2.5-fold higher than required by the norms, basically due to increased feed water consumption determined by too high heat carrier consumption from the heating network. Specific power consumption in the actual working mode of the heating network is several times higher than required by standards, which is determined by the low density of heat flow.

The data on parameters of the municipal DHS in Sakhalin Oblast below show, that lack of fuel and poor efficiency of boilers lead to a considerable reduction of thermal comfort. In none of the audited systems, average weighted indoor air temperature in buildings reaches comfortable values.

Parameters	Units	Gornozavodsk	Nevelsk	Okha	Uglegorsk	Kholmsk	Chekhov
Minimum outdoor air temperature for heating systems design	ºC	-16	-16	-29	-22	-18	-18
Connected heat load	Gcal/hr	9.7	27.6	20.8	33.7	16.2	8.91
Outdoor air temperature, average for heat supply period							
Average	ºC	-1.8	-1.8	-2.3	-4.7	-2.3	-2.3
Actual for 2004/2005	ºC	-1.1	-1.1	-2.3	-3.3	-1.4	-1.4
Duration of heat supply period							
Required	days	219	219	266	239	222	222
Actual	days	198	210	243	211	212	212
Fuel consumption							
Required	tce	6692	18759	24572	29807	9969	7159
Actual	tce	5322	11131	13605	25943	8330	4242
Heat supply							
Required	Gcal	29660	83998	67400	107762	48251	25276
Actual	Gcal	8566	44711	48960	82768	30880	13195
Share	*%*	*29*	*53*	*73*	*77*	*64*	*52*
Average weighted indoor air temperature in heated facilities							

power of population and the city budget[15]. Poor municipalities are able to supply only 50% of required heat to consumers. They reduce the duration of heat supply season and the heat supply temperature. Such low quality services are often accompanied by incorrect heat billing practices based on an assumption that normative heat services were provided. This, obviously, leads to a low payment discipline. In Koryaksky Autonomous District, where during the 2004/2005 heat supply season several DHSs failed, the collection rate stayed at 17% in 2005.

A low payment discipline makes municipal heat services sector less attractive for investors and reduces the role of economic methods in this sector management. As noted earlier, heat is responsible for 40-75% of housing and communal services payment burden, hence heat pricing policy is locked into a narrow range of affordability thresholds and the need to finance modernization programs. The key to this lock is heat costs reductions through optimization of the DHSs structure and improving their energy efficiency.

3 Ten Steps to Reform the Russian District Heating Market

The need for changes in the heat supply sector in Russia has been under discussion for many years. However, the responsibility for reliable heat supply was delegated to municipalities, with no federal agency responsible for promoting such changes through the government and the legislature. The RF Ministry of Industry and Energy has no control of the industrial and municipal part of the heating sector, while the RF Ministry of Regional Development has no control of the public utility part), the process is slow, though recently it was accelerated by the lobbying from private companies, which moved into the sector. Besides, investment programs and concessions legislation was adopted, and heat pricing was improved, which diminished the value of the draft law on heat supply (Box 3.1).

Nevertheless, many heat market parameters in Russia are yet to be changed. A saying "look before you leap" is very true when life support systems' reform is under discussion. To avoid Chernomyrdin's outcome ("wanted to do better, but ended up as usual") and to "buy time" it is important to do intense research to identify proper seeds of change and cultivate soil for these seeds. The Russian soil is practically ready for ten "seeds of change" many of which even are not addressed in the draft low:

1. Mandatory development of sustainable municipal energy plans;
2. "Menu" of well-designed heat market models to select from;
3. Regional and municipal heat supply reliability and efficiency standards;
4. Transition, where necessary, to billing for actually consumed and metered heat, gas, and water, and to more accurate consumption norms for consumers not equipped with meters;

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[15] I. Bashmakov, V. Papushkin, and V. Zhuze. The system of fast response to emergency situations in heat supply systems. Moscow, 2002 (In Russian).

5. Turning heat consumers into heat buyers by setting up Associations of communal services payers (ACSePs) and attracting ESCOs on a competitive basis to provide least-cost thermal comfort to ACSePs;
6. Launching "profits-from-savings" mechanisms to generate revenues to repay DHS rehabilitation investments;
7. Providing more operational flexibility to DHS companies;
8. Elimination of cross-subsidies and setting right price signals to inspire the rational level of DHS centralization;
9. Transition from the "cost plus" principle to sustainable "upper limits" tariffs, given transparent correction rules set by the "pricing formula";
10. Development of powerful information instruments ("IKEA-like" prefabricated technical and managerial guidelines).

Box 3.1. The RF draft law on heat supply

The first RF draft law "On heat supply" was published in December 2002. As of the end of January 2006, there are 7 versions of the draft law. The draft law has been significantly amended, and is no longer as conceptual as the initial version. It is no more technical, elaborating on the basic provisions of the RF Law No.131 "On the local self-government in the RF", the RF Law No.188 "The RF Housing Codes", the RF Law No.190 "The RF Municipal construction codes", and the RF Law No. 210 "On the basics of utility tariffs regulation", adopted in December 2004.

The latest version of the draft law basically provides descriptions of tariff setting procedures for heat supply systems; of procedures and programs of the utility sector (heat supply) comprehensive development; of relations between agents of heat supply. It also provides a new version of a heat supply contract. All this either duplicates, or contradicts the above laws. The draft focuses on the determination of responsibilities of various agencies in the regulation of heat supply, and obviously gives preference to tough top-down regulation.

The latest version of the draft law does not include descriptions of any mechanisms to form the interest in intellectual heat supply schemes on the part heat market agents. Instead, it suggests that some heat dispatcher, i.e. a firm responsible for heat supply management in a city, be responsible for all heat supply development solutions. Such firm is to be set up in all cities (settlements) of more than 200 thousand people. Basic functions of such heat dispatcher should include development of Comprehensive heat supply development programs. The federal government shall regulate the dispatcher's activities. Regional executive authorities and municipalities shall provide financing for, and exercise control over, these programs implementation.

The draft law does not incorporate the existing practice of comprehensive programs development, or determine the structure and development principles for these programs. It completely ignores the procedures of cooperation between the public and private sectors, and mechanisms to force heat market agents focus on the reduction of heat generation, production, and distribution costs.

3.1 MANDATORY DEVELOPMENT OF SUSTAINABLE MUNICIPAL ENERGY PLANS

According to the new legislation, every municipality is to develop a comprehensive program of communal infrastructure development. Such comprehensive program, or municipal energy plan, should include optimization of municipal life supporting system to make components better balanced with demand and through the whole supply chain with other life supporting systems to improve reliability and efficiency and to reduce costs. Such programs are to be developed annually by thousands of municipalities and DHS operators; however, there is no methodology foundation for their development. This extremely reduces both the scale and the efficiency of investment programs development and coordination.

To be effective, municipal planning needs to follow seven principles:

- ⇒ Clear setting the desired performance indicators for years to come based on the benchmarking approach: reliability indicators, energy efficiency, quality of service, economic indicators (see Table 3 for examples of such indicators). Since 2007 Russia would have no mandatory standards. So such standards-indicators are to be set up by municipalities and operator in the delegated management agreement of any form. Such improvements are the products which operator have to sell to the municipality;
- ⇒ Reliability, quality of service, prices, and loads density analysis are to be drivers behind the level of heat supply centralization (see Figure 7);
- ⇒ Ability to translate performance indicators into municipal programs to improve and modernize heat supply systems in place with an account of energy efficiency as a valuable resource;
- ⇒ Ability of the district heating companies to mobilize investments to realize the proposed program;
- ⇒ Shifting the affordability control focus from tariff to customers' purchasing power;
- ⇒ Full life-cycle costs analysis with sensitivity tests for energy prices volatility;
- ⇒ Differentiation of connection charges based on heat load densities and availability of reserve capacity.

Sustainable municipal energy plan should be developed on a regular basis (once every 4-5 years) to identify available heat supply resources for the municipality, future spatial heat loads distribution, rational balance between centralized and decentralized heat supply systems, technical policy in heat supply, metering requirements, reliability and efficiency standards, and purchasing power and affordability limits. Demographic and economic projections to estimate new construction activity levels and purchasing power for communal services including heat are a basis for such municipal energy plans. Some municipal energy plans are already developed, and some methodology approaches are tested.[16]

When decentralization decisions are made, they have to take into consider a number of factors. Uncompromised safety must be guaranteed; they must compete economically with

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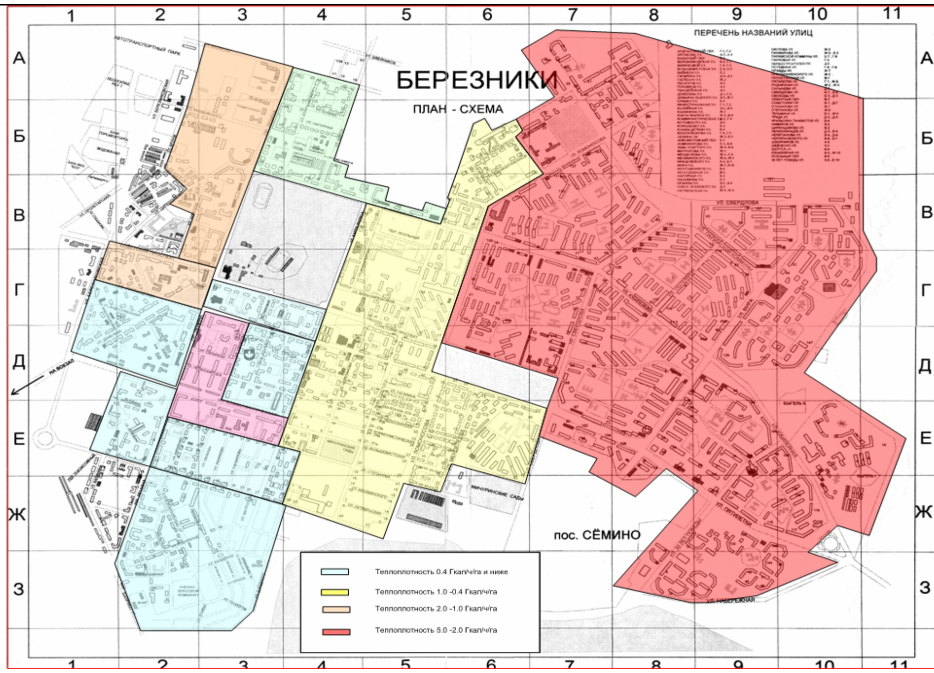
[16] I. Bashmakov and V. Papushkin. Development of comprehensive investment communal infrastructure modernization and development programs. "Enegrosberezhenie". No. 1 and 2, 2006.

large DHS; the heat load density must be right; and they must have more flexibility in meeting heat demand fluctuations. There must also be a guaranteed reliable fuel supply (possible double fuel or gas/solar combination), high boiler/fuel efficiency, and affordability and low capital intensity of boilers with high working resource. Such analysis is only in the initial stage in Russian municipalities.

Figure 7. Investigating heat loads density in municipal energy planning in the city of Bereznyaki



3.2 Heat Market Models

There is a menu of well-designed heat market models from which to select, with corresponding market rules and contractual arrangements. There are four basic heat supply models to choose from. Two are for centralized DHS:

United network with access: all sources are served by one operator and sell heat to the supply network company (HSNC), which then sells heat to final consumers. It is applicable for large DHS, which have a technical possibility to buy and transmit heat from different sources. This scheme may have provisions for the third party access. It stimulates producer's competition in the wholesale market.

Indivisible system: one company operates all system elements – heat sources, networks, and central-heating points. Only partial decentralization is cost-effective. This model is applicable to medium-size systems with high heat load density, where economy of scale does not justify the split of heat supply business into a range of separate activities. Operators can compete for managing such DHS;

Two more models for balanced decentralization process:

Balanced decentralization – heat – localization of DHS in areas with relatively dense heat loads, and decentralization of heat supply based on small DHS systems in other zones. The end-user still buys heat;

Balanced decentralization – gas (fuel, wood, etc.) – decentralization of heat supply at the end-use level. Consumers buy fuel and generate heat on site.

Sustainable municipal energy plan should adjust these models to different city zones, and institutional market arrangement should be adjusted to selected heat market model (see Table 7). Financial mechanisms and contractual agreements are to be tuned to selected models.

3.3 MUNICIPAL HEAT SUPPLY RELIABILITY AND EFFICIENCY STANDARDS

Indicative planning is not possible, unless there is a formal system of indicators reflecting utility systems status. These indicators are to be marked as of the program start up (baseline levels) and the program end date. And this new enhanced utility systems status is exactly the product that utility operators are selling to municipalities, while an investment program is the price of this product. Improved ***municipal utility services standards*** mean improved (optimal) structure of a utility system, its better reliability, energy efficiency and cost-effectiveness, better quality of service and availability to clients, accessibility of service and adequacy of the service costs to the affordability thresholds of major consumer groups. These indicators are measurable parameters of the social responsibility of municipal utilities business. They cannot be merely specified equal to what required by Building codes, because the state of many obsolete facilities is far from that required by the regulations for new construction. Baseline indicators-standards are to reflect the actual situation and to be set for each municipality individually, with an account of the actual state of utility systems. Target levels are to be the major focuses of investment programs of communal infrastructure comprehensive development.

The system of indicators is to characterize the technical shape of the systems, their reliability and favorable conditions for life support systems operation, financial sustainability of the municipal utility services business, and affordability of service. The system of indicators is to be compact, but should thoroughly describe the shape of the communal infrastructure; the indicators are to be comparable both in time and geographically (benchmarking). This last aspect makes it easier to identify target parameters based on the experience of similar Russian and foreign operators. A special attention should be paid to the comparability of conditions while comparing the indicators. A synthetic approach, based on both Building codes requirements and benchmarking with the best practices, is possible.

This approach is not just theory in Russia, it is already being applied in practice. A set of 77 municipal indicators for heat-, water-, and power supply for the period of 2006-2017 was approved and became a nucleus for the municipal communal infrastructure renovation program developed by CENEf and a private company "Novogor-Prikamye" and approved by Bereznyaki City Council on December 7, 2005. A similar set of indicators is monitored on a regular basis by the Department of housing and communal sector development of Khanty-Mansiysky Autonomous Okrug - Ugra for heat-, water-, and gas supply.

Some of these municipal standards may become a part of heat supply contracts. The quality of heat supply in many Russian municipalities is like a broken watch, which only shows correct time twice a day. In many heat supply systems, direct water temperature is about constant, so consumers face either overheating, for which they are billed if equipped with heat meters, or under-heating, for which they also have to pay if they use electric heaters to make up for low thermal comfort. Heat suppliers do not bear any responsibility for inappropriate water temperature. For several years now CENEf has been promoting the idea that heat consumers are not to pay for low quality service, i.e. for heat if direct water temperature by more than $3^{o}C$ exceeds, or is below, the agreed in the contract temperature curve, which is a function of direct water temperature from the outdoor air temperature. In the city of Rostov-on-Don, CENEf proved, that such “forced” heat supply was responsible for 36% of the overall annual heat bill of public buildings[17]. This proposal has already become a reality in the city of Kostroma, where a heat utility was willing to argue this contract provision in court, but the arbitration tribunal decided to leave this provision in the contract.[18]

[17] I. Bashmakov and S. Sivaev. Sustainable institutional mechanisms of efficient energy use in health care and educational organizations of Rosrov oblast. “Zhurnal rukovoditelia i glavnogo buhgaltera ZhKX”. No. 6, 2003.

[18] See “Novosti Teplosnabzheniya”. □ 12, 2005.

Table 7. Institutional arrangements of different heat supply market models

Market model	Owner	Operator		Contracts	Tariffs setting[19]
		Sources	Networks		
United network with access	Municipality (sources and networks)	Heat supply companies (joint stock private and public)		Lease or concession agreement. Contracts with consumers	Municipality
Indivisible system	Municipality (networks and some sources), private business (some sources)	Heat generating companies (joint stock public and private)	Heat trans-mission companies (joint stock public and private)	Lease or concession agreement. Contracts with heat suppliers. Direct contracts for heat supply through the network. Contracts with consumers	Municipality and regional public utility commission
Balanced decentralization – heat	Municipality (networks and some sources), private business (networks and some sources)	Heat supply companies (joint stock public and private)		Lease or concession agreement. Contracts with consumers	Municipality and public utility commission
Balanced decentral-ization – fuel	Municipality and private business (fuel supply infrastructure), consumers (heat generators)	Consumers (fuel utilization) Fuel supply and engineering companies (equipment service)	Fuel supply companies (joint stock public and private companies)	Contracts with consumers	Federal energy commission (gas), market (other fuels)

[19] In couple of recent years the whole heat pricing authority were transferred from municipal to Russian regional governments, while the responsibility for reliable heat supply was left at municipal level. So the balance between the responsibility and authority is to be reestablished.

3.4 CLEAR IDENTIFICATION OF THE CUSTOMER AND THE PRODUCT ON SALE

Over the last decade, the housing reform in Russia has been unsuccessful, because there has never been an effectively institutionalized customer. An important challenge of the reform is to turn consumers into customers, who will have a right to negotiate the quantity, quality, terms of delivery, and price of services. The problem is not only making a choice, but also identifying the customer to make this choice.

Home-owner associations (HOA) were declared to be the only tool to coordinate the interests of private housing owners. In Russia, HOA are developing very slowly for many reasons. HOAs or housing cooperatives are an important, but certainly not the only or even the dominant form of households' self-organization. By March 2006, all Russian households are to decide, whether they will create an HOA and hire a building management company. No enthusiasm has been displayed by the Russians to either set up HOA, or to turn away from their present management companies. This process requires careful social engineering, which has never been done.

As shown in Section 2, the definition of the product sold by heat supply companies (the quantity of delivered heat or indoor comfort services) is a key to introduce appropriate metering and billing systems. An energy service company may be a customer for heat supply services, which it will use to generate and sell comfort to the end-user, i.e. an individual household, or association of communal services payers (ACSeP), or HOA.

3.5 ENERGY EFFICIENCY AN IMPORTANT PART OF MUNICIPAL ENERGY PLANNING

Energy efficiency is an important resource for municipal energy planning and launching "profits-from-savings" mechanisms to generate a revenue source to repay DHS rehabilitation investments. This thesis may be illustrated with the data on economic and environmental effects evaluation for the heat supply systems modernization program for Khanty-Mansiysky Autonomous Okrug – Ugra for 2006-2012 developed by CENEf. The program budget is 9 billion rubles, or about US$ 315 million. The economic effect of the program will be comprised of several components. Part of this effect will be generated by additional revenues from heat sales, the other part is determined by fuel, heat, and power cost savings and reduced boiler-houses' and heating networks operation costs.

Maximum annual economic effect in 2012 will be 2,036 million rubles, or US$ 71 million. The whole program will pay back in 6.4 years. By the end of its implementation period in 2012, at least 69% of the overall program costs will be paid back. Fuel cost savings are the main component of the economic effect. Then come heat cost savings for heat purchased from power utilities by heat distribution companies, and savings from reduced operation and maintenance costs of inefficient boiler-houses and heating networks. Energy savings are estimated as a difference between additional resource consumption (for example, determined by new construction or expansion of the boiler-house service area) and energy savings generated by efficiency improvements.

The subprogram will allow for:

- ⇒ 570 thousand tce of fuel savings, which is approximately 24% of the overall energy consumption by boiler-houses in Khanty-Mansiysky Autonomous District;
- ⇒ Complete satisfaction of the additional demand for natural gas for new settlements where natural gas will become available with gas savings of 250 million m^3 through efficiency improvements in older boiler houses due to their efficiency improvements in gas combustion;
- ⇒ Get power savings of 84 million kWh in municipal heat supply systems;
- ⇒ Through partial decentralization of heat supply and heating pipelines replacement:
  - o Reduce distribution heat losses by 618 thousand Gcal and get their share from current 20% down to 11%;
  - o Reduce heat demand by 1,075 thousand Gcal.

GHG emission reduction will equal 262 thousand tons of CO_2. If the region takes part in emission trading, and if 1 ton of CO_2 costs around US$ 10, selling GHG emission quotas would allow for additional annual economic effect of US$ 2.6 million, or 73 million rubles. In this region, energy efficiency improvements have become a regular practice. The regional law stipulates, that in each municipality energy efficiency fund may be created with up to 3% of budget expenses allocated to the housing and communal sector. Every municipality develops an annual energy efficiency program, presents it to the regional government, and is required to substantiate it. Then such program becomes part of the municipal budget for the coming year. Table 8 illustrates the accomplishments of the region in 2004 financed through such energy efficiency allocations.

The are numerical examples of substantial savings generated by energy efficiency improvements in heat supply and heat consumption systems: 258 thousand Gcal were saved with around US$ 2 million investments in Irkutsk in the 2004/2005 heating season; about US$ 7 million were saved by "Mosenegro". However, evaluation of economic effects is a problem determined by lack of the effect monitoring and lack of schemes, by which the effects are distributed among potential beneficiaries. In "Mytishchenskie Heating Networks", one of the most aggressive companies in the application of new technologies in the heat supply sector, lots of information is available on the types and scale of implemented improvements, but not on the size of the effects or their distribution. Box 3.2 shows, that social engineering projects aimed at the institutionalization and motivation of beneficiaries and maintenance personnel are critical in generating the economic effect from expensive building renovations involving best available equipment and materials.

In Moscow in 2004-2006 many building were equipped by water meters/. This capital-intensive program financed from the budget made nor city neither residents beneficiary of savings. Only housing companies are potential beneficiaries and they do not let residents to control the accuracy of billing This is not an ownership issue, but rather the balance between the billing system, motivation and technical options to generate savings[20]. There are no bad habits, but there are bad incentives and bad market structures! In Russia, those who are capable of improving energy efficiency often have no wish to do so, and those

[20] I. Bashmakov. Effect form water metering: from virtual to real.. "Reforma ZhKX". No. 6. 2005.

willing have no capabilities. Motivation is a key to “swallowing up” the best practices by the district heating and building sector.

Table 8. Major directions and scale of energy- and resource efficiency activities in Khanty-Mansiysky Autonomous Okrug - Ugra in 2004

Measures	Implementation scale	Level of activities in municipalities
Elimination of small obsolete inefficient boiler-houses	12 units	Municipalities: Beloyarsky, Raduzhny, Pyt’yakh, Khanty-Mansiysk; Kondinsky District
Commissioning of new boiler-houses	8 units	Municipalities: Surgut - 1, Khanty-Mansiysk – 1, Nyagan’ – 1, Megion – 1; Kondinsky District – 1, Khanty-Mansiysky District – 1.
Boiler-houses fuel switch to natural gas	8 units	In the municipalities: Megion – 1, Nyagan’ – 1, Khanty-Mansiysk – 3; in districts: Kondinsky – 1, Nizhnevartovsky – 1, Khanty-Mansiysky – 1.
Renovation and capital repair of boilers	Capital repair and renovation of 327 boiler-houses in 18 municipalities of the autonomous District	In municipalities: Beloyarsky – 9, Kogalym – 16, Nyagan’ – 24, Nefteyugansk – 4, Pyt’yakh – 10, Pokachi – 2, Nizhnevartovsk – 2, Surgut – 7, Urai – 9; in districts: Berezovsky – 19, Sovetsky – 19, Surgutsky – 59, Kondinsky – 7, Nefteyugansky – 5, Nizhnevartovsky – 5, Oktyabrsky – 3, Khanty-Mansiysky – 12. In the city of Yugorsk, 115 boilers were repaired.
Introduction of independent heat sources	56 units	In the city of Urai, 56 individual gas-fired boilers were installed in residential buildings.
Replacement of old pipes with the new ones, with better insulation	138.1 km of pipes replaced	In all municipalities of the autonomous District. 73.1 km of these with pipes with foam poly-urethane insulation.
Installation of heat consumption regulators	476 units	Temperature regulators were installed at individual heating points in the following municipalities: Pyt’yakh, Nyagan’, Nizhnevartovsk, Surgut, Urai, Yugorsk, Megion, Pokachi; and districts: Nefteyugansky and Nizhnevartovsky.
Water treatment in heat supply systems		A water treatment unit was launched at the gas-fired boiler-house in Tayezhny (Surgut municipality). 642.6 thousand rubles of investments will bring monthly savings of 40 thousand rubles. Chemical water preparation was advanced: - in 4 boiler-houses in Sovetsky district; - in 1 boiler-house in Pyt’yakh.
Installation of VSD at pumps	78 units	In the municipalities: Langepas – 6, Nyagan’ – 1, Megion – 1, Pokachi – 29, Pyt’yakh – 7,

		Raduzhny – 5, Surgut – 10, Urai – 1, Yugorsk – 16; and districts: Nefteyugansky – 3, Surgutsky – 8.
Restoration of the flow capacity of obsolete pipelines	565.7 km	In the municipalities: Surgut – 148 km; Nizhnevartovsk – 112 km; Kogalym – 100 km; Megion – 50 km; Urai – 5.1 km; Khanty-Mansiysk – 6 km; and districts: Surgutsky – 128 km; Berezovsky – 0.23 km; Nizhnevartovsky – 2.57 km; Khanty-Mansiysky – 4 km; Nefteyugansky – 7.8 km; Sovetsky – 2 km
Measures to improve the performance of buildings envelopes	In 2004, 113,683 m2 of buildings envelopes were improved	In the municipalities: Nefteyugansk, Langepas, Nyagan', Raduzhny, Surgut, Urai, Yugorsk, Pokachi, Nizhnevartovsk, Khanty-Mansiysk; and districts: Berezovsky, Nizhnevartovsky, Nefteyugansky.
Repair, renovation, and insulation of buildings basements	In 2004, 57,388 m^2 were repaired, renovated, and insulated.	
Application of efficient windows and insulation films	1,330 m^2 of films and efficient windows were applied for the construction and renovation of the housing stock in municipalities.	

Source: Novitsky V., Zverev G., Zaitsev E., Bashmakov I., et al. Housing and municipal utility complex development in Khanty-Mansiysky Autonomous District – Ugra in 2004. Analytical paper. Khanty-Mansiysk, 2005.

3.6 HEAT METERING

As CENEf experience shows, for buildings with heat loads below 0.2 Gcal/hour potential savings can never cover the meters service and maintenance costs. Many buildings are to be demolished and in some there is no basement or any other location for a meter installation. Therefore, there is no need for "blind" installation of heat meters in all buildings. Heat metering programs are to be well-designed for the desired institutional market scheme allowing for transition, where necessary, to billing for really consumed and metered heat or comfort service, to more accurate consumption norms for those consumers who are not equipped with meters.

While many experts aggressively support transition to flat-level heat meters – allocators, - this is hardly a cost-effective solution. If four allocators are needed per flat, the costs would be US$ 20 per apartment. Plus annual billing costs will be in the range of US$ 12-20 per apartment. In the NIS countries, annual heating costs are US$ 50-400 per apartment per season. As shown above, an individual household may reduce its heat consumption by up to 7%. According to the billing practices with allocators, 30-50% of the bill is based on the flat space. So savings are US$ [50-400]*[50-70%]*7% = US$ [2-20], with an assumption that comfort is not sacrificed. That is less than, or equal to, annual billing costs, with no savings left to payback investments in allocators.

Over the last 14 years, Russia has accumulated some reengineering (upgrade, renovation, and new construction) experience in heat supply and heat consumption systems, including thermal performance of public and industrial buildings. All modern materials and equipment for the upgrades of practically all elements of these systems, from heat sources (boiler-houses CHP) to heaters, and from ventilated facades to effective window units, are presently available in Russia. Energy efficient materials and equipment are promoted under various projects dealing with renovation and new construction, including, for example, comprehensive renovation and repair of the housing stock under the World Bank Housing Divestiture project. Box 3.2 describes issues with a World Bank Housing Divestiture Project that implemented energy efficiency upgrades on multi-family building s in Cherepovets city, the technical aspects of which are described in the inventory "Housing stock energy efficiency: problems, practices, and prospects". [21]

At the same time, there is a critical need for fuel consumption and heat generation meters at boiler houses, and heat meters at the responsible division boundaries between different agents in the heat supply market. In Khanty-Mansiysky Autonomous Okrug – Ugra, which is by Russian standards, in 2005, only 70% of gas- and crude oil-fired boiler-houses were equipped with fuel consumption meters, and only 35% of boiler-houses had heat generation meters. Therefore, specific consumption and efficiency of boiler-houses are often estimated, rather than metered. Until meters saturation reaches the desired levels, many customers will still be billed based on consumption norms. The consumption norms are to be reconsidered, as more data on the actual level of heat consumption are available from the analyses of readings of already installed meters. Transition from municipal average consumption norms to the type-of-building average norms is needed to motivate demand for more energy efficient dwellings in the real estate market.

3.7 GIVING MORE OPERATIONAL FLEXIBILITY TO DH COMPANIES

Performance of district heating companies is to be evaluated on the basis of municipal performance indicators for a DHS operator with much more operational flexibility. DHS management rules need to be modified to give more operational flexibility to DHS operating companies. Presently, decision-making by municipal enterprises is very limited: they do not set salaries for their personnel determine the number of their employees, etc. If transformed to joint-stock companies, they acquire much more flexibility. With all the high inefficiencies locked up in current heat tariffs, reduction of heat supply costs under fixed or upper cap tariffs provides a strong motivation for improvement of managerial practices. Stable market rules and tariffs setting rules, as well clear indicators for performance evaluation would motivate DHS management to apply life-cycle costs and least-cost planning approaches to meet established performance standards with minimal costs for the duration of lease or concession contract.

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[21] Housing stock energy efficiency: problems, practices, and prospects. Inventory. Deutsche Energie Agentur (DENA) and Fund "Institute of Urban Economics". Moscow, 2004.

Box 3.2. Experience with energy efficiency upgrades of multi-family building s under the World Bank Housing Divestiture Project in Cherepovets city

This project progressed best of all in the city of Cherepovets, where around 600 residential buildings, i.e. half of the municipal housing stock, were renovated with World Bank financing. The project aimed at 15-17% reduction of heat consumption. Its effects were monitored for several buildings. The monitoring revealed heat savings (over-consumption) for space heating and DHW supply, and tap water savings (over-consumption) for tap water and DHW supply. The idea was to also monitor reduction (increase) of the equipment operation costs. Monitoring results proved that in buildings with renovated equipment major savings were achieved through reduced heat consumption in DHW systems, while over-consumption (compared to the baseline level) was revealed in space heating systems. Average reduction of heat consumption in buildings accounted only for 6-7%. Some errors made during the first and second phases of the project were properly analyzed and addressed, so in the two following phases savings (12-14% of heat and water) practically reached the target level.

One important result was a possibility to accumulate data for designing further energy efficiency improvements and improving personnel skills. However, after the project was completed, most remaining opportunities were not implemented because the city has preserved for these buildings a heat billing system based on the occupied floor space. This essentially nullified the positive results. Residents, who would have been major beneficiaries of the improvements, were not able to benefit due to the lack of heat consumption monitoring and the per person hot water billing. Housing companies were not able to benefit from the gap they collect from residents and pay to heat and water suppliers based on calculated heat loads until meters were commercially registered. Such registration was dine initially in two buildings which had no heat supply automatics. The readings have shown consumption comparative to norms. This made municipality reluctant to inspire commercial registration of other already installed meters. Based on readings from many meters the city heat consumption norm was adjusted. Later more meters were commercially registered. But city faced another problem: difficulty in allocation of readings to heating and hot water bills. After transition to full cost coverage by residents in 2001 in Cherepovets the city administration lost some interest in getting savings from the project while still was responsible for serving the WB loan. In such situation only housing companied potentially were able to benefit from the project. Some of them do benefit, while others are afraid that they may loose money and do not go through commercial registration of meters. In such scheme no cooperation from the residents in savings maximization may be expected. This project illustrates very well that technology alone bring no savings if market rules are not tuned to let some market agents to benefits from new technological options.

The same project was also realized in the city of Petrozavodsk. Poor-skilled personnel of the local housing companies failed to operate automated building-level heating points, so they switched them off or ruined the automatics. The lessons from this project are simple: social engineering projects aimed at the institutionalization and motivation of the beneficiary and maintenance personnel are crucial for generating the economic effect from expensive building renovations involving best available equipment and materials.

3.8 ACCOUNTING FOR LIMITS OF AFFORDABILITY

Purchasing power of both budgets and residents should be monitored and predicted to escape bankruptcy and pursue a balanced heat pricing policy. Dominance of heat tariffs setting issues over evaluation of heat consumers' purchasing power at the level of Federal Tariffs Service or Regional Energy Commission creates problems with achieving dynamic balance of requited revenues with the ability to pay. Many Russian municipalities have approached, and some have exceeded, affordability thresholds, which are given in Table 9.[22]

Table 9. Affordability thresholds in Russia

	Share of H&C costs in income	The share of communal services costs in the income (including energy)	Share of energy costs in income
Average affordability threshold	7%	4-5%	3-4%
Marginal affordability threshold	15%	8-10%	6-8%

As a result, heat supply companies are facing low payment discipline, which in many cases originates exactly from exceeding the ability and willingness of consumers to pay for delivered heat. In reality, it often happens that heat, which was never delivered, is also billed to customers, as well as excess heat provided due to the failure of the heating company to regulate direct water temperature. In some municipalities, residential consumers with no installed meters very accurately pay for heat as much as was actually delivered. But unless the low quality service is improved, they stay in debt of the heat supply company. In many cases, when customers are under-heated and have no meters, they are billed full cost, but when they have meters and are overheated, they are billed extra costs. In other words, poor quality heat service deteriorates the affordability and indebtedness problems.

In Russia, not high heat prices are driving consumers to use heat more efficiently, but low efficiency of DHSS escalates heat costs and tariffs. Transition to full costs coverage, after subsidies are eliminated, means that residents are requested to pay for the inefficiencies, which have been embodied in the DHSs for decades of the central planning and transition economy. The responsibility for improving the efficiency of heat supply systems ought to be shared between consumers and suppliers. A household, or a group of households, can only control heat consumption at the building level, but has very limited possibilities to influence the overall efficiency of DHS. Households are to be responsible for covering the full costs of heat supply only *under an assumption that heat generation and transportation efficiencies meet the municipal or regional standards*. It is not fair to expect that the households shall pay for unacceptably low efficiency of heat generation or too high transmission and distribution losses.

[22] Bashmakov I. Affordability of Utility Services in Urban Housing: Energy and Water Efficiency Solutions, Alliance to Save Energy and CENEf, 2006.

3.9 MAKE HEAT PRICING FLEXIBLE

In 2004-2005, a substantial progress was made to improve heat pricing. Nonetheless, much remains to be done to move the pricing process further and make it more flexible and market oriented:

- ⇒ Bring heat pricing closer to the municipal level (today heat prices are mainly set by regional authorities) and get a better balance of heat pricing and customers' purchasing power;
- ⇒ Introduce seasonal heat prices;
- ⇒ Improve fuel allocation methods at CHP;
- ⇒ Attribute generation costs to every heat source to enable purchase of least-cost heat first by heat networking companies;
- ⇒ Eliminate cross-subsidies and set correct price signals to inspire the rational level of DHS centralization;
- ⇒ Switch from the "cost plus" principle to sustainable "upper limits" tariffs, given transparent correction rules set by "pricing formula" to keep production cost savings;
- ⇒ Evaluate real, not "normative", heat losses and include those in tariffs.

A tariff should include three components: production component, transmission and distribution component, and consumer service component.

3.10 DEVELOPMENT OF POWERFUL INFORMATION INSTRUMENTS AND "IKEA-LIKE" PRE-FABRICATED GUIDELINES

DHSs are to become intellectual ones. As mentioned above, heat is traded in the midst of uncertainty. So much more data collection and information support is required to drive effective policies and monitor the outcomes. This is needed in order to "buy time", improve the learning curve, build more confidence that things can be changed for the better, and build a heat market reform process fine-tuned to local conditions. Substantial effort needs to be devoted to the development of powerful information tools: "prefabricated" technical and managerial guidelines, draft and model regulations and contracts, price regulation schemes, demo sites, labeling, awareness raising and advising programs for decision-makers.

There is no need for each municipality to start developing institutional, technical, economic, and financial decisions from the scratch. Replication of successful practices requires understanding of which capacities are to be built, and which policies are to be adopted; implementation of the policy choices; and evaluation of the effectiveness of similar policies under different conditions. Similar policies and measures can differ widely in impacts among countries and municipalities depending on the implementation strategies and the existence of other regulatory policies designed to prevent the undesired effects in the presence of externalities, information and coordination problems.

Many problems arise from poor communication between the heat market agents. Much confusion was observed by private companies in their negotiations with municipal agencies, even more confutation resents in the relationships between heat suppliers and their clients, especially residents. Residents only have a vague idea of what they are paying for, of the heat supplier's obligations, what they can do to cut their heat bills, and how monetary savings may become real. There is a great need for local experts training to enable them develop and implement energy efficiency improvement measures and launch public awareness campaigns; for educating local and foreign bankers in EE projects and country specific conditions; for establishing effective (MUNEE-like) networking.

There is a need for effective monitoring tools for all market agents, from municipality (to monitor performance indictors) to an individual household (to monitor its heat bills and service quality). So data collection, processing, analysis, and often projection tools are badly needed.

Residential heat consumers need information support. So as to address this need, CENEf has developed "A Tale About Lost Heat"[23] for kids, an insulation materials labeling program "Plus 20"[24], and is considering writing "From A to Z in the housing and municipal utility services" to educate households. Poor communication never gives good results. Only development of powerful information and effective communication instruments and guidelines may increase a capacity to absorb and scale up the "best practices" all over the Russian Federation.

[23] I. Bashmakov. "A Tale About Lost Heat". Published by Moscow oblast regional energy commission.

[24] This brochure is available bridge the gap in knowledge on how to weatherize the flat with least costs and how much savings at electricity bill such weatherization may bring. This is a part of labeling program for weatherization materials. CENEf welcomes those willing to launch such program.