Recent Advances in Energy Codes in Russia and Kazakhstan. Harmonization of Codes with European Standards

Yuri Matrosov
The Research Institute for Building Physics (NIISF),
Moscow, Russia
e-mail: yuri_matrosov@mtu-net.ru

A ten-year struggle in Russia over a new generation of building energy codes has recently culminated in the passage of a sweeping new federal energy code. This federal code employs approaches and locks in energy-performance targets of innovative regional codes adopted since the late 1990s, based on a model code developed by the author of this paper. These new codes are causing a major shift in the Russian building sector — a transformation without parallel in Russia's other industrial sectors — toward increased energy efficiency. The Russian market has undergone fundamental transformation toward production, sale, and use of energy-efficient building materials and products, and the use of new energy-efficient technologies. Kazakhstan has also started down the path blazed by Russia regarding energy codes.

The proposed article will discuss important recent developments in Russian and Kazakhstani building energy codes, including setting of energy-efficiency criteria and targets for buildings, and development of rating systems and new federal and regional codes embodying these targets. We also discuss oversight over the quality of design and construction, and monitoring of energy performance of buildings during operation. We close by discussing next steps in code development and implementation in both countries, and opportunities for further increasing energy efficiency.

Over the past 8 years we have informed readers of the development, step by step, of a new generation of codes and standards in Russia for energy-efficient buildings (see WEB www.cenef.ru/home-pg/hp-1r_fr.htm, then follow links to publications). The time has now come to reap the results. A new generation of codes has been **created and implemented successfully** at federal and regional levels. The system of codes includes

at the regional level:

codes in 50 regions of the Russian Federation, implemented between 1995 and 2004; and

at the federal level:

the new code "Thermal Performance of Buildings" (SNiP 23-02 [1],[1] adopted late 2003);

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[1] Throughout this paper, we will refer to Russian federal building codes and standards by their commonly used initials – SNiP means *Stroitelnye Normy i Pravila*, or Construction Codes and Regulations, and GOST means *Gosudarstvennye Standart*, or State standard.

- the code of practice (supplemental technical manual) “Design of Thermal Performance of Buildings” (SP 23-101 [2]);
- the standard “Microclimate Parameters in Residential and Public Buildings” (GOST 30494 [3]);
- four standards on building energy audits (GOST 31166 [4], GOST 31167 [5], GOST 31168 [6], GOST 26254 [7]);
- a standard on the detection of concealed defects of building thermal insulation (GOST 26299 [8]); and
- sections entitled “Energy Conservation” and “Sanitary-Epidemiological Requirements” in two new residential codes (SNiP 31-01 [9] and SNiP 31-02 [10]).

All the documents mentioned above have been officially adopted by the relevant authorizing agencies, have entered into force, and are mandatory. In accordance with the new Russian Federation law “On Technical Regulation,” all GOSTs and SNiPs adopted before the passage of this law will carry mandatory force for 7 years, after which they will become recommended. Regional codes will be in force beyond that time as mandatory documents.

Energy Savings and Market Changes to Date

The results of implementation of this system of codes are evident. Under new regional and federal codes over the past 8 years, energy consumption for heating in newly constructed and renovated buildings has been reduced by 35 to 45 percent, depending on building type. According to data from Gosstroy RF, already 6 percent (170 million sq. m) of the entire residential building stock of Russia complies with the requirements of new codes. There has been a transition from universal use of single-layer and three-layer wall-panel construction to monolithic frame construction with external insulation and unventilated and ventilated facades and light thermal insulation materials. Building designs with widened frames (up to 22-25 meters, in comparison with 12 meters previously) have become widely used. Types of light porous concrete have also been in use. Factories that produce concrete wall panels have made the transition to producing a great variety of products. Buildings made of these components do not differ in outward appearance from monolithic-frame buildings. Meanwhile, in terms of cost, external walls made of panels with triple the thermal performance of previous wall types are also 10-15 percent less expensive than those previous types — for example, in the wall-panel plant in Yakutsk and Tomsk. At the same time, windows with sealed glass units with low-reflectivity glazing and composite wood or plastic frames have begun to be used as well.

One can make an assessment of the effect of code implementation on energy use by considering volumes of residential construction. According to 2002 data, Russia introduced about 14.3 million square meters of single-family low-rise homes and about 19.5 million square meters of multistory multifamily buildings, for a total of 33.8 million square meters of new residential floor area in Russia overall. We have calculated the energy-saving effect as the difference in energy consumption for heating for this volume of buildings built in compliance with 1995 codes, versus those built in compliance with the new system of codes, and calculate a final saving of heat energy of about 11.3 exajoules for residential buildings. If we assume that heat supply systems are 50 percent efficient on average – that is, half of the energy in primary fuel is converted into useful heat energy, with the other half lost en route to the end user — then the energy-saving effect in terms of primary fuel is calculated at almost 23 EJ in 2003, or about US $46-50 million. Annual figures grow cumulatively over a 10-year period up to 1,260 EJ assuming constant construction volumes, and under constant energy prices, reflect a savings of US $2.4 billion. If we assume a 5% growth in residential construction volume, which is highly realistic, then the dollar savings grow to US $2.9 billion.

The New Russian Federal SNiP

The new federal code adopted in 2003 locks in energy savings embodied in regional codes, implements innovations from these regional codes, sets forth additional new elements, and of course, dramatically expands geographic coverage of codes from selected regions to the whole country. Gosstroy of Russia adopted this code by executive order №113 in June 2003, and the code [1], entitled "Thermal Performance of Buildings," entered into force on October 1, 2003. The new code replaces the previous federal SNiP "Thermal Engineering for Buildings," which despite major modifications between 1995 and 1998, still had a variety of deficiencies, in content as well as form.

The new SNiP "Thermal Performance of Buildings" seeks to address these deficiencies by:

- establishing numerical values for required performance targets, corresponding to world levels;
- classifying new and existing buildings according to their energy efficiency;
- encouraging buildings that are more efficient than required by code;
- creating a mechanism for identifying low-performing existing buildings and mandating necessary upgrades;
- developing design guidelines for both prescriptive and performance-based compliance paths; and
- developing methods for oversight and enforcement of compliance in terms of thermal performance and energy efficiency (energy passports), during design, construction, and prospective operation phases.

In its general principles, the new SNiP "Thermal Performance of Buildings" is a completely new document in terms of structure, applicability, criteria, oversight and enforcement, computer-compatibility, linkages with energy audits for operating buildings, harmonization with European standards, and in light of all these factors, its very name. Still, the new document maintains continuity with the code it replaced, and provides for equivalent levels of energy efficiency, while offering wider technical options for compliance. Below we summarize the general principles of the new federal code.

Performance criteria

The code establishes two means for achieving compliance:

a) a prescriptive path, with required thermal resistance values for individual building envelope elements; these values have been defined so as to be consistent with whole-building specific energy consumption requirements, and have been retained from the former SNiP for continuity;

b) a performance path, with required specific energy consumption levels for heating the whole building, allowing for tradeoffs in the energy performance of individual envelope elements (except the buildings for industry), taking account of heating controls and heat-supply system efficiency.

The choice of which of these options to use is left to the owner and/or designer. Methods and paths for achieving these requirements are chosen during the design process. Prefabricated buildings may achieve compliance only via the prescriptive path.

In calculations of design whole-building energy performance, indoor air temperatures are set at the lower limits of optimal ranges. A new standard, GOST 30494-96 [3] “Residential and Public Buildings. Microclimate Parameters for indoor enclosures,” has been developed at our initiative and with our participation, in order to define these temperature input data. In accordance with this standard, design indoor air temperature is set at 20 ^{o}C instead of the previous 18 ^{o}C. The resulting change in temperature differences near cold surfaces has been taken into account and applied to new code requirements for windows.

Classification and rating buildings on the basis of energy performance

The new federal code, in contrast to previous codes, applies not only to new and renovated buildings, but also to existing buildings already in operation, with instructions for evaluating and monitoring thermal-performance and energy parameters during both design and operation.

Figure 1 shows a set of rating categories based on the degree to which design or normalized measured parameters for specific energy consumption deviate from required values from the new code. This classification applies both to newly construct and renovated buildings designed according to the new code, as well as to operating buildings built according to previous codes, even those from before 1995.

Buildings whose designs have been developed according to the new code can be assigned to classes ***A***, ***B***, and ***C***. In the process of real operation, the energy efficiency of such buildings may deviate from design data into better classes (***A*** or ***B***) within the limits shown in Figure 1. Where classes ***A*** and ***B*** are earned, the use of economic incentive measures by local government agencies or investors is recommended.

Classes ***D*** and ***E*** apply to operating buildings, built under codes in force at the time of construction. Class ***D*** corresponds to code-compliant levels from before 1995. These classes give information to local government agencies or building owners on the necessity of immediate or less immediate measures for increasing energy efficiency. Thus, for example, for buildings falling into class ***E***, energy-efficiency renovation is urgently required.

Specific actions regarding the rating of existing buildings, awarding of incentives, requiring upgrades, and levying sanctions are left to regional and municipal agencies, which are responsible for enforcing the federal code.

Figure 1: Classes of Energy Efficiency for Buildings

Letter grade and graphical representation	Name of the class	Deviation of design or normalized measured specific energy consumption from code-stipulated level, %	Recommended measures
	For new and renovated buildings		
A	*Very high*	less than –51	economic incentives
B	High	From -10 to -50	as above
C	**Normal**	from +5 to –9	-
	For existing buildings		
D	Low	from +6 to +75	Renovation desirable
E	*Very low*	greater than +76	Upgrades urgently required

Taking account of building geometry

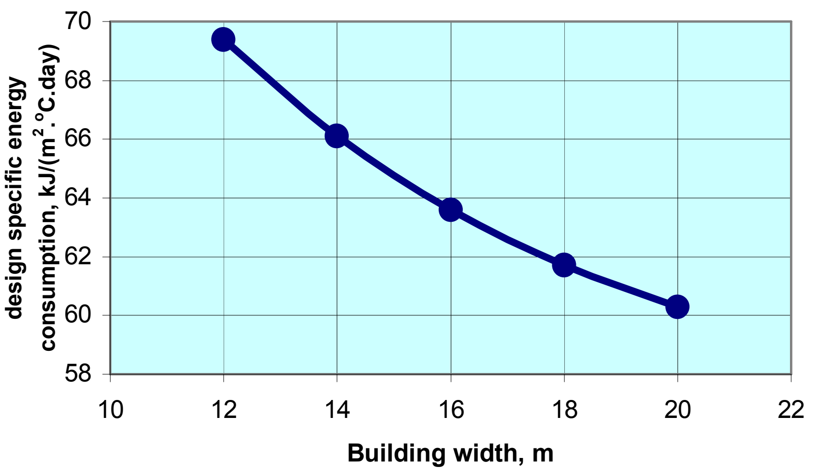
The geometric form of the building has a real influence on energy consumption. In Figure 2, the influence of the width on the building on reduction in specific energy consumption is shown for a nine-story three-section residential building in the city of Orenburg. In this light, geometric criteria for the building compactness have been included in the new SNiP 23-02, as the ratio of the building envelope surface area to the volume that it encloses. The necessary reduction in energy consumption will be achieved by means of building geometry where the following criteria are met: 0.25 m^{-1} for buildings 16 stories tall, and higher; 0.29 for buildings from 10 to 15 stories; 0.32 for buildings from 6 to 9 stories; 0.36 for 5-story buildings; 0.43 for 4-story buildings; 0.54 for 3-story buildings; 0.61, 0.54, and 0.46 for two-, three-, and four-story black or sectional buildings, respectively; 0.9 for two-story and single-story buildings with mansards; and 1.1 for single-story buildings. (This parameter has been used in German codes since 1975.)

Quality control and energy audits

The new SNiP also requires the performance of quality control for the thermal insulation in every building by means of thermographic testing, in accordance with GOST 26629 [8] "Method of thermo vision control of enclosing structures thermal insulation quality," upon the building's entry into operation. Such oversight helps to reveal hidden defects and means to remedy them before the departure of the construction crew from the site. The new SNiP also requires selective monitoring of air permeability of the inhabited areas of buildings entering into operation, in accordance with the new GOST 31167 [5].

The new code also has a section on building energy audits, which are defined as a sequence of activities intended to determine the energy efficiency of the building and to assess measures for increasing energy efficiency and energy conservation. The results of energy audits are used for general classification and certification of buildings according to energy efficiency.

Figure 2. Change in specific energy consumption depending on the width of a residential building (9 stories, 3 sections) in the city of Orenburg



The specific elements of an energy audit depend on how the task is defined. For example, an energy audit may be carried out with the goal of rating the building in terms of energy efficiency in accordance with the new SNiP or regional code. The goal of such a step for government enforcement agencies is to reveal those buildings that must urgently be renovated from an energy-efficiency point of view. The other type of energy audit is carried out with the goal of energy-related certification of the building. In this case, the goal is to document that the operating building complies with various code requirements.

In order to confirm that the specific energy consumption for heating for an existing building already in operation corresponds to code-stipulated values and oversight requirements of the new SNiP, three new standards have been developed by a broad team of participants, including ourselves, and confirmed by Gosstroy of Russia in 2003:

GOST 31166 [4] “Envelop constructions of buildings and structures. Method for calorimetric determination of the heat transfer coefficient.”;

GOST 31167 [5] “Buildings and Structures. Method for determination of air permeability of buildings envelops in field conditions.” (made consistent with ISO 9972);

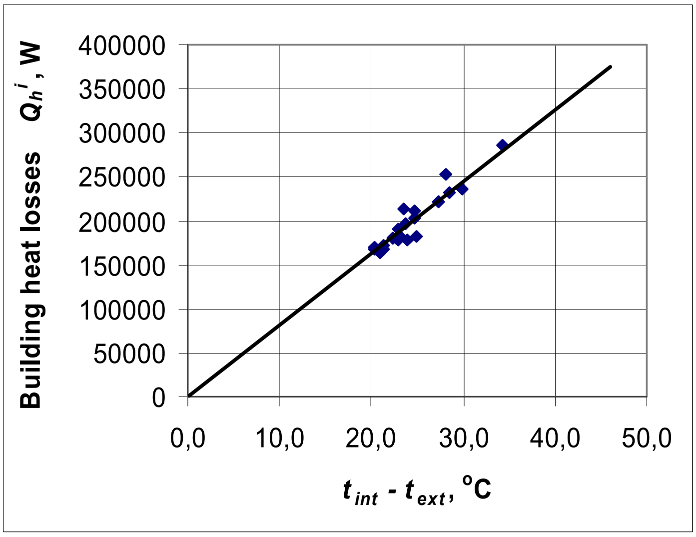
GOST 31168 [6] “Houses. Method for determination of specific heat consumption for building heating.”

The latter two standards are fundamental, providing a method for oversight over parameters shown in compliance documents and energy audits for existing buildings.

These standards have also been adopted in the Republic of Kazakhstan.

The essence of the method for determining specific energy consumption for heating is that during the heating period, over predetermined intervals, energy consumption, average indoor and outdoor air temperature, and the averaged intensity of incident solar radiation on horizontal surfaces are measured, either for occupied areas (such as a single apartment) or a whole building. For the same intervals, values are calculated for overall heat losses through the building envelope, equal to measured energy consumption plus internal and solar gains. Then, for calculated heat losses and corresponding temperature differences between indoor and outdoor air temperature, one can generate a linear regression reflecting the greatest fit to these data (see Figure 3). According to this linear relationship and the internal dimensions of the premises and of envelope elements, one determines the overall coefficient of heat transfer through the building envelope and the specific energy consumption for heating, and also can assign an energy-efficiency classification to the building.

Figure 3 Functional relationships between building heat losses and temperature difference between indoor and outdoor air



Monitoring of energy performance of the eleven storied residential building during preparation (see Figure 4) was conducted on March, 2004. The building is built according to the Swiss technology by the "Plastbau" system.

The result of the study is shown in Figure 3. Using the metering data (see the rectangle points in Figure 3) the total heat transfer coefficient of the external building envelops, is equal to 1.044 W/(m^2·°C), was calculated. For comparison, the design value of this coefficient is equal to 0,993 W/(m^2·°C). Thus, obviously the real value of the total heat transfer coefficient practically coincides with the design value. The specific heat energy consumption during the heating season was also calculated by GOST 31168 and is equal to 70,33 kJ/(m^2·°C·day). This energy consumption is a little bit lower than the code-regulated value which is equal 72 kJ/(m^2·°C·day). According to building classification on the figure 1 this building is regarded as a "normal".

Figure 4. The residential building for the monitoring of energy performance

Regional Energy Codes

The legal basis of the regional codes in Russia is set forth in Article 53 of the "Civil Construction Codex of the Russian Federation." At present, 50 regional codes have been adopted and confirmed by Gosstroy RF, and 3 more are in the stage of final editing. See Figure 5.

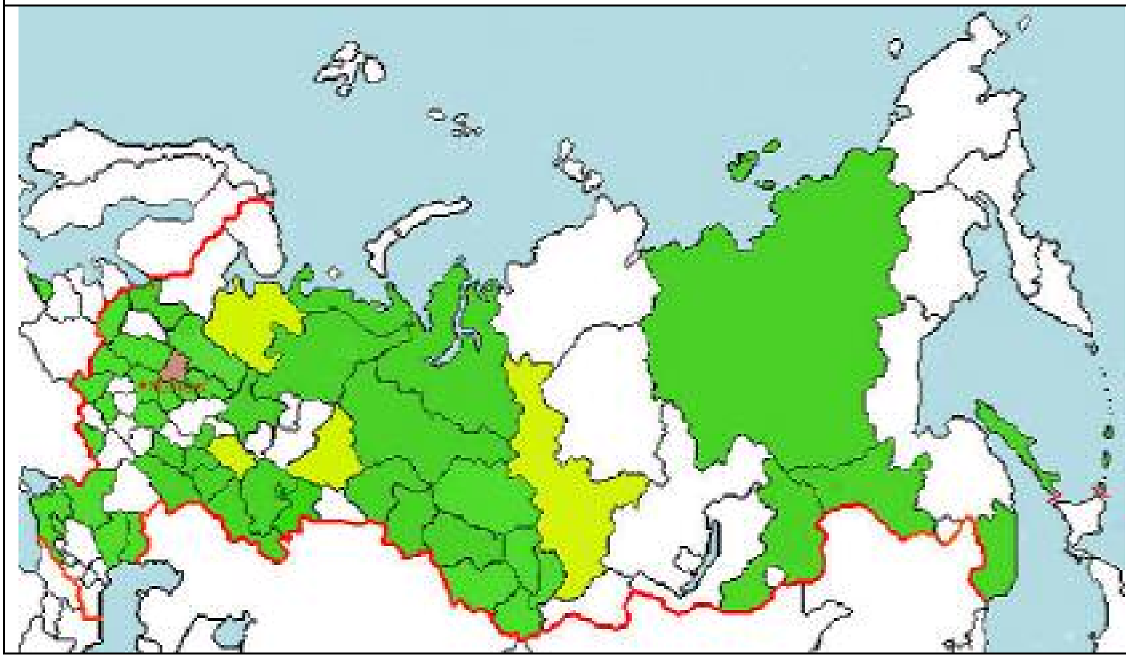
Regional codes are mandatory for all Russian and foreign entities involved with construction in the given region, even in isolated cases where federal codes do not apply. All regional codes are developed according to criteria described above – they may be consistent with federal codes, or more stringent. Regional codes also contain detailed climate parameters not contained in the federal code, including heating-season degree days and solar radiation under real cloud conditions. In a few regions, climate data are provided on a district-by-district basis.

Energy Passports

The new federal SNiP and regional codes require the completion of an «Energy Passport» for the building, a document intended to verify energy performance in design, construction, and operation. Energy Passports also give potential buyers and resident's information on what they can expect regarding the building's energy efficiency and real costs, helping to stimulate market preferences for high-performance buildings.

During construction, there are often deviations from design – for example, a change in material or components. As a rule, these deviations must be allowed by the design organization. But in practice, there do exist cases where the construction company carries out unsanctioned changes from the original design. Therefore, upon the building's entry into operation, regional codes require that the design organization complete a second, updated Energy Passport with the same goals and content as the one completed during design.

Figure 5. Regional Codes in Russia, 2004



Note: Regions with dark shading have their own codes. Regions with light shading have codes in the final stages of editing.

For existing buildings, the new federal code and regional codes require selective inspection and review to determine compliance with relevant codes, or to assess the need for renovation. The results of this review must reflect technical, energy-related, and thermal aspects, as well as technical and economic analysis of options for renovation.

To help ensure quality in energy-related aspects of building design, the new federal code and regional codes also require the preparation of a special section of the building design, entitled "Energy Efficiency." This section must include summary parameters for energy performance for various parts of the building design. These parameters are presented side-by-side with code-required values. The section is completed at review stages for pre-design and design documentation. The design agency completes the section; funding the work is the owner's responsibility; as necessary, the owner or designer may choose to engage the services of outside specialists.

In issuing final approvals, regional or municipal plan review agencies must specifically confirm the compliance of the pre-design and design energy-efficiency documentation with relevant codes.

Computer tools

To facilitate and standardize calculations, a PC version of the Energy Passport has been developed. This version enables quick calculations, iterative assessment of design variants, and comparison with code values at all stages of design, construction, and operation. It is available upon request to interested organizations.

Three other programs for PC are available, intended to facilitate thermal-engineering calculations in the design of building envelopes. The first program enables the user to carry out complex calculations of envelope performance under conditions of steady-state linear heat transfer, as described in the federal supplemental guidance manual, and helps to verify compliance with code-required values for thermal resistance, thermal stability, air permeability, vapor permeability, and thermal assimilation of floors.

The second and third programs define the overall thermal resistance of heterogeneous elements with two- and three-dimensional temperature fields, under conditions of steady-state heat transfer.

Harmonization of codes with European standards

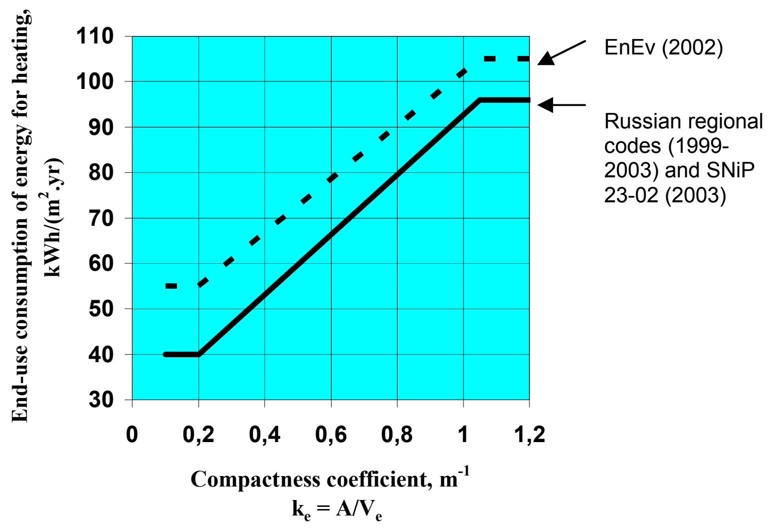
The new federal SNiP and regional codes are consistent with international levels and in particular, with the requirements of EU Directive (law) №93/76 SAVE [11] and EU resolution №647 [12] on a long-term program for energy efficiency in buildings, with the new German executive order EnEV 2002 [13], and with the new EU Directive [14] on energy-efficiency indices for buildings. In terms of approach, the Russian codes even go beyond those of EU countries. It is interesting to compare the code-required energy performance targets of Germany and Russia; German codes stipulate targets that fall between 40 and 96 kWh/(m^2·yr) for baseline heat-supply systems. Values from Russian regional codes and the new federal SNiP, adjusted to Germany's climate conditions fall between 55 and 105 kWh/(m^2·yr). See Figure 6. German codes are clearly more stringent - by 20 to 27 percent for multifamily residential buildings, and 9 to 10 percent for single-family homes.

The Codes are take account according to EU directive on the energy-performance of buildings:

- a system approach to the buildings and the total energy use for heating;
- an energy declaration / energy passport for the energy certification;
- the measures in both new and renovate buildings;
- a general principle of methodology for calculation to obtain the overall energy performance of a building including energy for ventilation, internal heat gain and solar radiation;
- an efficiency of heat supply system;
- a thermal comfort.

  The Codes are not taking account (except Code for Moscow):
- a domestic hot water supply;
- an artificial lighting.

Figure 6. Comparison of Required Energy-Performance Levels of Russian Regional and Federal Codes, and Germany's EnEV-2002



Codes of the Republic of Kazakhstan

New codes have also been developed (SN RK 2.04-21 [15], adopted on May, 2004) in the Republic of Kazakhstan (RK) — one of the most successfully developing central Asian republics of the post-Soviet sphere. The rate of GDP growth of this republic over the past few years has not fallen below 10 percent per year, in comparison with 5 percent in Russia. Thanks to economic reforms and liberal laws, foreign investment in this republic has grown without cease, especially from western countries. The building sector is also growing mightily. But the RK has practically no base of codes of its own for the building sector. Buildings are being built in accordance with the expertise of construction companies hired by the future owner or investor, often according to the codes of the country where hired companies are based, or according to Russian codes. In this light, the government of the RK has set forth a goal of creating its own code for energy efficiency in the building sector and of including in these new code performance targets for civilian buildings that correspond to world levels, as well as methods for oversight and enforcement.

We have been developing this code in close collaboration with the Department of Technical Codes and New Construction Technologies of the Committee for Construction Affairs of the RK, under the support of the U.S. Environmental Protection Agency.

The table on figure 7 below presents required target values for area-specific consumption of energy for heating buildings, as proposed for the RK code, in comparison with levels implied by codes in force between 1980 and 1995.

In establishing target values for energy performance, we proceeded based on a criteria of 40 percent reduction of energy consumption relative to the average level of energy consumption of existing buildings in the republic, assuming connection of buildings to a baseline (centralized) heat-supply system. The average republic-wide level was defined based on Russian construction standards that were in force in the RK between 1980 and 1995.

Figure 7

Specific Energy Consumption for Heating Permitted by Building Codes in Kazakhstan, kJ/(m^2·^{o}C·day) [kJ/(m^3·^{o}C·day)]								
Building type	**Number of stories**							
	1-3		**4-5**		**6-9**		**10 and higher**	
	1980-1995	**2004**	1980-1995	**2004**	1980-1995	**2004**	1980-1995	**2004**
Residential	192	**135**	158	**90**	133	**83**	117	**75**
Educational and Office Buildings	[70]	**[38]**	[55]	**[33]**	[50]	**[30]**		
Medical facilities	[57]	**[34]**	[52]	**[31]**	[50]	**[30]**	--	**--**
Preschools	[75]	**[45]**	--	**--**	--	**--**	--	**--**
Offices	[60]	**[36]**	[45]	**[27]**	[39]	**[23]**	[33]	**[20]**

The expected effect in the first year of code implementation in the RK is almost 600 TJ in avoided energy consumption, and the cumulative effect through 2013 is projected at 33000 TJ. This energy savings implies a reduction in carbon dioxide of close to 600,000 tonnes.

Pilot design according to the draft RK code

Our project team has scarred out a pilot design according to the draft of the new RK code for a ten-story residential building in the educational-scientific complex for "KazGYuU," which will be built on the left bank of the Ishim River in Astana. The design is at the stage of initial sketches.

The general appearance of the building is shown in Figure 8. The designed building consists of four sections and 10 stories, the first of which is nonresidential and intended for an array of service facilities. Construction of the building is monolithic-frame from reinforced concrete, without crossbeams. The attic and crawlspace are unheated, and the floors are directly on the ground. Exterior walls are made of brick with efficient insulation, windows with triple-glazing and paired-sectional frames. Glazing constitutes 18 percent of the surface area of the walls, as permitted by code. The building is connected to centralized heat supply. The energy-efficiency class of the building is normal.

Results of the pilot design

The results of calculations are presented as the components of the heat balance of this building, in Figure 9. The figure shows the following parameters: Q_h^y – overall energy consumption for heating, Q_t – transmission heat losses, Q_v – heat losses via air leakage, Q_i and Q_s – internal and solar gains. From the figure, one can see that the greatest heat losses are through the envelope (Q_t), which is related to the architectural form of the building. Russian building design experience in compliance with regional codes shows that usually, transmission heat losses $\boldsymbol{Q_t}$ are comparable in terms of absolute values with heat losses via air leakage and with internal and solar gains.

Figure 8. The pilot building design

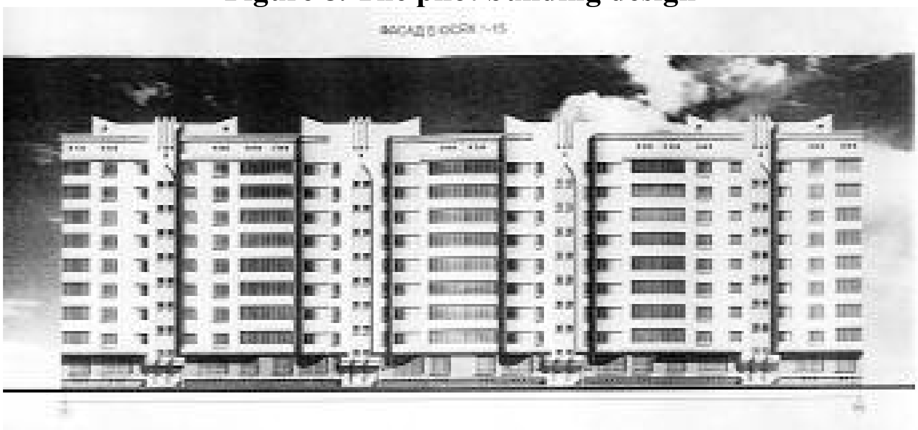
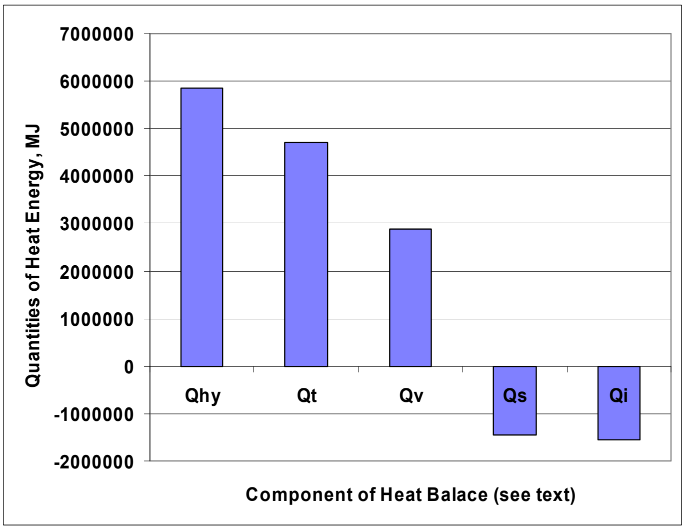


Figure 9. Heat balance
for pilot design of building compliant with new RK Code



Having analyzed the results, we can draw the following conclusions. The building's geometry and floor plan do not comply with the recommended values for compactness coefficient from the RK code – the proposed design of the pilot building has a compactness coefficient of 0.33, while the recommended value is 0.29. This implies that the architectural plan is not sufficient in terms of energy efficiency, though it is permitted by code. This deficiency requires compensation with increased thermal performance of the envelope.

From the thermal-engineering parameters chosen for the design, we get the following code requirements for envelope elements: for walls, 2.65 $m^2 \cdot {}^oC/W$; for windows, 0.55 $m^2 \cdot {}^oC/W$; attic floors, 4.73 $m^2 \cdot {}^oC/W$; ground floor 3.23 $m^2 \cdot {}^oC/W$. For compliance with these requirements, the following wall types would be recommended (layers listed from exterior to interior):

- cement-sand plaster 20 mm thick;
- a red brick layer 250 mm thick;
- a stiff mineral-wool plate 180 mm thick;
- fiberglass netting;
- lime or polymeric plaster 10 mm thick.

Another variant was also considered, involving a change to more efficient windows made of a single-space sealed glass unit and glass with a hard selective coating in separate frames, with a thermal resistance of 0.65 $m^2\cdot{}^oC/W$. In this case the requirement for thermal resistance of walls would then fall to 2.25 $m^2\cdot{}^oC/$, equivalent to a wall with a mineral-wool plate 150 mm thick – that is, 30 mm thinner.

The pilot test of the RK building confirms the real practicability of the proposed codes.

What Next?

Reduction of energy consumption in the building sector is a complex problem, the most important element of which is designing and verifying thermal performance. Over the next ten years, further improvements in envelope thermal performance will probably not be readily achievable; instead, further savings will come from more efficient ventilation systems (systems that deliver air on demand, heat recovery from exhaust air, and so on) and from improved control systems, including nighttime automated temperature setback. Furthermore, perfection of an algorithm for calculating energy consumption in public (nonresidential) buildings is also needed.

Performance-based code-compliance methodologies for prefabricated buildings are needed, though heat losses through the envelopes of these buildings is relatively small compared with inefficiencies of HVAC systems. The other part of the heretofore unresolved problem is determining the level of thermal performance for buildings with mechanical cooling. Future code methodologies will also be developed in this area. In this case, the level of thermal performance required from the point of view of energy efficiency may be higher, than determined based on heating alone. This means that for northern and central regions of Russia, code requirements may be based on heating considerations alone, but in southern regions, requirements may be driven as much (or more) by cooling as for heating. It will evidently be worthwhile too to create integrated code requirements for energy consumption for domestic hot water, electricity consumption for lighting and other needs, and also for gas – thus leading to a code that is based truly on whole-building energy performance.

Conclusion

- A new generation of codes has led to real results in design and construction of efficient buildings, and accompanying standards have helped clearly define key parameters for code-compliance inputs and assessment of energy performance of operating buildings. New code methodologies were first approved and implemented in great numbers at the regional level in Russia; the experience gained from regional codes has confirmed the applicability of these new approaches, and has made possible the development of codes with similar innovative elements at the federal level in Russia and in Kazakhstan. There is no precedent for such change in codes in Russia, Kazakhstan, or the former USSR.

- New codes have made a wider range of compliance options available to designers, including building geometry as well as selection of materials, components, and heating systems, thus leading to improved overall building design quality. But taking advantage of these options requires more effort and expertise. To simplify the use of the performance approach, the Energy Passport was developed. Designers have met this documentation system and its computer version with enthusiasm, and in general, complaints about the complexity of new codes dissipate after demonstration of automated compliance calculations.
- The principal methodological basis of the new codes and their basic requirements are consistent with advanced international levels, and these codes are harmonized with European codes and standards.
- Russian codes and standards for energy efficiency, despite pessimistic predictions, have created conditions for market transformation for new construction technology, have made possible a construction boom, have increased employment, have led to real energy savings, and have increased indoor comfort.

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Yuri Matrosov
(7095)4823710
Chief of Laboratory of Energy Conservation
and Indoor Climate in Buildings
Research Institute of Building Physics (NIISF)
21, Lokomotivny proezd
127238 Moscow Russia