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The ways and problems of power efficient development of housing and communal services economy of the Russian Northern regions on the basis of innovation techniques

The article considers the problems of power savings and increase in power efficiency in the housing and communal services economy of the Russian northern regions and the ways of solutions to these problems on the basis of innovation techniques using power servicing contracts as a possible mechanism to finance the investments in this sphere. As an example the author examines the implementation of pilot project "Power efficient quarter" in the city of Apatity in the Murmansk Oblast.

Power efficiency, innovation techniques, housing and communal services, northern regions, power servicing contracts.

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Using of high technologies in the industry and agriculture is one of the basis and necessary prerequisite for modernization of Russia's economy but at the same time under the Russian capitalism it doesn't have a direct positive impact on the quality of life of the most part of the country.

At the same time introduction of innovation techniques and materials in the housing and communal services can reduce power consumption directly, increase power efficiency and improve the living conditions. It is especially urgent for the northern municipalities, where people are pressed from different aspects. One of them is severe climatic conditions, that are not softened in any way for some reason, despite "the global warming", and it leads to the increase in the length of heating season in these regions to 8 – 9 months a year. Another is a raise (constantly advanced the inflation) in heat and power rates for the population under the monopolistic market of these products and power deficit in most northern regions.

The Housing Code and the laws and the subordinate acts adopted in addition to it exacerbate the situation with the population's debts to the energy sector for the consumed heat because management companies have no regulation for using the funds collected from the population, and because of the lack of security risks associated with the bankruptcy of these companies. Besides it, this situation is typical of not only the northern regions, but also of virtually the entire country: "Almost total lack of competition in the power companies market resulted (from 2001 to 2010, author's comment) in more than a tenfold increase in the cost of utility tariffs" [1]. According to the elite estate sales department of the company Penny Lane Realty in 2001 the Muscovites paid 15% of their monthly income for utilities at the average, and in 2010 – 25%, and the elderly

spend almost all pension (without additional payments from Moscow budget) on housing and communal services. Thus, "... the growth of utility tariffs provokes a rise in the price of management services for residential properties and creates conditions for the illicit enrichment of many management companies, and it also increases social tensions among the residents of the capital" [1].

Thus, energy saving and increase in energy efficiency in the sector of housing and communal services can partially dampen the negative effects of the growth of rates in this sector and mitigate social tensions.

According to the World Bank estimates given in the report "Energy efficiency in Russia: hidden reserve", the potential of energy efficiency is as follows *(tab. 1)*.

As the table shows, only about 45% of the potential of energy efficiency in the housing sector and social sector is attractive to investors, while the remaining 55% (at best) must be paid by the homeowners and municipalities ("public sector") from their largely deficit budgets.

Legal basis for the implementation of energy saving and energy efficiency in the sector of housing and communal services in Russia

Federal law № 261-FL [2] made the duty of municipalities "to adopt and to implement municipal programs concerning energy conservation and increasing energy efficiency, to organize energy audit of apartment houses, which are municipal housing stock within the boundaries of the municipality...". Ib. paragraph 4 of Art. 12 directly states: "In order to improve energy efficiency in housing stock and its energy efficiency the list of requirements for maintenance of common property of the owners of the premises in an apartment building includes demands for measures on energy saving and on increasing energy efficiency of apartment building...; executive authorities of the subjects of the Russian Federation approve the list of measures on energy saving and on increasing energy efficiency in respect of the common property of the owners of the premises in an apartment building, these measures are to be carried out simultaneously and (or) on a regular basis. **The person responsible for the maintenance of an apartment building or the owners of the premises in an apartment building with direct management of apartment house must conduct the energy saving and energy efficiency measures included in the approved list of measures on energy saving and on increasing energy efficiency in respect of the common property... The owners of the premises in an apartment building must bear expenses of these measures** ... may require that the person responsible for the maintenance of an apartment building implements the actions aimed at reducing energy resources used in the apartment building, and (or) makes an energy service agreement (contract) providing the reduce in energy resources used in the apartment building".

Thus, in respect of the common property the owners will have to pay regardless of their wishes. The costs of these activities seem to be included in the receipts for utility services.

Table 1. The increase potential of energy efficiency in Russia on average

Sector for achieving energy efficiency	Total potential (%)	Financially attractive potential (%)
Buildings	68.6	30.9
Processing industry	41.5	33.2
Electrical power engineering	44.4	5.8
Heat production	10.4	2.6
Heat distribution	17.3	15.9
In transport including pipeline transport	23.4	19.7

In addition, Section 5 of Art. 13 of this law states: "Prior to January 1, 2012 ... **the owners of the premises in the apartment buildings put into the operation on the date of this Federal Law coming into force must provide such buildings with metered water, gas, heat and electricity devices and they also must put these metered devices into operation.** Meanwhile by the time fixed the apartment buildings must be provided with collective (general building) metered water, heat energy and electrical energy devices, as well as individual and common (for a communal apartment) metered water, natural gas and electricity devices".

Taking into account the average cost of one residential meter of about 1.5 – 2 thousand rubles only for the purchase and installation of meters in one's own apartment, every owner will have to pay additionally from 3000 to 6000 rubles during 2011, and it will make for from 150 to 300 billion rubles on a national scale! It is unknown where the low-income people will take money from, probably so as not to cause social protest, such as followed the launch of the Federal Law № 122-FL, the law will have to be adjusted during the course of execution. As for the energy service contracts, they will be discussed below.

As of today in house-building there are many technologies of production and using of advanced energy-saving materials and structures, energy-efficient heating and lighting, information technology of the optimal control over power consumption and heat in the housing. Widespread use of the existing world experience as well as the Russian one in this field in our country would fully ensure the power settings within the time prescribed in the Russian Energy Strategy until 2030 (approved by Government Decree of 13.11.2009 № 1715-d) [3]), the Federal Law of 23.11.2009 № 261-FL, the State Program on energy saving and increase in energy efficiency for the period until 2020 (approved by Government Decree of 27.12.2010 № 2446-d) [4] and the accompanying regulations.

Of course, this is mostly so-called "catching up" innovation, but they are better than nothing.

The most important condition for this is the availability of source(s) for funding necessary and sufficient investment. Under Russian conditions we cannot apply either the experience of Western countries with their developed housing market regulated by ecological law and aimed at energy saving and energy efficiency, nor the experience of our neighbors – Belarusians, where the government routinely conducts the proper activities, paying for the bulk of expenditures from the budget. By the income of population and because the primary beneficiary in the implementation of energy saving still is the state, the Belarusian experience is closer to us, but by the ideological and political reasons it seems to be unacceptable for the Russian elite in power at present. Therefore, as it has already shown, the bulk of the cost of activities to improve energy efficiency of housing stock will fall heavily on the shoulders of Russian homeowners.

In accordance with the 261-FL, in Russia in 2010 all regions and municipalities developed the programs of complex development of systems of communal infrastructure of the municipalities (PCD SCI). According to the guidelines, these programs must contain the measures for energy conservation and increasing energy efficiency of communal infrastructure, including the housing stock. For example, paragraph 32.3 of "Guidelines for the development of PCD SCI", approved by the Ministry of Energy and Housing and Communal Services of the Murmansk oblast of April 5, 2010 № 16 says: "The section "Proposals for the use of resource-saving technologies" should be developed to meet the requirements of Federal Law of 23.11.2009 № 261 "On energy saving and energy efficiency improvements and on amendments to some legislative acts of the Russian Federation", and it was formally made in the regional program.

Innovation potential of the programs for energy saving and increasing energy efficiency in the sector of housing and communal services

At the same time, the sector of housing and communal services could be an extensive and attractive market for the introduction of innovative technologies of energy efficiency. We list some of the innovative projects that are potentially realizable in the sector of housing and communal services [5]:

1. The use of modern insulating materials for heat insulation of envelope buildings as well as glass packs for construction and major repairs of residential buildings.
2. Construction of block (house) electric boilers of high voltage for diversification of heating sources and reduction of heat loss in the city networks with centralized heat supply.
3. Application of modern thermal centers and heaters with automatic temperature control and adjustment when constructing and doing major repair of residential houses.
4. Introduction of automated control of street and in-house lightning.
5. Use of the energy-efficient light sources including the light-emitting diodes in order to significantly reduce energy consumption, both for street and house-side lighting, as well as in apartment buildings.
6. Use of wind power plants in integrated systems with diesel power plants and small hydroelectric power stations to supply remote isolated users with energy.
7. Use of heat pumps in the construction of residential buildings with low potential energy of the earth, air and water body.
8. Heat recovery of ventilation streams and waste waters.
9. Conversion of existing black oil and gas boilers to advanced technology using steam coal as fuel (Vorkuta, Inta, Artyomovsk etc.) and chippings with the possibility of using wood waste.
10. Construction of new modern solid boilers near the centers of thermal loads to reduce heat loss when transporting heat carrier.So in Belarus the use of mineral plates, which are produced in Gomel and Bereza by stone casting of basalt raw material for heat insulation of facades and roofs of prefabricated houses ("thermal fur"), made it possible to reduce by 3.5 – 4 times heat loss through the envelopes of buildings, and respectively, and to reduce the costs of heat carrier for their heating. Payback period of such projects is 7 – 8 years. Currently, active work on the application of this technology in heat insulation is going on in the cities of Belarus (Minsk, Vitebsk, Gomel, Mogilev and elsewhere) [6]. Russia, for example, the Murmansk oblast has all prerequisites (raw materials, electric power, market) for the development of production of similar products that fits well with the strategy of improving energy efficiency.

The use of electric boilers of high voltage in the Murmansk oblast, where there is an excess capacity in electric power generation, helped to reduce the costs for buying of expensive export raw materials – black oil and to improve the environment. At the same time the use of low-voltage electric boilers became unprofitable.

During the major repair of apartment buildings the replacement of unregulated thermal unit of elevator-type by heating unit with automatic control and the possibility of computer eavesdropping (for example, thermal unit, LLC "Danfoss"), as well as a range of proper activities related to in-house heating systems make it possible to consume only really necessary heat and to pay actually consumed amount of heat carrier, providing uniform heating of the whole house. The higher is the effectiveness of such activities, the better is the complex of energy-efficient measures, such as:

- installation of collective meters;
- repair of electrical networks;
- repair of heat supply networks;
- repair of water supply networks;
- repair of drainage system;

- repair of basement;
- heat insulation of the envelopes of the buildings;
- installation of metal insulated front doors with entrance door intercom;
- replacement of wooden windows by glass packs in the public areas (entrances) and in the flats, etc.

According to the company "Danfoss", the payback of these projects makes up 2.5 – 3 years and requires a cost of 200 – 400 rubles per square meter of floor area. The part of these works can be performed with the use of Housing Reform Fund in accordance with Federal Law № 185-FL. The rest of activities require the use of the mechanism of energy service contracts and fundraising owners. It should be noted that the implementation of this work package should be preceded by the phase energy audit of the building using a thermal imaging survey in the cold (winter) season.

The use of energy-efficient lighting devices in the sector of housing and communal services, including the devices based on the use of LEDs in conjunction with the automated control systems that control the level of natural light, and with the motion sensors in the rooms is able to reduce energy consumption for street and in-house lighting by 3.5 – 4 times.

Some northern regions of Russia, for example, the Murmansk oblast has all the necessary components (raw materials, technology, equipment, personnel, market) to establish production of LED lighting. In particular, there was arranged production of prototypes of street and entrance lanterns at the LLC "Severnye Kristally" in Apatity. Now they are in-service inspection in the framework of the project "Energy Efficient Quarter", but it is already clear that it is necessary to reduce both cost and price of equipment significantly.

Over large areas of the north and north-east of Russia there are practically no main electricity networks. Existing centralized power systems are isolated from the Unified Energy System (UES) of Russia, there is a lot of remote isolated users using diesel power plants (DPP). Because of the remoteness and complexity of delivering diesel fuel the price of electricity derived from such plants is by 3 – 4 times higher than the market price. Because of the high degree of wear many of these stations consume twice as much fuel as it is necessary according to the established standards. It is for these users that the use of alternative energy sources and the use of wind and small hydropower stations (where it is possible), integrated with DPP, can not only improve the reliability of energy supply, but also save up to 50% of diesel fuel [7].

Unfortunately, the use of heat pumps in the Russian construction practice is episodic in nature, unlike, for example, the developed countries. For example, in Stockholm about a quarter of the housing stock is heated with heat pumps. The use of heat pumps in new construction can completely or partially abandon the district heating, saving to 75% of electricity by electrical heating of heat carrier. Some northern regions of Russia, for example, the Murmansk oblast [8] has sufficient conditions for the effective use of heat pumps in both urban planning and industry. Also, under the Russian context we practically don't use the technology of Heat recovery of ventilation streams and waste waters, and it leads to additional costs of heat carrier for heating the buildings and "warms" the environment.

Of course, replacing of oil-fired boilers and thermal power-stations by the coal ones is difficult to be directly attributed to innovations in the sector of housing and communal services, but it is connected with the heat carrier price for the public and when a series of requirements are satisfied some elements of innovation are also present. According to the JSC "Regionenergo Management Group" (the Murmansk oblast), such requirements include:

✓ **drive feed of coal and ash removal (it is necessary for installation high efficiency);**

✓ automation of technological processes;

✓ compulsory presence of cyclones for cleaning the flue gases;

✓ compulsory equipment of boiler installation with water-conditioning system to prevent corrosion in heating networks;

✓ **the ability to use wood waste (50%)**;

✓ **transferring the boiler installations to the center of heat loads – to reduce heat loss when transporting the heat carrier.**

Meanwhile it is possible to use low-grade thermal coal and even chippings, and thermal coal and chip burning in the "fluidized bed" significantly increases the coal-fired plants efficiency. By the way, Orshynsk power men (Belarus) have received the power plant efficiency similar to the coal-fired plant efficiency, when burning milling peat in a mixture with sand in the "fluidized bed". Finland has gained a significant experience in the use of peat, along with bio-fuels as a local energy resource and fuel for heat stations. Maybe, the use of the our neighbors' experience is a desired alternative to the annual fires on the moors near Moscow and an additional source of hydrocarbon fuel in the Northern European regions that are rich in this resource, isn't it?

Of course, when transferring from black oil and gas to coal, ash-disposal area is a problem that must be solved in each case individually. On the other hand, both black oil and gas in particular is an export raw materials and its savings in the domestic market will keep the export potential even under the conditions of reduction in oil and gas production.

Another reason for transferring to coal for heat and electricity production may be the price of raw materials *(tab. 2)*.

Thus, excluding the costs for ash dump, the use of coal in the Russian context is more economical than the use of black oil by 2.8 times. These calculations are confirmed by practice: for example, the price of Giga-calorie received by the residents of the town of Apatity from the Apatity heat station, which burns coal, is by several times less than from the black oil boilers and the heat stations in other cities of the Murmansk oblast.

Another source to increase energy efficiency for the heat stations is a complex heat and electricity generation (CHEG) with a centralized customer service. So in Finland the use of CHEG has resulted in substantial fuel savings compared with other methods of power supply, at the same time the emissions of harmful substances have declined by 40%. At the present time CHEG at the Apatity heat station is being prepared for implementation within the framework of the project related to connecting the town of Kirovsk (located 17 km from Apatity) to district heating from this heat station with decommissioning of the Kirov black oil boiler having outdated equipment.

Energy service contracts

The Budget Code of the Russian Federation (paragraph 3 of Art. 72) was amended by the Federal Law № 261-FL as follows: "Supplement with the following proposals: "The state or municipal customers may enter into the

Table 2. Comparison of coal and black oil as fuel for generating heat

Fuel	Coal	Black oil
Caloric equivalent	0.822	1.370
Specific consumption of standard fuel, kg of coal equivalent / Gcal	220	180
Specific consumption of natural fuel, kg / Gcal	268	131
Price of fuel including delivery, thousand rubles	2200	12500
Fuel component, thousand rubles / Gcal*	589	1642
% of fuel component to coal	100	280

* Analyzing the cost of the fuel component, the boiler efficiency was taken into account.

state or municipal energy service agreements (contracts), in which the price is determined as a percentage of the cost of saved energy resources, for the period exceeding the period of the approved limits of budget obligations. The expenses for payment of such agreements (contracts) are planned and implemented in the expenses for payment of respective energy resources (services of their delivery)".

However, the experience of some northern municipalities with deficit-ridden budget (Apatity, Vorkuta) in the pilot project "Energy Efficient Quarter" showed the impossibility of immediate entering into the energy service contracts even for the subjects of public sector. To do this the town of Apatity had to create a special mediator – Autonomous non-profit organization "Energy Service Company of Apatity" and to resolve all issues related to energy servicing through it.

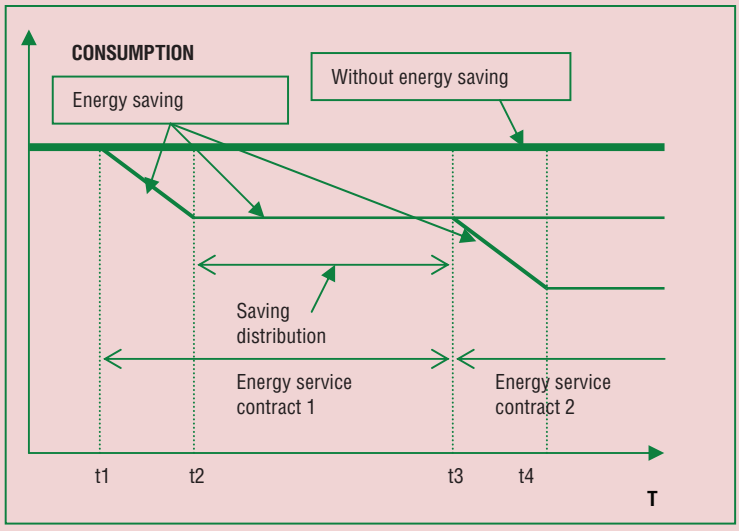
Investing in energy efficiency can save energy resources (especially – export ones) both directly as a result of an absolute reduction in consumption and indirectly as a result of reduction in power inputs for transportation and conversion of energy carriers for final consumption.

The essence of the energy service contract is to apply the principles of public-and-private partnership when investing into energy saving of public buildings and apartment buildings. The share of savings as a result of the implementation of energy saving measures for the entire payback period, is removed by the energy service company – a mediator – in favor of the investor and only then this share becomes the "income" of the consumer (municipality or apartment building), reducing the payment for energy carriers by the magnitude of the effect achieved.

It is desirable to implement the energy services contracts in the "revolving" mode, when the completion of one contract immediately "starts" the next contract, ensuring continuity of small and medium-sized enterprises - performers of energy-efficient measures. Graphically, the scheme of work based on the energy service contracts is shown in *figure 1*.

One of the possible sources of investment in these activities is to obtain loans from international organizations contributing to the problems of energy efficiency in Russia (such as NEFCO or IFC).

Figure 1. Energy service contract, energy consumption, «revolving process» of starting



Such company as IFC (International Finance Corporation) offers to organize cooperation on the following principles:

- establishing long-term partnerships;
- conducting a detailed assessment of financial, legal, economic, environmental and social aspects of the project;
- client's willingness to follow the requirements and recommendations on compliance with the best international practices in procurement under the project, as well as compliance with environmental and social standards;
- the operation of Federal Law on procurement does not apply to the attraction of credit resources of IFC;
- preparation for funding from 4 to 6 months;
- the repayment period and schedule are adapted to the needs of the project.

Possible conditions for obtaining a credit from IFC:

- the borrower is a region or state or municipal enterprise under the guarantee of the region or municipality;
- capacity – from 250 million rubles;
- maturity – up to 8 years;
- time sampling – up to 2 or 3 years;
- the grace period for repayment of outstanding principal – up to 2 or 3 years;
- interest rate on loans:floating (based on 3-month MOSPRIME) or fixed interest rate (fixed equivalent of 3-month MOSPRIME) plus;
- spread according to the risk (borrower, provision, credit period and other risks);
- commissions for the issuance of credit, evaluation and compensation of legal expenses.

The funding scheme on energy servicing for apartment building is proposed by IFC and it is shown in *figure 2*. This software realized with the support of IFC includes:

- increase in energy efficiency of the residential sector;
- encouraging of investment in resource efficiency (direct investment);
- promoting of energy efficiency investments (through banks);
- development of renewable energy.

In Russia one of the projects supported by IFC was a program for the buildings of social sector. The city of Petropavlovsk-Kamchatsky (its popuation is 200 thousand), 87 schools and kindergartens -energy audit 17 model buildings to identify effective measures (with heat viewing). Investments – 200 million rubles.

Achievements:

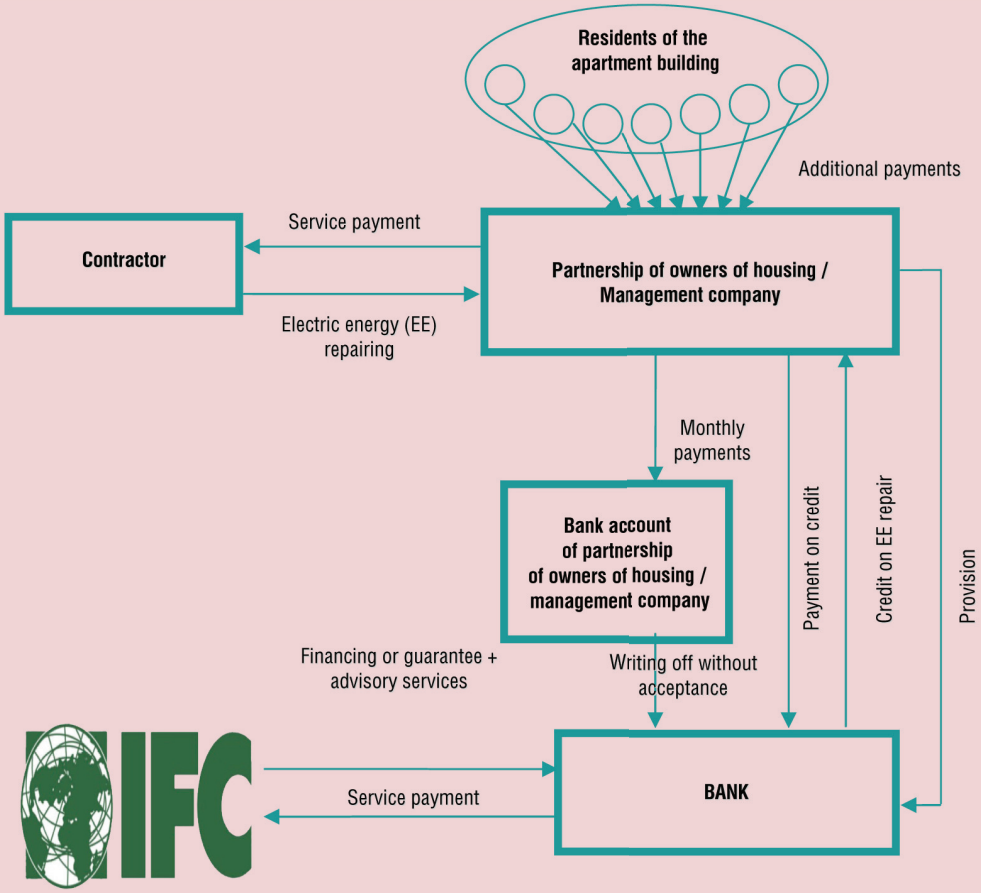
- economy of the budget – 45 million rubles, the payback period is 4.4 years;
- energy saving – 13 thousand Gcal;
- saving water – 104 thousand cubic meters.

Experience in energy saving in the town of Apatity, the Murmansk oblast

From 2000 to 2007 in Apatity there were implemented 3 projects (2 – social objects and 1 – apartment buildings) with investments from North European financial corporation ("NEFCO") on the principles of parity co-financing (50% as "conditional grant") with the obligation of creating revolving fund (revolver lending at the expense of saving achieved by the way of energy efficiency projects). The condition was to create Energy Service Organization (ESKO) in 2002 in Apatity. However, prior to 2006 it was impossible to provide revolver lending. In 2006 the mechanism has been developed to return extra-budgetary funds, it allowed to transform the debt formed in the period 2001 – 2004, the debt of Apatity was 3200 thousand rubles in energy saving measures for heat insulation of contours of municipal institutions.

Since 2009 the part of the energy saving measures and work on warmth keeping and repairing of residential houses are carried out within the framework of the Federal Law № 185-FL at the expense of the Fund for Reforming Public Utilities. Negotiations are underway with NEFCO and other financial institutions for the resumption of the energy service scheme at the objects of public sector.

Figure 2. The scheme of financing energy service contract with IFC



Unfortunately, the city has never received money which was provided from the regional (15%) and federal (20%) budgets and promised in 2009 when running the pilot project "Energy Efficient Quarter".

The experience of the pilot project "Energy Efficient Quarter" has shown that within the framework of public-and-private partnership for financing, **money of Federal and Regional Development Funds should be used on the principles of co-financing with the involvement of property owners**.

A main investor must be the Federal budget, using the Stabilization Fund, as it is replenished by the export of primary resources. At the same time to implement the principle of co-financing we can use a model similar to the tested model of the Federal Law № 185-FL, i.e., through the Fund for Reforming Public Utilities, with annually increasing share of the owners – energy consumers. And the validity of the law should be extended at least until 2015.

We must debug the mechanism of use of local budgets (the objects of public sector), with the involvement of targeted budgetary credits from the budgets of higher levels.

And, as it was mentioned above, we should simplify **obtaining the loans by the municipalities through trusted banks from foreign organizations that help to solve the problems of energy efficiency in Russia (for example, NEFCO, IFC)**.

All of the above will break the deadlock in the process of modernizing the Russian economy in energy saving and energy efficiency, and in the most important area - raising the living standards and reducing social tension in the housing sector, which is especially important for Russia's northern regions.

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