How to make efficient buildings a reality in Russia?

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Abstract
Russia adopted its first Federal Law on energy efficiency, the Russian Federal Law on Energy Savings and Energy Efficiency, in 2009. The law sets a target to reduce Russia's energy intensity by 40 % by 2020 compared to 2007 levels. To achieve this challenging target, several decrees were adopted and the Russian Energy Agency was created to ensure an effective and smooth implementation of the law.

Recent analysis conducted by the Russian Energy Agency in collaboration with the International Energy Agency highlights the important role the buildings sector in Russia can play in achieving the overall energy savings target.

In fact, the buildings sector is responsible for 33 % of Russia's final energy consumption, 80 % of which is used for space and water heating. The building stock includes over 3.2 billion sqm of residential buildings with 120.7 million sqm or about 4.4 % constructed since 2010.

According to IEA estimates, Russia's annual final residential energy consumption could be 88 % lower in 2050 than in 2010 if energy renovation of the existing buildings stock was made mandatory and stringent energy requirements were considered for new buildings. To estimate the savings potential and accelerate the pace of its realization, the Russian Energy Agency is developing in collaboration with the International Energy Agency a policy framework based on international best practices, taking into account the broad economic and policy context in Russia.

This paper summarises the main findings and recommendations to support Russia in achieving its 40 % energy intensity reduction target through the renovation of the existing residential building stock. It also draws a path to increase the share of efficient new buildings in Russia's building stock.

Introduction
Russia is the sixth largest economy in the world and has the highest GDP per capita among emerging economies (IEA, 2012). From an energy perspective, Russia is the largest oil producer and the largest producer and exporter of natural gas (Figure 1). Russia holds about one-third of the world's natural gas reserves, 6 % of the world's oil reserves as well as exceptional reserves of coal, uranium, metals and ores. It also has a major potential for hydropower and other renewables (IEA, 2011). The energy sector is therefore important both for the Russian economy and for global energy security.

The total final energy consumption in Russia dropped from 625 Mtoe in 1990 to 446 Mtoe in 2010 (Figure 2) due to the economic decline experienced during the 1990s. However, in 2010 Russia remained the third world's largest primary energy consumer after China and the US while the Russian population is much lower (Figure 3).

The buildings sector is the largest end-use sector (Figure 2). Globally, Russia ranks fourth in terms of energy consumption in buildings, behind the United States, China and India despite a much smaller housing stock (Figure 4). Compared to other sectors, the buildings sector also has the fastest growing energy consumption. In fact, its share of the final energy consumption increased from 19 % in 1990 to 33 % in 2010

(Figure 2), 80 % of which was used for space heating and hot water (IEA, 2011). This reflects Russia's large size and harsh climate, and the poor quality of its building stock. The combined share of consumption for cooking, appliances and lighting is estimated to be less than 20 % (IEA, 2011). The challenge for Russia is therefore to develop a policy package to enable the renovation of the existing building stock and the construction of efficient buildings.

From a supply side perspective, based on data from the Russian statistics agency (ROOSTAT), in 2011 83 % of the housing stock was connected to the district heating network. About 22.2 million Russians still live in buildings not equipped with heating systems (ROSSTAT, 2012). However, the market for centralised heat supply is being squeezed by the industry moving away from urban areas and by the rising popularity of new single-family homes located far from city centres. Some better-off residential customers are also opting for decentralised space heating in apartments. These trends exacerbate a number of the problems facing the district heating sector. Suppliers are increasingly left with relatively low-income customers, who often do not pay. As the number of users decline, the efficiency of heat and power plants is affected because of the lack of investments to modernize and upgrade them.

From an energy price perspective, over the last decade, Russia has increased its residential energy prices significantly. However, subsidies in energy prices for households have not yet been removed and residential prices for both electricity and gas are still regulated (IEA, 2011). This does not help in raising awareness among consumers on energy costs and on the need to renovate their buildings.

Regarding energy efficiency policies, Russia developed in 2008 a legal framework for energy efficiency at both the federal and municipal levels (IEA, 2011). However, these efforts are not sufficient to realize Russia's untapped energy savings potential as targets are not defined per sector. Russia needs to further develop its energy efficiency legislation on a sector by sector basis, improve its capability to monitor and evaluate the implementation of energy efficiency policy measures, and attract and mobilise investments in the implementation and deployment of efficient solutions.

In 2012, the International Energy Agency (IEA) and the Russian Energy Agency (REA) have undertaken an analysis of buildings energy efficiency policies, the existing building stock and its energy consumption in Russia. The aim is to provide country specific recommendations in the area of energy efficiency to help Russian authorities with the design of their 2050 buildings roadmap, with an objective to capture untapped energy savings.

This paper provides an overview of current energy efficiency policies in Russia with a specific focus on the buildings sector. A bottom-up model based on the overall energy performance of the buildings sector has been used to estimate the savings potential for the residential sector. Preliminary estimates of the technical savings potential and investment needs for realizing this potential are also discussed in the paper. Finally, the paper includes recommendations based on international best practices in the design of buildings roadmaps. The aim is to help the Russian government overcome challenges in the design and implementation of energy efficiency policies.

Energy efficiency policy development in Russia

Since 2008, energy efficiency is a top priority in Russia. The presidential decree No. 889 from 2008 included "some measures to improve the energy and ecological efficiency of the Russian economy". The decree targets the reduction of the energy intensity of GDP by at least 40 % by 2020 as compared to 2007 levels (IEA, 2011). As a consequence of the adoption of this decree, a massive work on energy efficiency legislation has been initiated. In 2009, the Russian government adopted the Federal Law No. 261-FZ "On energy savings and increasing energy efficiency and on introducing changes in selected legislative acts of the Russian Federation". The law sets a framework to promote energy efficiency at both the federal and municipal levels and to monitor the effectiveness of energy efficiency measures. It is therefore considered as the key legislative document on energy efficiency in Russia. To ensure the effective implementation of the law, the Russian government adopted a program on energy efficiency improvements up to 2020 with intermediate targets and timelines for the key sectors. The program included measures for energy efficiency development in Russian regions (89 in total) and a list of energy efficiency indicators. However the law does not specify how the monitoring should be conducted, or its frequency.

In terms of buildings energy efficiency policies, Russia had adopted and implemented mandatory building energy codes since 1979. The code is prescriptive in nature. It includes minimum energy performance requirements for different building components in each of Russia's four climate zones. Most of Russia's territory is in the temperate climate zone, while some parts are in the arctic and sub-arctic climate zones. Another extreme climate zone is the subtropical area located on the Black Sea coast of Caucasus. The climate is mostly continental. Average monthly temperatures in January range from 0 to -6 °C in the European part of the country, and from -40 to -50 °C in eastern Siberia; in July, they range from 22 to 24 °C and from 4 to 14 °C respectively (Figure 5 and Table 1).

The building energy code in Russia applies to new buildings, both residential and non-residential, and existing buildings when they undergo ordinary renovation. However, an evaluation of the code's implementation is not conducted. The last revision of the code was adopted in 2003. Since the adoption of the Federal Law on Energy Efficiency, the Russian Ministry of Regional Development has drafted a new version of the building energy code. The aim of this draft is to strengthen the existing regulation in order to achieve the energy reduction target specified in the Law No. 261-FZ. IEA analysis of the current draft of the updated buildings energy code shows that the new proposal is still prescriptive in nature. As such, it is not in line with proven IEA best practices that consider the overall performance of the building, with an absolute primary energy consumption target for each building segment and each climate zone (IEA, 2013).

In recent years, voluntary labels have been developed in Russia for new buildings. However, most of these labels are green labels such as the LEED label, that consider the environmental impact of a building, but that do not include specific primary energy consumption requirements.

In terms of appliances and lighting products, a Technical Committee on "energy efficiency, energy conservation, and

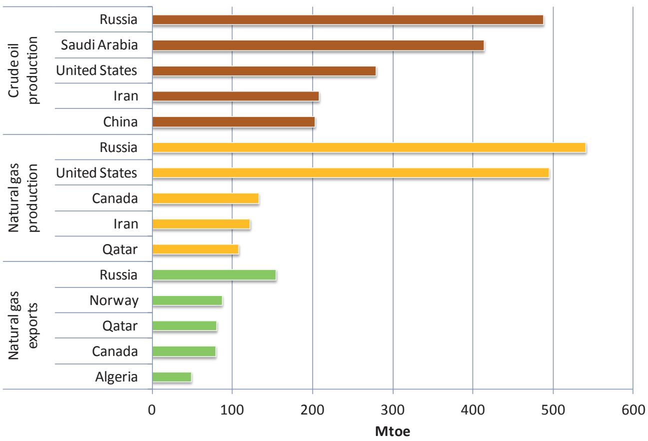

Figure 1. 2010 Largest oil and gas exporters (IEA Statistics).

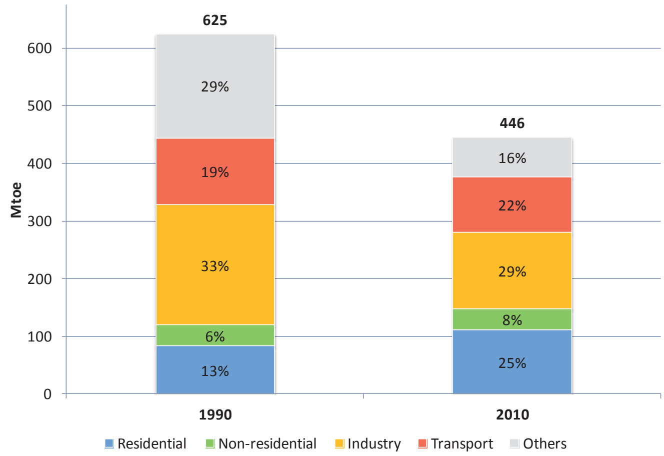

Figure 2. Total final energy consumption in Russia in 1990 and 2010 (IEA Statistics).

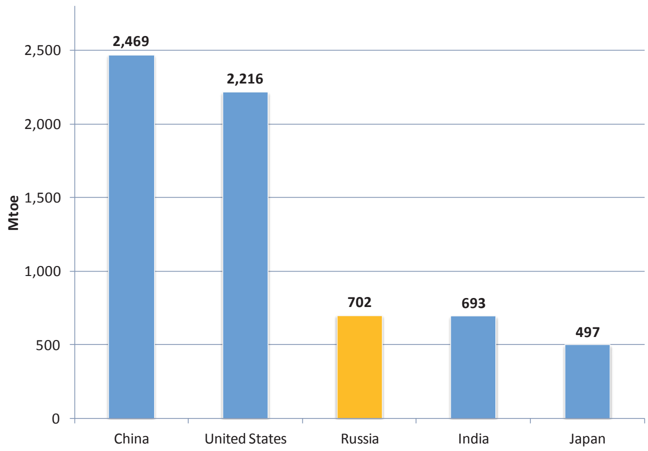

Figure 3. World's 5 largest primary energy consumers in 2010 (IEA statistics).

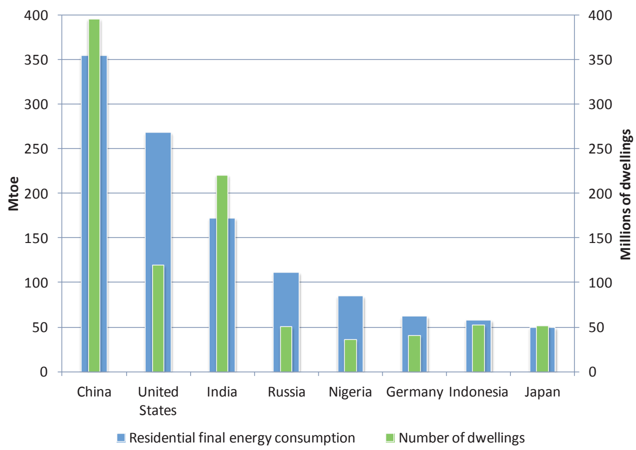

Figure 4. Final energy consumption and number of dwellings in selected countries in 2010 (IEA Statistics).

energy management" has been established in 2011. The aim of this committee is to develop technical regulations and standards on energy efficiency, including lighting equipment. One of the directions of the Committee is to provide regulatory guidance to harmonise energy requirements with those included in the EU Ecodesign Directive and the EU labelling directive. The Technical Committee benefits from international technical support provided by UNDP (The United Nations Development Programme). For lighting products, Decree No. 602 based on the Federal Law No. 261-FZ has been adopted in 2011. It sets minimum energy performance requirements (MEPS) for lighting devices and electric lamps. In parallel, incandescent lamps have been banned from state and municipal procurement. The Russian Federation has also joined the global phase-out project, en-lighten, to benefit from the technical assistance provided by UNEP (United Nations Environment Programme) to countries in the design of their phase-out policies and the implementation of the complementary tools such as quality control and awareness campaigns.

Governance structure and institutional arrangements

The federal authority responsible for energy efficiency is the Russian Ministry of Energy. The Ministry develops the state's policy on energy efficiency, monitors key energy efficiency indicators and performance measures, and reports progress in the implementation of energy efficiency policies to the Russian Government. There is a number of authorities that are closely involved in the development and implementation of energy efficiency policies, such as the Russian Ministry of Economic Development and the Russian Ministry of Regional Development.

In 2009, the Russian Ministry of Energy established the Russian Energy Agency (REA) to facilitate implementation of energy efficiency policies. The REA reports to the Russian Ministry of Energy on energy efficiency, renewable energy sources and energy innovations in Russia. The REA also manages the State Program "On saving energy and increasing energy efficiency in the Russian Federation up to 2020" and coordinates the State Information System "On saving energy and energy efficiency". This system will be an information centre on energy

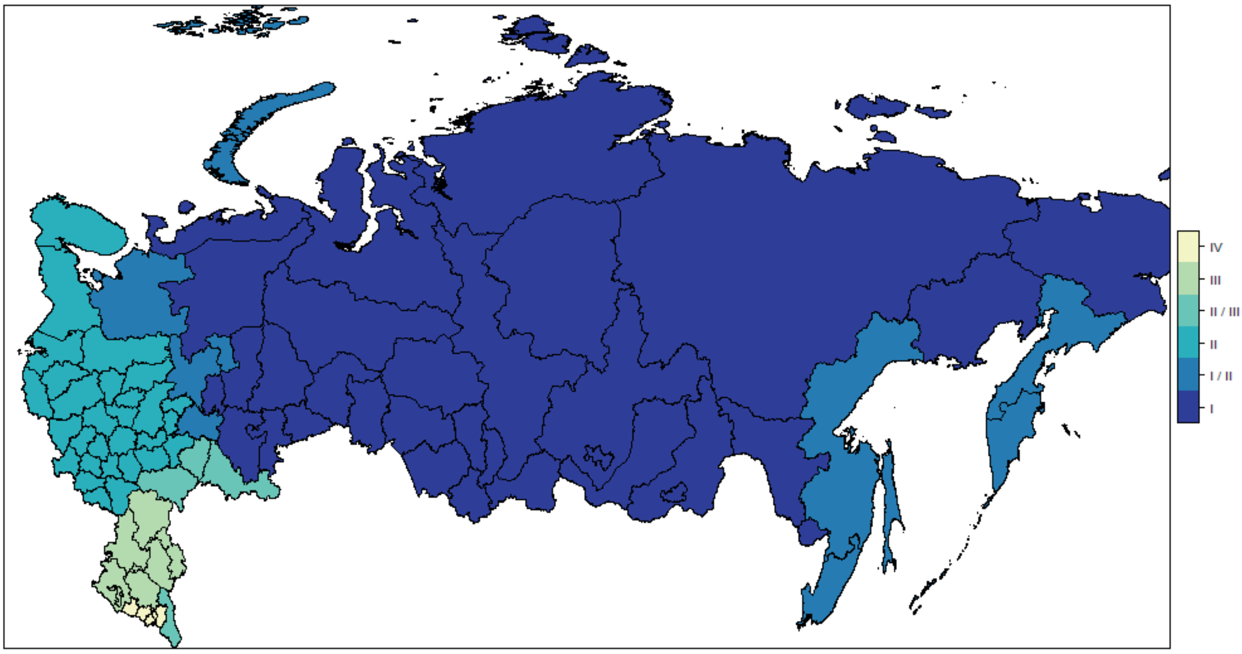

Figure 5. Russian climate zones (source: construction climatology No. #23-01-99).

Table 1. Weather conditions in different climate zones in Russia (source: construction climatology No. #23-01-99).

Climate subzones	Average air temperature in January, °C	Average wind rate in three winter months, m/sec.	Average air temperature in July, °C	Average relative air humidity in July, %
Climate zone I				
IA	< -32	-	4 to 19	-
IБ	< -28	> 5 m/s	0 to 13	> 75%
IB	-14 to -28	-	12 to 21	-
IГ	-14 to -28	> 5 m/s	0 to 14	> 75%
IД	-14 to -32	-	10 to 20	-
Climate zone II				
IIA	-4 to -14	> 5 m/s	8 to 12	> 75%
IIБ	-3 to -5	> 5 m/s	12 to 21	> 75%
IIB	-4 to -14	-	12 to 21	-
IIГ	-5 to -14	> 5 m/s	12 to 21	> 75%
Climate zone III				
IIIA	-14 to -20	-	21 to 25	-
IIIБ	-5 to +2	-	21 to 25	-
IIIB	-5 to -14	-	21 to 25	-
Climate zone IV				
IVA	-10 to +2	-	> 28	-
IVБ	+2 to +6	-	22 to 28	> 50% at 15h
IVB	0 to +2	-	25 to 28	-
IVГ	-15 to 0	-	25 to 28	-

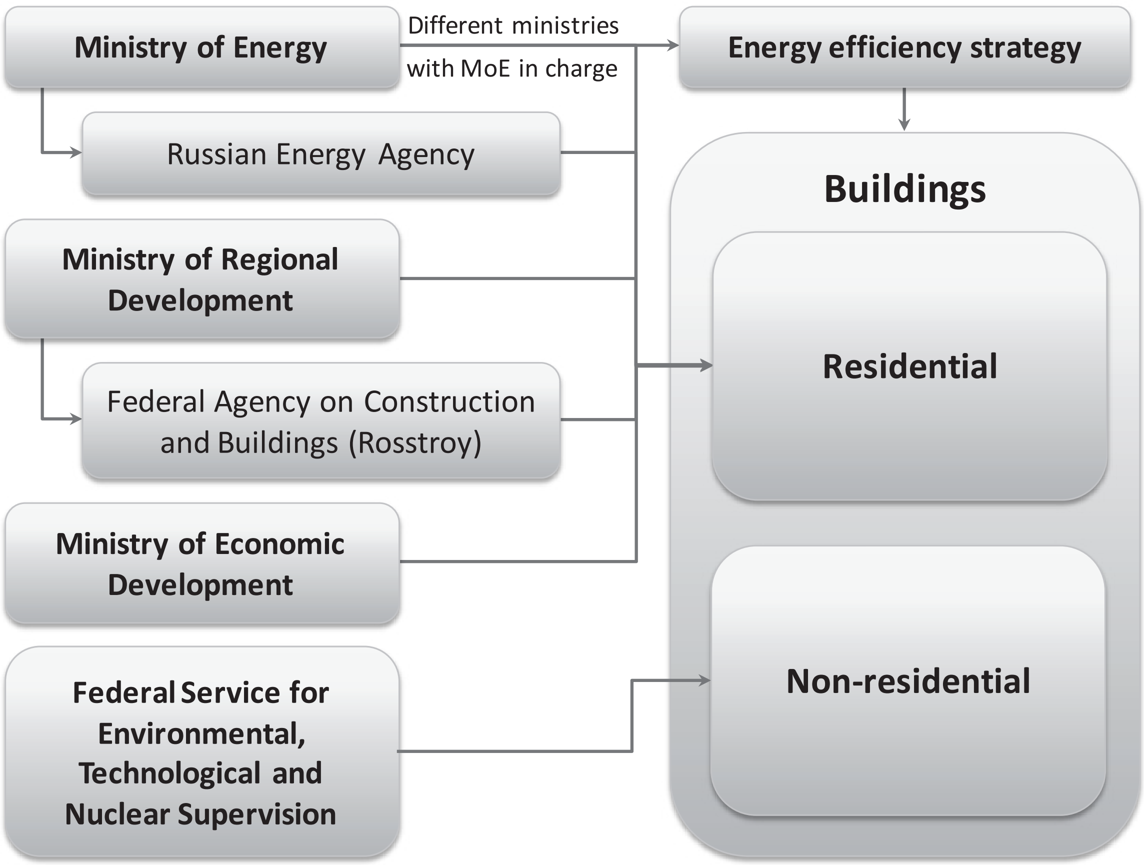

Figure 6. Russian federal authorities involved in the design and implementation of building energy efficiency policy. Source: designed by the authors based on interviews conducted with policy makers in Russia.

efficiency performance and improvement in Russia both at the national and at the regional level. The REA has a broad representation in more than 70 Russian regions, which allows it to work directly with Russian regions.

The Russian Ministry of Regional Development is also responsible for certain aspects of energy efficiency in residential buildings. Under the authority of this Ministry, a Federal Agency for Construction and Buildings (ROSSTROY) has been established in 2012.

In addition to REA and ROSSTROY, specific commissions and groups work on energy and energy efficiency issues on an intra-ministerial or cross-government level. For example, the Presidential commission on modernisation and technological development established in 2009 includes a Working Group on Energy Efficiency and Resource Saving led by the Ministry of Economic Development. Its aim is to ensure that energy efficiency targets specified in the law are met.

This institutional framework reflects a great step forward in political will and backing for energy efficiency in Russia. However, a major element still lacking is a body responsible for the evaluation of the progress in implementing energy efficiency policies and measures. The Russian Ministry of Energy has to report to the Russian Government on the implementation of the Law on Energy Efficiency and related state program. However, this reporting covers energy efficiency across the whole Russian economy and not on a sector by sector basis. This leaves a lot of questions unanswered as to the effectiveness of policy implementation. In terms of the building sector, there is no monitoring or evaluation of the progress in the implementation of energy efficiency measures for the building sector itself.

There is also no enforcement agency for the residential sub-sector, while for the non-residential sub-sector, the Federal Service for Ecological, Technical and Nuclear Control recently became responsible for compliance-checking of buildings energy efficiency policies at different stages (design, construction, and refurbishment). This department is also in charge of installing energy meters.

The main federal authorities involved in energy efficiency in the buildings sector are summarised in Figure 6.

Methodology

This work is carried out in several stages. The first stage sets out to understand the development of energy efficiency policies in Russia and more specifically those related to the buildings sector. The aim was to understand how Russian buildings energy efficiency policies compare to the European ones and what challenges Russia may face in the upgrade of its policies to the stringency level of the European ones. The analysis is based on the IEA methodology developed to assess the effectiveness of buildings energy efficiency policies in IEA countries. Each policy instrument is analysed based on criteria and indicators developed by the IEA (Saheb, 2012). Policy analysis shows that Russia needs to upgrade its building energy codes to performance-based code and to set stringent minimum energy performance for the overall building to compensate for the harsh climate.

The policy analysis was followed by the estimate of the technical savings potential of the existing buildings stock and the new buildings over a period of time that goes from 2013 to 2050. In 2011, the IEA conducted analysis of savings potential for the overall Russian economy using the WEO (World Energy Outlook) model (IEA, 2011). However, since the WEO model is a top-down supply-side econometric model, it does not allow for an estimate of energy demand reduction through the implementation of the stringent MEPS to be included in building energy codes for the overall building and those to be considered in Standards & Labelling policies for appliances, lighting products and equipment. Therefore, the estimates were conducted using the SBC (Sustainable Building Centre) model developed by the IEA to draw recommendations for its members on their 2050 buildings roadmaps (IEA, 2013).

Modelling methodology

The SBC model is an overall performance bottom-up model designed to estimate the impact of effective implementation of buildings and appliances energy efficiency policies in terms of energy savings, CO_2 emissions reductions and impact of the renovation of the existing building stock on the overall economy.

The SBC model consists of three sub-models, namely a) a thermal building simulation sub-model, b) a building stock sub-model, and c) an economic sub-model.

The aim of the thermal building simulation sub-model is to estimate the MEPS level for each building segment in each climate zone per construction period in order to achieve low-energy and low-carbon building stock by 2050. Data required to run the thermal simulation sub-model are the technical characteristics of the building and its equipment including efficiency level of the building envelope as well as those of heating systems, appliances and lighting. However, given the lack of appropriate data on the Russian building stock, this sub-model could not be used in the scenarios presented below. Instead, a combination of literature review and expert interviews was used to assess the technical potential of energy renovations in Russia.

The MEPS level estimated by the thermal simulation building sub-model is then considered in the building stock sub-model. The data required to run the building stock sub-model include stock data obtained from the national housing surveys or censuses. The aim is to use a disaggregated description of the building stock at the country level by building segment, construction period, and climate zone. The model considers floor area, number of dwellings and number of buildings in the residential sub-sector, but only floor area and number of buildings in the non-residential sub-sector. The thermal building simulation sub-model and the building stock sub-model provide an estimate of the technical savings potential for the overall building stock over the pre-defined period of time; 2013–2050 for Russia.

Model iterations unfold as follows. The model uses a time-step of one year. Each year, a demolition rate is applied uniformly to all construction periods and all building segments:

$$a_{p,i,t} = (1 - \delta)\, a_{p,i,t-1} \tag{1}$$

where:

$a_{p,i,t}$ is the floor area of construction period p, within segment i, in year t

δ is the annual demolition rate

In each year, in each construction period, part of the stock is already renovated while the remainder is not yet renovated:

$$\forall p, \forall i, \forall t, \qquad a_{p,i,t} = r_{p,i,t} + \overline{r_{p,i,t}} \tag{2}$$

where:

$r_{p,i,t}$ is the floor area already renovated for construction period p, within segment i, in year t

$\overline{r_{p,i,t}}$ is the floor area not yet renovated for construction period p, within segment i, in year t

Each year, a renovation target is to be fulfilled, and is ventilated across the building stock by targeting the most inefficient dwellings first. The floor area renovated each year in each construction period and building sub-segment is calculated using equation 3:

$$r_{p,i,t} = \frac{\overline{r_{p,i,t}}\, e_{p,i}}{\sum_{segment} \overline{r_{p,i,t}}\, e_{p,i}} R_{i,t} \tag{3}$$

where:

$e_{p,i}$ is the average energy consumption per square meter before renovation for construction period p within segment i

$R_{i,t}$ is the floor area to be renovated in segment i in year t

The economic sub-model has two purposes: a) estimating the investments needed to achieve the market transformation of the building stock through the renovation of existing buildings and the construction of low energy buildings; b) assessing the impact of these investments on the overall economy. Investment needs are calculated using estimated labour and material costs by square meter for deep renovations. These costs are based on industry estimates for both the residential and non-residential sub-sectors. The economic impact of the renovation programmes is then evaluated through the use of input output analysis. An input-output model represents an economy using a "system of linear equations, each one of which describes the distribution of an industry's product throughout the economy" (Miller, 2009). It therefore enables the analysis of the interlinkage between different sectors of the economy.

For the purpose of this paper, only the residential sub-sector has been considered. The energy consumption considered was based on the metered total final energy consumption for all end uses provided by ROSSTAT, for both single and multi-family dwellings for each of the five construction periods considered by the Russian authorities for their existing building stock (see Table 2).

At this stage of the research, the economic analysis is limited to the estimate of investments needs because of the lack of available input/output tables for Russia.

Table 2. Building stock and energy consumption in Russia (based on ROSSTAT, 2010).

Construction period	Share of the total floor area	Average energy consumption per dwelling
< 1920	3%	13,184
1921–1945	5%	11,974
1946–1970	31%	18,241
1971–1995	44%	38,354
> 1995	18%	26,657

Table 3. New build construction in Russia, 2000 and 2003–2010 (ROSSTAT data).

	2000	2003	2004	2005	2006	2007	2008	2009	2010
Total number of residential buildings	110.8	119.8	121.3	131.0	148.7	194.6	208.9	217.2	200.5
Total residential floor area (million m^2)	36.4	43.4	49.3	54.8	62.3	74.5	79.2	72.5	71.6

Assumptions

The base year considered for total final energy consumption is 2010 as it is the latest year of available data for both the IEA and ROOSTAT.

We assumed that existing buildings are retrofitted to a total final energy consumption of 80 kWh/sqm/yr for both single- and multi-family buildings.

For new buildings, we assume that total final energy consumption for all end uses is reduced progressively from 300 kWh/sqm.yr in 2010 which is the average energy consumption per square meter in dwellings built after 1995, to 80 kWh/sqm.yr by 2020.

To estimate carbon emission reduction, we considered the CO_2 emissions factor calculated for 2010 (3.34 $MtCO_2$/Mtoe) constant until 2050 as no improvements to be made on the supply side have been announced.

Regarding the buildings stock, based on ROOSTAT data, in 2011, Russia's building stock included 3,229 billion sqm of residential buildings, with 2,374 billion sqm (72 %) in urban area and 924 billion sqm in rural area (28 %) (ROSSTAT, 2011). About 40 % of residential buildings are made of brick or stone.

Starting from early 2000s, the construction rate was quite high (Table 3); each year between 35 and 80 million sqm of additional new residential stock was built. Between 2004 and 2009 320.4 million sqm of residential buildings were constructed, which corresponds to about 10 % of all residential building stock in Russia.

The average living space per person is equal to 23 sqm and the average surface of new apartments in multi-apartment buildings is 83 sqm, while in single apartment buildings it is 140 sqm.

Based on our discussions with buildings stakeholders in Russia, we assumed 60 million sqm of new residential buildings are to be built every year from 2011 to 2050, with a ratio of single to multi-family dwellings assumed constant throughout the period. We also apply a demolition rate of 0.1 % for each construction period throughout the time-frame considered.

The full cost of renovation is estimated to be €156 per sqm in 2013. We assume an annual cost reduction of 2 % per year until 2050, stemming from productivity gains and an expected decrease in renovation materials cost. The average energy renovation cost over the period 2013–2050 is €107 per sqm.

Scenarios

For the purpose of this paper two different scenarios have been considered. For both scenarios we assume that an energy renovation will be made mandatory each time an ordinary, non-energy focused, renovation is conducted. From a policy perspective this would mean that the energy renovation of residential buildings would become mandatory starting from 2013 with the target to achieve a low energy residential buildings stock by 2050.

For new buildings we assume that starting from 2013, all new buildings move progressively towards low-energy buildings in both scenarios. Concretely, we assume that final energy consumption for all end uses in new buildings is reduced from its average for buildings built from 1995 to 2010, 300 kWh/sqm, to 80 kWh/sqm by 2020. This would entail that the building energy codes under revision would be performance-based and an overall final energy consumption of 80 kWh/sqm.yr would be targeted by 2020 for both single and multi-family buildings.

The Business As Usual scenario (BAU) is based on the current renovation rate (0.6 %), which remains constant over the period considered (2013–2050), while the Low-Energy Building (LEB) scenario is based on an increase of the rate of renovations from 0.6 % in 2013 to 0.8 % in 2015 with a progressive increase every year to reach a peak at 5.6 % in 2030 and then a progressive decrease going down to 0.6 % in 2050.

Energy savings, CO_2 emissions reduction and investment needs

In the BAU scenario with a constant annual energy renovation rate of 0.6 %, the final energy consumption of the existing stock built before 2010 will decrease from 111.5 Mtoe in 2013 to 80.5 Mtoe in 2050 (Figure 7). This will be equivalent to 17.4 Mt CO_2 annual emissions reduction (Figure 8) and will require on average €2 billion investments per year. In this scenario, only 24 % of the stock would be renovated by 2050 and the final energy consumption per construction period would vary from 350 kWh/sqm.yr to 260 kWh/sqm.yr.

The LEB scenario which assumes an increase of rate of energy renovation allows for the renovation of the entire existing building stock by 2050. The total annual final energy consumption of the existing building stock built prior to 2010 would be reduced by 81 % and would drop to 21.2 Mtoe in 2050 (Figure 7). CO_2 emissions would drop to 71 Mt CO_2 in 2050 (Figure 8). In the LEB scenario, nominal annual investments need increase from €2 billion/year in 2013 to reach a peak in 2030 at €19 billion/year while the average annual investment needed over the retrofit period is €16 billion/year (Figure 9). In the LEB scenario the overall existing stock, all construction periods combined will reach 80 kWh/sqm.yr by 2050.

In both scenarios, new buildings built after 2010 are considered to be built at a low energy consumption from 2020 onward, with a total annual final energy consumption of 16.3 Mtoe in 2050. In the LEB scenario, the energy consumption of the entire stock including new, low energy, buildings would be reduced by 66 % by 2050 compared to 2010. By 2050, these savings would represent 74 million ton of oil equivalent annually which is equivalent, on an energy basis, to 38 % of Russia's crude oil export in 2011.

Discussion and preliminary recommendations

In recent years, Russia has made substantive progress in the design of energy efficiency policies. A policy framework is already in place and clear institutional arrangements have been adopted and implemented. However, specific decrees to ensure effective implementation and sectoral approach are still missing. Also, an independent third party in charge of evaluating progress is still to be defined or established.

Russia has to address simultaneously the challenges of renovating the existing building stock and reducing the energy consumption of new buildings, due to its high construction rate.

Although Russia implemented its first building energy code in 1979, the entire existing building stock was constructed with little to no attention to the thermal performance of the building envelope and the efficiency level of appliances, lighting and equipment.

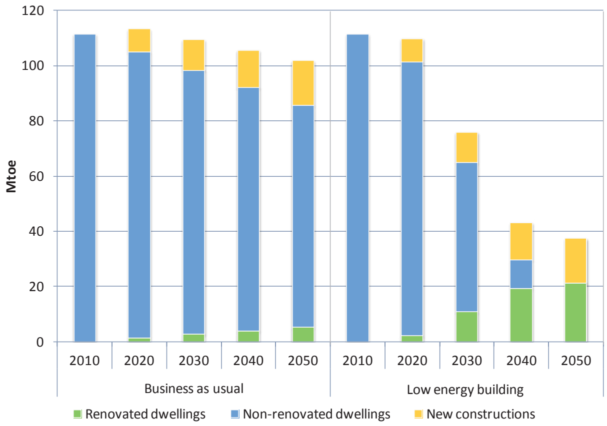

Figure 7. Total final energy consumption for all end uses of the whole stock by 2050 in each scenario.

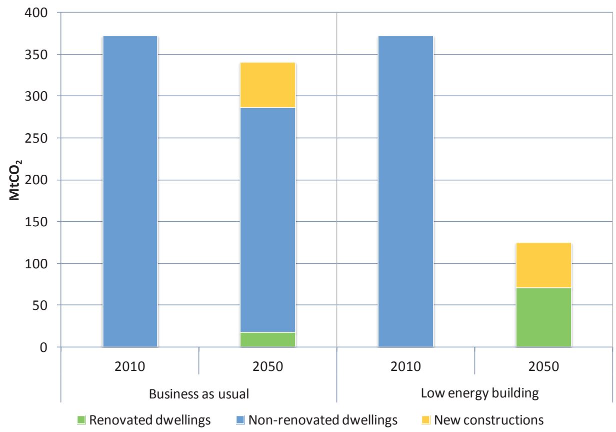

Figure 8. CO_2 emissions in each scenario.

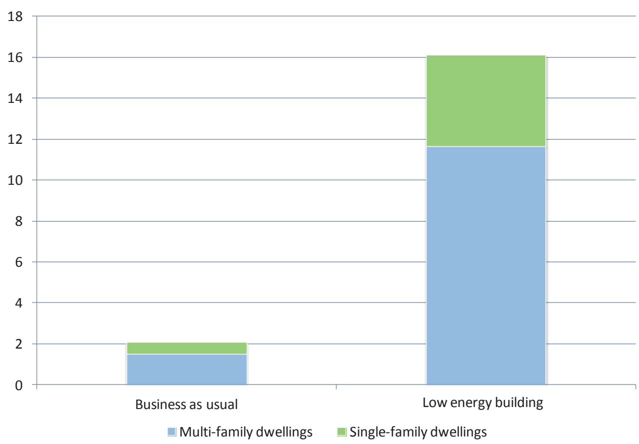

Figure 9. Average annual investments needs in billion Euro.

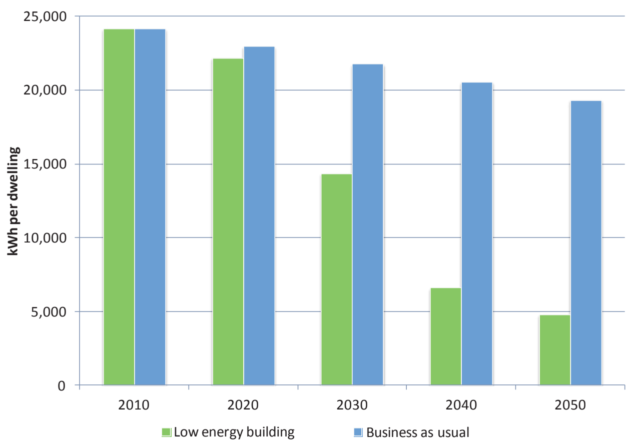

Figure 10. Average total final energy consumption for all end uses per dwelling.

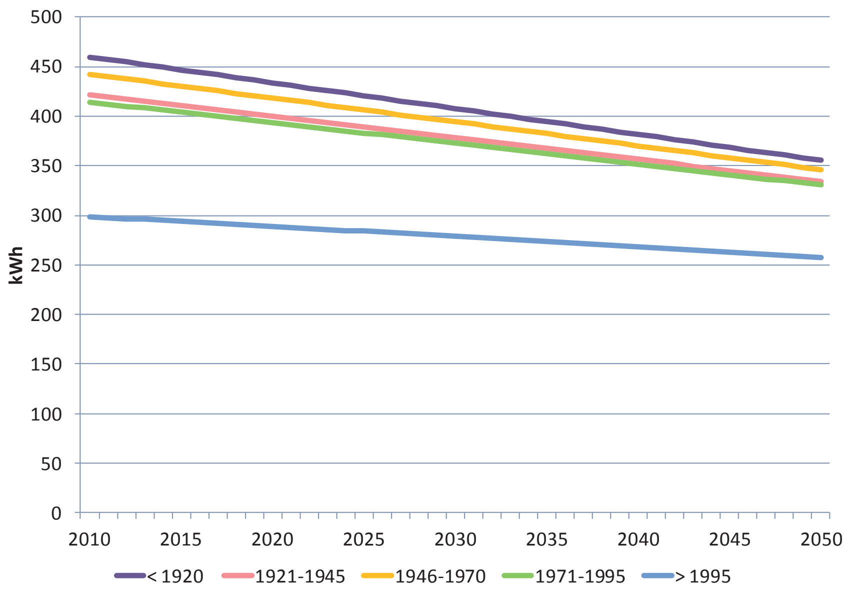

Figure 11. Final energy consumption per sqm for each construction period in BAU scenario.

During the Soviet period, the residential sector was highly regulated. The housing stock was predominately owned by the government and apartments were granted on the basis of waiting lists and could not be sold. This led to a permanent housing shortage. To solve this problem, the Soviet Union developed the so-called communal apartment model. In communal apartments, two or more families shared a common space, usually having one room per family. The model was designed for temporary occupancy, but in practice most communal apartments were occupied for decades by the same families. The law on "Property in the RSFSR" adopted in 1990 and the one on "the Privatisation of the Housing Fund in the RSFSR' adopted in 1991 was an opportunity for Russians to own their apartments. Privatisation took place on a voluntary basis, initially with a nominal payment, and subsequently, free of charge. The apartment property taxes were and have remained relatively low. Starting from 1993, the privatisation progressed very rapidly and almost doubled the share of private housing by 1999 (up to 63 %). By the end of 2011, around 86.3 % of Russia's residential housing was privately owned (ROSSTAT, 2011).

The privatisation of the residential building stock, without defining responsibilities and regulations for maintenance and renovation, further accelerated the deterioration of the building stock. Based on ROSSTAT data (ROSSTAT, 2011) 3 % (99 million sqm) of the total residential building stock requires urgent action. The Russian authorities acknowledge this urgency. Unfortunately, at this stage, the current definition of 'urgent action' doesn't include energy measures.

The main recommendation to the Russian government is to consider energy renovation when the urgent renovation will be undertaken as well as each time an ordinary renovation is undertaken (0.6 % annual ordinary renovation rate). This will allow building technical capacity and reducing the cost of energy renovation. The deepness of the renovation should be based on a cost-optimum analysis calculated over the overall buildings energy consumption, with a long-term perspective. The second recommendation is therefore to define energy reduction targets for the overall building stock by 2050 and for each building to consider the overall energy consumption.

For new buildings, the draft revision of the building energy code will need to be more ambitious. The new building energy code needs to be performance-based to maximise the savings potential and avoid the lock-in-effect. The overall performance building energy codes for both new and existing buildings need to be completed with stringent MEPS for appliances, lighting and equipment to ensure the best available technologies in the Russian market are installed each time equipment are replaced.

During the Soviet Union era, the renovation and maintenance of buildings was organized and financed by the government. Today, apartment owners are responsible for their own property and are supposed to organize and pay for their own renovations. However, regulations for tenant associations and condominiums do not exist. Further, given the ageing housing stock and population, renovation costs are high and retirement pensions cannot cover them. As a result, most owners are not able to invest in the renovation of their building. One of the options to achieve the renovation of the existing building stock is to implement market instruments to enable third-party financing. This is likely necessary in a market where residential energy prices are highly regulated and plans to remove subsidies cannot be included in the political agenda for social reasons.

To achieve its energy intensity reduction target, Russia needs to increase its current annual renovation rate and secure funding for the renovation of existing buildings through a renovation fund. This fund will guarantee loans to buildings industry stakeholders, thus removing the perceived riskiness of energy efficiency investments for commercial banks. A tax on energy exports revenues could be used to feed this renovation fund.

Overall Russia needs to develop a comprehensive policy package that includes a regulatory framework to make energy renovation mandatory and specifies the renovation rate needed to achieve its energy intensity reduction target; performance-based building energy code for both new and existing buildings; and a market framework that includes a renovation fund to enable energy renovation and ensure enough public funding is available to leverage private financing. The policy package should be based on a long-term perspective to avoid the lock-in effect. In other words, what Russia needs is an energy efficiency revolution.

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Glossary

IEA	International Energy Agency
Mtoe	Million tons of oil equivalents
REA	Russian Energy Agency under the Ministry of Energy of the Russian Federation
ROOSTSAT	Russia's Federal State Statistics Service
RSFSR	Russian Soviet Federative Socialist Republic
SBC	IEA Sustainable buildings centre
WEO	World Energy Outlook, annual IEA publication