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Assessment of possible investments in energy efficiency increase in housing sector of Russian Federation

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Abstract
This article was performed within the Russian State tasks MSUCE project "Methodology of ideas, design and verification of energy-efficient engineering systems conventionally abstract objects (on formal models of buildings).

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Russia ranks third in the world in the scale of power and uses more energy per GDP's unit than any other countries in top ten largest consumers of energy. Geographical size, air temperature and industrial structure explain a certain amount of energy, but not all of its scale. These facts are often used as the explanation the relatively high energy intensity. Such explanations have some merit, because there are unique conditions in Russia: it ranks second in the world, in terms of the lowest average air temperature, first place in the world's largest territory. However, the combination of these factors does not explain the current level of high intensity. Overall the higher GDP of any country, the more its territory, below average temperatures and higher the industrial products share in total production, the higher level has the power consumption. By comparative analysis of energy consumption in other countries, energy consumption in Russia is approximately 20% higher. Russian energy efficiency potential can be assessed by comparing for each sector of the efficiency level of technologies used in Russia, with the performance level of commercially available technologies used in the world. Thus, the Russian energy efficiency potential is determined by the technologies currently used in other countries for commercial purposes, and not some theoretical minimum level of energy efficiency.

Technically possible investments in energy efficiency investments leading to energy savings, but they are too expensive or providing too little savings over the investment project lifecycle and couldn't be attractive to consumers. Financially attractive investments are investments that lead to energy savings and funds end-investors (private companies, households or institutions). Economically viable investments are investments that lead to energy savings and funds overall for the investment project lifecycle, but the savings or income from the sale of recovered resources may not necessarily be obtained to any particular energy consumer or to provide an attractive level of income for the private investor. For individual investors, these investments are not appropriate, but the government should make such investments in the interests of the country.

The investment is financially attractive if the cost of saved energy unit (for example, 1 kWh) is less than the cost of acquiring an energy additional unit. The cost savings per energy unit depends on the initial capital costs; possible additional operation costs and maintenance to achieve energy savings and alternative investor, in addition to improving energy efficiency is taken into account through the discount rate for the investor).

Investments are economically justified if the cost of saved energy unit (for example, 1 kWh) is less than the expenditure on the construction of new generating capacity (for example, 1 kW) or than the amount of lost profits for the country's export unit gas - depending on which of these values more.

Russia could achieve energy savings equivalent to approximately 300 million tons of oil per year, or 2.1 tons of oil per capita (The World Bank estimates). Such savings are equal to total volume of primary energy consumption in countries such as France or Britain or 2% of the total world energy resources' production (the World Bank estimates). The most significant reduction in final energy consumption could be achieved in the residential sector (53,4 million toe) (million tons of oil equivalent) electricity production (44.4 million toe), manufacturing (41.5 million toe), transport (38.3 million toe) and heating systems (31.2 million toe).

Investments in energy efficiency can save energy directly, through the reduction of energy consumption by end-users, and indirectly, by reducing the amount of fuel needed for the transformation and energy for final consumption (primary energy) transportation. For example, the reduction of electricity consumption by households reduces the amount of

fuel consumed by the generators covered the load. The less fuel will be used by generators, the less fuel is needed to extract and transport (pipelines, Railways or roads), and the less energy will be used in the production of this fuel. In Russia, the reduction of electricity consumption reduces total primary energy consumption is almost five times; reduction of heat energy consumption reduces total primary energy consumption by almost three times.

The greatest potential for improving the efficiency of final energy consumption exists in residential, commercial and public buildings, where investments in energy efficiency could yield annual savings of up to 68.6 million toe. The share of buildings (144.5 million toe) account for more than one-third of all final energy consumption. Two-thirds of the potential energy savings in this sector could be achieved through the reduction of heat energy consumption for heating and hot water in district heating systems.

A large part of the potential energy savings in buildings can be achieved by economically and financially efficient investment. Approximately 85% of the technical potential can be realized through cost-effective investments. Nearly half of the technical potential (45%) can be implemented through attractive financial investment.

The housing sector is the second largest final energy consumption after manufacturing. The share of heating accounts for 60% of total energy consumption in residential buildings; three quarters of the buildings connected to district heating systems. The share of hot water accounts for 25% of total energy consumption in residential buildings.

In the housing sector there is the greatest potential for energy efficiency in Russia. Technical potential to reduce energy consumption is 53.4 million tons of oil equivalent. More than 80% of the technical potential can be realized through economically viable investments and 50% through investments financially attractive at current domestic prices for fuel. The largest part of the potential energy savings can be achieved as a result of measures to improve energy efficiency in heating and hot water.

The average energy consumption of heating systems in the Russian apartment buildings is 229 kWh/m2/year. The energy consumption of heating systems in new apartment buildings in Russia is 77 kWh/m2/year of thermal energy. Modernization of the existing housing stock can result in reduced energy consumption to approximately 151 kWh/m2/year. A small percentage of buildings built after 2000 in accordance with the new standards of thermal insulation, meets all modern requirements for thermal insulation and efficient heating systems. However, most of the existing buildings have a much lower efficiency heating systems. As in heating systems, the energy consumption of hot water depends on the age of the building.

There are significant opportunities for energy saving in heating systems and hot water systems in residential buildings. Technical potential to reduce energy consumption of heating systems in residential buildings can vary between 17 and 42 million tons of oil equivalents, depending on the methodology used to assess this potential. The range of energy savings is 35-50% of the total final consumption of heat energy. Modernization of existing residential buildings can bring savings of 30-60% of energy consumption for heating purposes. Technical potential for improving the efficiency of hot water supply is 13.4 million tons of oil equivalent, which corresponds to 35% of consumption. Approximately 15% of savings achievable through the modernization of hot water systems: devices for automatic regulation of the temperature of the water, improving the efficiency of thermal insulation of pipes hot water systems. Almost 40% of the potential savings can be achieved through investment at the level of individual apartments, for example, in the installation of metered consumption of hot water. The majority of investments in improving the efficiency of heating systems and hot water are economically and financially efficient. Approximately 80% of investments are economically viable. About 40% is technically possible investments financially attractive.

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