ICSC – Policy for energy saving and increase of efficiency in Russia in the spheres of construction, housing and community amenities

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Abstract. Russia's GDP energy intensity today is approximately 2.5–3.5 times higher than that of economically developed countries. To increase its economic competitive ability, Russia needs to achieve energy efficiency in different spheres, including construction, housing and community amenities. Close examination of implemented management measures and world experience revealed that in order to achieve a further energy efficiency increase Russia needs to boost economic interest of the participants concerned and to form effective mechanisms of economic management, and this should be done along with improvement of administrative governance. The paper focuses on the barriers that hamper economic motivation and provides recommendations for energy efficiency increase. Even partial implementation of suggested measures, in our opinion, will increase energy efficiency in the spheres of construction and housing accommodation, which is illustrated through the example of a residential building located in Yekaterinburg (Russia, Middle Urals).

1 Energy saving governance in Russia in 1998–2016

Energy saving is one of the rational ways to achieve economic management efficiency on an individual country scale, as well as stable development on a global scale. This can be explained by the fact that energy saving costs are 2–6 times lower than the costs of generation of the same amount of energy due to commissioning of new capacities, and, as this takes place, original energy resource is being saved. Today it is safe to say that the efforts made by foreign developed countries several years ago and aimed at improvement of energy saving mechanisms have become an advanced trend, which has been duly appreciated by Russia among other countries.

The first Russian state-run energy saving program for 1998–2005 revealed imperfection of governance and legislative framework in this sphere marked by general production decline and growth of energy consumption during that period of time. By the end of this decade, in order to achieve energy saving efficiency at par with economically developed countries, Russia must reduce economic energy intensity by at least 40% as of the 2010 level. This is required by the Decree of the President of Russia No. 889 (2008),

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as well as by the second state-run program known as *Energy Saving and Energy Efficiency Increase for the period of up to 2020* (state programme of the Russian Federation «Energy-saving and energy efficiency increasing for the period up to 2020», 2010) and its latest version (state programme of the Russian Federation «Energy efficiency and power industry development», 2014). However, energy efficiency of the Russian economy in the period from 2010 to 2014 has only seen a 13.3% increase, and even less than that, i.e. 5.61% increase, if we compare the year 2014 with the pre-crisis year 2008 (see Figure 1).

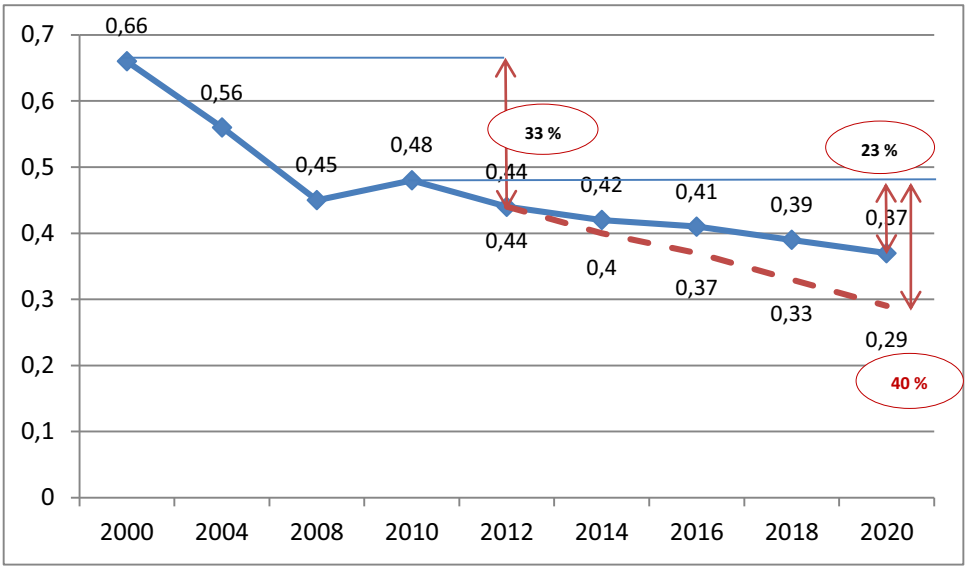

Fig. 1. Energy intensity changing per unit of GDP in Russia from 2000 to 2020, tons of equivalent fuel per $ 1,000.

Such rates are obviously insufficient to achieve the stated objectives. This is what experts define as inertial path of development, which potentially can reduce GDP energy intensity of Russia by only 23% instead of desired 40% (up to 0.37 TCE/$1,000 instead of 0.29). Factor analysis of energy intensity decrease in 2000–2012 (0.66 and 0.44 TCE/$1,000 respectively; 33%) carried out by the Russian Ministry of Energy explains the reasons for such inertia. As this analysis shows, it was not the progress in science and technology that became the main factor influencing the decrease rates, but the changes occurred in the structure of economy at the level of sectors and sub-sectors (Figure 2).

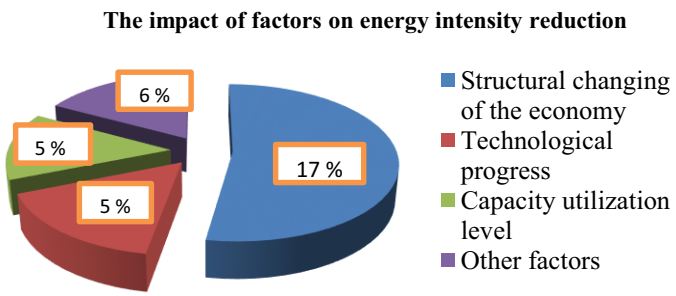

Fig. 2. Key factors of the energy intensity reduction per unit of GDP in Russia from 2000 to 2012, %.

Advanced energy saving technologies may enhance the interest of the participants concerned. Under market economy conditions, this means, first of all, economic interest. With this in mind, let us develop a potential action plan for energy efficiency in an industry that is vital for the economy of the country, such as construction and in an energy-intensive industry such as housing and community amenities (Figure 3).

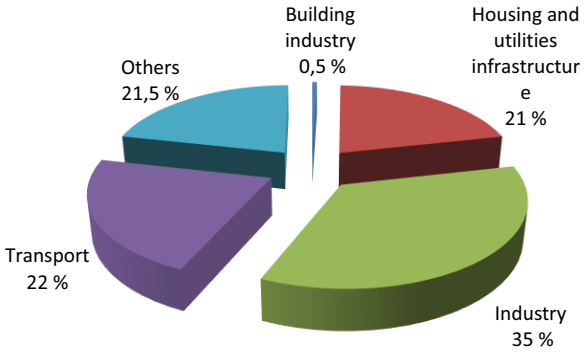

Fig. 3. Structure of the Energy balance of the Russian Federation, %.

First of all, let us describe peculiarities of construction, housing and community amenities in Russia. These industries in Russia have historically been subject to a strong state control. Although they develop in conformity with the laws of market economy and are profit-motivated, an administrative component is also very important for effective governance. One more peculiarity of the above mentioned industries is a high percentage of non-energy efficient buildings. Finally, a key aspect, specific not only to Russia, is that a real estate item undergoes change of ownership during its life: the ownership is transferred from the developer and/or investor (construction) to the owner/apartment complex manager (represented by municipal services in the majority of cases).

In other words, till the onset of market self-regulation, energy saving increase in the spheres of construction, housing and community amenities needs proper guidance with simultaneous provision of economic incentives for all the participants.

2 Analysis of energy saving administrative governance in the spheres of construction, housing and community amenities

At the moment, in order to ensure state control in the spheres of construction, housing and community amenities in Russia, administrative and economic instruments are applied (such division is rather conventional). Besides the development of main legal acts and energy saving planning (state programms «Energy…» and Federal Law No. 261 «On energy-saving and energy efficiency increasing and on making changes to the certain regulations of the Russian Federation», 2009), the following has been implemented:

a) Requirements for energy efficiency of buildings, newly built or already in use, have been defined.

b) Mandatory energy audit and energy certificates have been introduced for the buildings under construction and the buildings undergoing modernization and repairs.

c) Conformity to energy saving requirements is supervised by respective government agencies.

d) Administrative violations in the sphere of energy saving have been defined.

e) Budgetary support for federal and regional Energy Saving Programs has been implemented.

f) Reform of the sphere of housing and community amenities has been completed; instrument metering of the resources consumed has been introduced (mandatory for water and electric power so far).

However, these measures are not sufficient. For example, to achieve the desired level of energy resources consumption, a step-by-step transition from basic values of energy efficiency to the higher ones is envisaged for real estate items. In accordance with *Regulations of Energy Efficiency Requirements,* annual specific energy consumption values must be reduced at least once every five years starting from 2011 for buildings, constructions and structures: up to 15% with regard to base level till the end of 2015, starting from 2016 – up to 30%, and from 2020 – up to 40% (Decree of the Government of the Russian Federation No. 18 «On approval of the Regulation of establishing energy efficiency requirements for buildings, constructions, structures and the requirements to the rules determining the class of energy efficiency of apartment buildings», 2011). So, we see the policy of gradual energy "retooling" of the real estate items, though so far it covers only buildings under construction and buildings undergoing reconstruction and repairs. At the same time Capital Repairs Program developed for the period from 2015 to 2020 will cover only 4.5% of total amount of constructed buildings (Federal Law No. 261, 2009). The owners of the real estate items exempt from renovation and repairs can increase their energy efficiency on a voluntary basis at their own expense. In other words, the current situation with existing buildings does not contribute to rapid growth of energy savings, as their total number is much higher than that of the buildings under construction.

For rapid expansion of energy saving technologies, special energy service contracts have been introduced abroad. However, this strategic way stipulated in federal law (Federal Law No. 261, 2009) is not being implemented due to lack of interest from both the customers and the executors. In view of the above, the Russian Ministry of Energy has decided to set up a 100% state-run energy service company with further possibility of setting up private-state companies. But in order to achieve this goal, we will need to travel the long path of introduction and approbation of novelties with due regard to peculiarities of the Russian economy, therefore no rapid results can be expected in the near future.

3 Economic governance of energy savings in the spheres of construction, housing and community amenities

Since administrative governance has not yielded desired results during the initial period of implementation of the second energy saving program (from 2010 to 2014; Figure 1), the emphasis must be made on economic governance mechanisms, which is envisaged by market economy.

The factors defining economic interest of different real estate participants are quite specific:

1) For the developer these are:
- Demand for energy efficient real estate property.
- Effective mechanisms of state incentives.
- Availability of technological novelties in the energy saving sphere and maturity of the market of their production.

2) For the buyer these are:
- Information awareness of advantages of this category of dwelling.
- Price affordability and free consumer choice.

3) For the real estate owner/apartment complex manager these are:
- State financial support for implementation of energy saving technologies.
- Developed service market of energy saving engineering support and its introduction.

Consumer demand for energy efficient real estate is a basic incentive for the developers. At the same time it is driven by economic interest of future real estate owners. However, its growth in Russia faces a serious obstacle.

Low rates of demand generation are attributed to relatively low tariffs for consumed resources, as compared to Europe. For example, gas tariffs in Russia are approximately 10 times lower than European ones, water tariffs are from 2 to 10 times lower. Only electric energy tariffs are more or less the same. However, an actual housing and community amenities affordability index is represented not by the not by the tariff rates, but by the total amount of utility charges expressed through the percentage which the utility bills represent in the family budget. This index (16% of an average salary) places Russia slightly on top of the better-off Europe (up to 10–13%), though the tariffs indicate that it should be opposite [1]. This happens due to the fact that despite relatively low tariffs, utility norms in Russia assume increased consumption of the resources [2]. For example, in Yekaterinburg the regulatory standard (Standards of consumption of utilities approved by the Resolution REC Sverdlovsk region No. 131-PC, No. 132-PC, 2012) stipulates per capita consumption of hot and cold water as about 300 l per 24 h (for the apartments with a bath) in equal proportions, while thermal energy for heating and hot water supply as 1.3 Gcal per month.

We believe that normalization of consumed volumes of resources and their tariffs applied with due regard to a multiplying factor for overconsumption, as well as improvement of housing and community amenities must yield substantial results in demand generation for energy efficient apartments and resource savings due to development of explicit economic motivation.

Besides tariff and resource normalization, financial incentive of energy saving measures implementation might be quite effective as well. At the moment financial incentive is especially appropriate for owners of the apartments older than 1998, as some energy saving measures have high implementation costs. For example, heating modernization (installation of thermal energy meters and heating controllers) equals half the monthly income of the owner and requires even greater expenses in old buildings.

Germany managed to cope with this problem thanks to an innovative finance system developed by the German state bank for development *Kreditanstalt für Wiederaufbau (KfW) Förderbank (KfW)* within the framework of *Residential Stock Modernization Program* [3]. The aim of this Program is to render assistance to the owners with regard to initial expenses, including replacement of heating systems, windows and thermal insulation of external walls. As a rule, *KfW* offers beneficial loan conditions for its client: low and fixed interest rates, longer terms, possibility of redemption without any penalties, high maximum loan limit and possibility of its combination with other financial loans. Any residential project meeting energy saving requirements can seek a *KfW* low interest loan [4]. This finance system has proven successful in other EU countries as well.

Financial incentive is also important for the developer. In the situation of a vicious circle, when there is no supply due to lack of demand, and no demand due to lack of supply, government must intervene and act as a catalyst. Investment tax credit is a principal financial leverage anticipated for the developers in Russia. As stipulated in the Tax Code of Russia (para 1, Article 67), investment tax credit can be issued to any organization that constructs the items (including multi-dwelling buildings) of "the highest energy efficiency class A".

Both international and Russian experience prove that such a credit is beneficial, but Russia is facing two serious limitations today. Prior to issue a loan, the regulatory agencies verify financial position of a credit user, as well as its eventual organization expenses, which is a rather disturbing than well-established practice in our country. Besides, the highest class of energy efficiency (class A) means that specific thermal energy consumption for heating, ventilation and hot water supply of the building is 45%

lower than the base level (power inputs for 1 sq.m), which will definitely require greater investments in technologies and will increase final cost of the item (Order of the Ministry of Regional Development No. 161 "On approval of the Rules determining the class of energy efficiency of apartment buildings", 2011). Thus, receiving of the investment credit requires preliminary calculations of economic benefit which is rather doubtful in today's situation. However, we should take into account that such requirements are not more strict than those applied in Europe, though the transition towards them in the EU countries was gradual in the environment of a more developed market.

4 Recommendations for energy efficiency increase in the spheres of construction, housing and community amenities

To find a path to increase energy efficiency, we should avoid following a passive inertial way of development and actively influence the energy efficiency processes, implementing innovative products among other things (Figure 2). Based on the results of our studies, we suggest the following recommendations (a sample estimated amount of finance is specified in parentheses for each recommendation):

1. Adjustment of normative consumption rates and tariffs for energy resources in the housing sector. As for the tariffs, general utility charges should be taken into account. Thermal energy tariffs in Russia are substantially lower than in Europe. Low costs lead to lack of incentives for energy savings. However, sharp increase of tariffs may lead to popular dissatisfaction and financial problems in the economy of the country, particularly in the spheres of construction, as well as housing and community amenities. In view of the above, we suggest setting an annual adjustable pace for tariff growth for normative consumption with regard to predictive inflation rate, set forth by the Russian government. Overconsumption must be charged with application of differentiated tariffs with overconsumption penalties. This will allow achieving the immutability principle of legal framework, establish conditions for stable operation of the business structures and encourage them to implement energy saving measures.

2. Development of an effective credit system of energy saving measures for apartment owners. German experience adopted by the majority of European countries can be taken as a basis (described above). Loans will be issued by the State Bank for a justified amount at a nominal annual interest rate (say, 50,000 RUR for a family with subsequent annual inflation adjustment. At the initial stage this amount will be sufficient to lay thermal insulation, install meters and ventilation in the apartment). The state will compensate the difference between the market rate and credit rate as it does now, for example, for agricultural organizations (amount of finance equals to 300 bln RUR for 10 years).

3. Improvement of the system of financial incentives for construction of energy efficient buildings. To achieve this goal, the government must increase financial appeal and reduce the number of documents that the organizations seeking investment credits and constructing Class A buildings must present. When constructing small apartment complexes and individual houses, the main problem, as we believe, arises when they need to be connected to power grids (electrical supply networks, gas pipelines, heat plants). Since the organizations responsible for such connections are de facto state-controlled, the bureaucratic procedures must be simplified and connection charges must be canceled for small private real estate owners (villa owners, country house owners). "Losses" incurred by utility companies can be compensated in this case by means of application of increased tariffs for real estate owners. Thus, connection charges will be collected by installment via application of increased tariffs (amount of finance equals to 125 bln RUR per year).

4. Support of production and sales of energy efficient equipment and engineering systems at the country level via application of a tax deduction program; support of local

manufacturers via a state procurement program for such equipment and systems; this program must also cover the purchase of such equipment for capital repairs of multi-dwelling buildings at the expense of regional repair funds. Introduction of such equipment through a wider application of PPP energy service contracts and contracts signed with regard to market competition (amount of finance equals to 2 bln RUR per year, partially at the expense of capital repair funds).

5. Launch of the information awareness campaign for population, developers and property management companies. Government must launch the Russian integrated portal which will provide official detailed information about capital repairs and technical and economic energy saving novelties. The sites of property management companies must present information about organizations responsible for sales and installation of meters, installation works, thermal insulation, etc. Availability of such information and free consumer choice will form demand for energy-efficient goods and lead to quality improvement of the services offered in the energy saving sphere (amount of finance equals to 2 mln RUR per year).

Implementation of these recommendations can be funded through the costs planned for Sub-program 1 (*Energy Saving and Energy Efficiency Increase*) of the state program *Energy Efficiency and Energy Development*.

We believe that even partial introduction of these measures will increase energy efficiency in the sphere of construction and housing accommodation. Let us prove this point, taking Yekaterinburg as an example.

5 Determination of energy efficiency for a standard accommodation building located in Yekaterinburg (Russia, Middle Urals)

Energy efficiency is characterized by such principal energy and economic indicators as energy savings by volume and value, capital investment and payback period. Required scope of energy saving measures is determined by physical characteristics and state of the building. According to the regional energy saving program (Sverdlovsk region's programme "The energy-saving and energy efficiency increasing for the period from 2010 to 2015 and target settings for the period up to 2020", 2010), energy efficiency increase in the housing sector in Sverdlovskaya Oblast is equal to at least **5.240 mln TCE or 32,927.87 mln RUR.**

As a rule, existing non-energy efficient housing accommodation needs several mutually reinforcing measures: additional thermal insulation, installation of thermal energy flow regulation system for heating, modernization of ventilation and window frames. Besides, in accordance with legal requirements, the apartments must be equipped with meters for all types of resources, including thermal energy (i.e. heating and hot water supply). We calculate energy efficiency for each measure separately.

As an example, pre-feasibility study of the energy efficient modernization of a typical 3-storey building which consists of 36 apartments was produced. The total building square is 3767.7 square meters; the facade area is 2511.8 square meters; square of heated floors is 1980 square meters; the total heated building volume is 1320 cubic meters.

Selection of heat-insulation materials for the building was founded on the comparative feasibility study of the most popular brands of heat-insulation materials (Rockwool®) and foam polystyrene, as well as a new product of the Russian market - the HDPE membrane heater (Tyvek®) (Feasibility study of energy-saving measures and energy efficiency increasing, Cheboksary, 2014). These feasibility studies are summarized in the Table 1.

Capital costs for one apartment are determined by dividing the common utilities cost by the number of apartments.

Table 1. Technical and economic justification for the choice of heat-insulating material.

Parameter	Reference	Polystyrene foam	Rockwool	Tyvek
Annual thermal energy savings due to reduction in heat losses through cladding structures, Gcal	ΔQ	175.78	199.035	206.01
Energy savings at a thermal source for thermal energy production, kWh	ΔE	3,164.11	3,582.64	3,708.2
Fuel savings at a power-supply source, TCE	ΔB_e	0.727	0.823	0.852
Fuel savings due to reduction of thermal energy consumption, TCE	ΔB_q	38.45	43.389	45.06
Cumulative fuel savings, TCE	ΔB ($\Delta B_e + \Delta B_q$)	39.18	44.212	45.92
Capital investment into the measure, RUR	C_i	5,023,600	2,906,403.8	4,822,656

Cost of purchase and installation of the thermoregulators for heat consumption control, modern air-handling unit, window frames with triple glazed insulating unit (three frames per one apartment, one of which comes together with a balcony door), meters for heat flow in central heating (3 thermal energy meters for the same amount of heating radiators per apartment, in average) and water meters (two per apartment) was determined on the basis of market price for the services and most popular models of the equipment available on the market.

Energy saving due to installation of a thermal energy flow regulation system for central heating, modernization of ventilation system and window frames was calculated with regard to heat consumption norms (average monthly consumption is 0.024 Gcal/sq.m; 8-month heating season), tariff rate and design procedure of heat loss. Calculation of economic efficiency for the complex of mutually reinforcing energy saving measures is laid out in Table 2.

Table 2. Economic justification of energy efficient modernization of one apartment building in Yekaterinburg.

Measure/ Energy and economic indicator	Items for investment	Capital investment, RUR	Energy savings, Gcal / %	Energy savings, RUR	Payback period, years
Thermal insulation	Purchase of mineral wool insulator *Rockwool* for external walls, attic floor and basement (295.4 RUR / sq.m); installation (180 RUR / sq.m); daubing of a front (consumption of a stucco – 1,8 kg / sq.m; cost – 70–90 RUR / kg; basement – 180 RUR / sq.m) total area with cladding 3,767.7 sq.m; front area 2,511.8 sq.m.	3,767.7 • 295.4 + 3,767.7 • 180 + 2,511.8 • 1.8 • 80 + 2,511.8 • 300 / 36 = 1,112,978.58 + 678,186 + 361,699.2 + 753,540 / 36 = **80,733.44**	5.53 Gcal / 25 %	5.53 • 1,579.18 = **8,730.89**	9.25
Heat	Thermoregulator *Danfoss*	1,876.54 • 3	4.23 Gcal /	4.23 •	1.4

consumption control through heating systems	(valve and thermostat – 1,876.54 RUR); installation (about 1,200 RUR); 3 widgets / apartment; average monthly consumption is 0.024 Gcal / sq.m; tariff rate – 1,579.18 RUR / Gcal; area apartment – 42 sq.m	+1,200 • 3 = **9,229.62**	35 %	1,579.18 = **6,685.61**	
Modernization of ventilation system	Purchase of Ventilation installation with a recuperator Systemair VX (61,000 RUR); installation (10,000 RUR)	**71,000.00**	4.8 Gcal / 25 %	4.8 • 1,579.18 = **7,580.1**	2.5
Modernization of window frames	Purchase and installation of triple -glass pane (1,400 x 1,600 mm – 11,650 RUR; 700 x 2,200 mm – 8,300 RUR); strength of heat transmission of ordinary window (SNIP 23-02-2003) – 06 (sq.m • °C) / Wt; strength of heat transmission of triple-glass pane (with I-glass, material – plastic; Ar) – 0.90 (sq.m • °C) / Wt	11,650 • 3 + 8,300 = **43,250**	0.621 Gcal / 30 %	0.621 • 1,579.18 = **980.67**	14.7
Installation of meters	Purchase of thermal energy meters with the set of respective equipment (11,000 RUR); installation (4,000 RUR); 3 widgets; average monthly consumption is 0.024 Gcal / sq.m; tariff rate – 1,579.18 RUR / Gcal; area apartment – 42 sq.m	15 000 • 3 = **45,000**	– / 40 %	0.024 • 42 • 1,579.18 • 12 • 0,4 = **7,640.7**	5.9
	Purchase of water energy meters (600 RUR), 2 widgets; installation (800 RUR); tariff rate – 1,579.18 RUR / Gcal; average monthly consumption of a water is 5.61 cub.m / man or 0.583 Gcal; live 2 mans	600 • 2 + 800 • 2 = **2,800**	– / 75 %	0.583 • 2 • 1,579.18 • 12 • 0,75 = **16,628.8**	0.17
Total		**252,013.06**	**23.13 / -**	**48,246.77**	**5.22**

Thus, introduction of even a minimum required complex of energy saving measures, many of which can be implemented by the occupants at their own expense, will ensure 14% energy savings and significant cost savings. With energy efficient equipment available on

the market, especially high quality domestic models, savings by volume and by value can be even more substantial.

6 Conclusion

Elaboration of recommendations aimed at energy efficiency increase in the spheres of construction, housing and community amenities in Russia has yielded the following conclusions.

Energy efficiency governance in these spheres must take into account peculiarities of the real estate market, i.e. its dependence on the administrative control and the presence of several key participants (such as the developer, investor, buyer, real estate owner (represented normally by a property management company)). Administrative control has proven to be inefficient and needs additional economic mechanisms. Principal barriers for the development of economic interest of the participants of the real estate market are as follows: low demand, insufficient information awareness of the key participants, insufficiently effective incentives or their total absence, bureaucracy of natural monopolies and regulatory agencies in the sphere of construction.

We recommend the following to tap energy savings:

1) Adjust tariffs for energy resources in the housing sector with due regard to general utility charges.
2) Develop an effective credit system of energy saving measures for real estate owners.
3) Improve the system of financial incentives for construction of energy efficient buildings.
4) Enable legislation in support of production and sales of energy efficient equipment and engineering systems.
5) Introduce such equipment through a wider application of energy service contracts signed with regard to market competition.
6) Launch an information awareness campaign for population, developers and property management companies.

Implementation of these suggestions will help achieve world level of energy savings due to introduction of innovative solutions, thus supporting and developing domestic economy.

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